RRC Business Training

NEBOSH

International General Certificate

in occupational safety and health

THE COURSE WRITER

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INTRODUCTION

Most people would agree that poor working conditions of any type have the potential to affect a worker's health and safety. It would also be agreed that our aim should be to eliminate or at least minimise the risk of accident or injury; and to protect workers from the effects of ill-health caused by their working conditions. However, those aims are not that simple to achieve in practice.

Take almost any country in the world and people are still killed either at work or as a result of work activities; many more have non-fatal injuries at work or suffer from work-related ill-health.

The cost of workplace accidents or diseases is very high. There is both a direct cost to the employer in lost working time, medical costs, repair or replacement of equipment, etc., and also a much higher indirect cost which affects the injured or sick workers and their families.

This unit sets out a framework of health and safety by looking at the practical, moral and financial issues surrounding the goal of a safe workplace environment, and the legal and organisational framework which seeks to ensure that goal. In doing so, the unit is designed to meet the following aims and learning outcomes as specified by NEBOSH for this part of the syllabus for the International Certificate.

Overall Aims

On completion of this unit, you should understand:

- The scope and nature of occupational health and safety

- The moral, legal and economic reasons for promoting good standards of health and safety within an organisation

- The role of national governments and international bodies in formulating a framework for the regulation of health and safety

- The basis of a system for managing health and safety

- The costs of failing to manage health and safety.

Specific Intended Learning Outcomes

When you have worked through this unit, you will be able to:

- Explain briefly the moral/social, legal and economic bases for maintaining good standards of health and safety

- Outline the roles and responsibilities of employers and workers

- Identify sources of information on health and safety

- Outline the key elements of a health and safety management system.

THE NATURE AND SCOPE OF HEALTH AND SAFETY

Health and safety at work is based on an understanding of the causes of accidents and other events at the workplace which lead to harm to workers and others who may be close by. In general terms, though, this is perhaps not as easy as may at first be thought.

The Multi-Disciplinary Nature of Health and Safety

The roots of a systematic approach to health and safety lie in the development of large-scale manufacturing operations. In the past, factory machinery was operated with little or no regard to the safety of workers and it was far from uncommon for factory staff (including young children) to suffer bodily injury from unguarded machines. Reacting to these effects, the causes were addressed by concerned factory owners and politicians, allied to increasing pressure from workers themselves, by putting in protective measures (such as machine guards) and developing safer working practices.

As scientific knowledge has grown and political and social concern over workplace health and safety has broadened, the effects of work have been studied extensively. The range of issues identified, which started with those clearly identifiable physical injuries such as losing fingers or arms, has widened to include less apparent injuries (such as deteriorating eyesight and bad backs) and illnesses (both physical and psychological), which very often build up over time, rather than being caused by a single incident. The causes of these problems themselves are often not easily identifiable.

Occupational health and safety today, then, has moved a long way from its engineering roots and brings together a wide range of subject specialities to investigate what the ill-effects of work are and what causes them. It draws on the study of both the physical world – chemistry, physics, biology, etc. – and the social world, of how and why people behave as they do. As a health and safety practitioner, you would not expect to be familiar with the detail of all these subjects, but should be aware of the range of different disciplines which contribute to knowledge and understanding of health and safety issues. These include:

- Chemistry and physics, which explain the properties of different substances and the ways in which they behave in different circumstances – for example, electricity, explosive or flammable materials, acid, etc.

- Biological sciences (including toxicology, hygiene and medicine), which explain the composition and processes of living organisms – for example, the effects of harmful organisms on people, the responses and reactions of the human body when under physical stress, etc.

- Engineering, which is responsible for the construction of buildings and mechanical processes – for example, the safe design of machinery and vehicles, fireproofing buildings, etc.

- Psychology, which attempts to explain the behaviour of the individual – for example, the effects of stress on the mind, the motivation behind the behaviour of individuals and groups at the workplace, etc.

- Sociology, which attempts to explain the behaviour of people in groups – for example, management processes, patterns of work, communication in organisations, etc.

- The law, which contains the rules and regulations of society – for example, the mass of law which deals with workplace activities.

Obstacles to Good Standards of Health and Safety

As we have noted, health and safety is based on removing, or minimising, the causes of accidents and other events in the workplace which may have adverse effects on workers. It should be clear now that this cause-and-effect relationship is not always easily identifiable and, as the processes and activities in the workplace continue to develop, that the complexity of the problem is a continuing obstacle to good standards of health and safety. However, other obstacles arise from the nature of the workplace itself – the characteristics both of the organisation within which work is carried out (including private commercial businesses and public sector bodies) and of the people who carry out the work.

Complexity of the Problem

We can see three ways in which the issue of health and safety in the workplace is far from simple.

- **The cause-and-effect relationship**

  Whilst this is self-evident in respect of certain events – for example, dropping a still-burning cigarette into a wastepaper basket can cause a fire – there are many ill-effects suffered by people at work for which there is no readily identifiable cause or, where there is an identifiable cause, its relationship with the effect does not seem to be straightforward. For example, in some offices, workers have suffered from a variety of symptoms such as headaches, or eye, skin, nose and throat irritations, etc. where there is no one apparent cause. Rather the problem is attributed to "sick building syndrome" – a general term which may cover a whole variety of causes, including the lighting, air-conditioning, presence of static electricity, etc. Another example is that of work-related upper limb disorders (WRULD for short, or, as it was often known in the past, repetitive strain injury or RSI), which affect some workers using computer keyboards but not others.

  In general, these issues may be resolved by increasing our scientific understanding of the nature of the injury or harm, and the ways in which the working environment acts to cause them. Thus, the incidence of lung disorders among certain workers was only attributed to the workplace when the link between asbestos exposure and such health problems was established, and since then there have been ever stricter controls over the use of the substance.

- **Work processes and activities**

  In many western countries, the last 30 years has seen a revolution in the way in which work is carried out and the type of work which is undertaken. In the main, this has been fuelled by technological change – primarily, the computerisation of manufacturing and information processing – and the drive for increased efficiency and productivity to keep costs down in the face of increasing competition.

  The effects include an increase in the range and complexity of activities, the speeding up of operations and changes to the traditional patterns of organisation and management. Thus, the increasing complexity of the modern workplace has perhaps increased the range of hazards and risks.

- **Extent of the problem**

  It may be argued that as the hazards and risks to health have become better understood, the range of issues which have to be addressed have themselves made health and safety more complex. Reflecting this, the legislation and official guidance covering workplaces have steadily increased in both number and complexity over the years. Those responsible for health and safety have an ever increasing task of keeping abreast of new developments and requirements, and of implementing appropriate responses to them through policies and practices, in an already complex working environment.

Competing and Conflicting Demands

Organisations exist to produce the goods and services demanded of them by their customers and clients. If they do not do this and do it profitably, they will go out of business or, in the case of public sector organisations, there will be political and/or management changes to ensure that they do. Therefore, the primary objective of management in a competitive and cost-conscious environment will be to achieve those goals.

Under this way of looking at organisations, health and safety represents a cost, which might be regarded as a non-productive cost in that it does not directly contribute to the efficient provision of goods and services. As a result, in many organisations, health and safety is not a priority of management. Instead, it may be seen as conflicting with the need to increase production, to pursue higher sales figures or to cut costs. In the situation where an employer takes little responsibility for the protection of his workers' health and safety, the result will be that serious workplace accidents, injuries or diseases are commonplace.

Behavioural Issues

The first thing we should note is that for occupational health and safety practice to work successfully, there has to be the collaboration and participation of both the employers and the workers in health and safety matters.

To some extent, the management measures taken to implement good health and safety standards at work can be integrated into the working processes themselves. Thus, guards may be placed on machines, circuit breakers incorporated into electrical appliances, or automatic fire detection devices fitted which immediately set off alarms when they sense the presence of smoke. However, most measures rely, to a greater or lesser degree, on the actions of workers to make them effective.

Unfortunately, this is a major source of weakness. It has been estimated that 60% of workplace accidents are caused by human action (or lack of action), with the main reasons for this being ignorance, carelessness or incompetence.

The extent to which workers, individually or collectively, are conscious of the hazards and risks at the workplace and are motivated to maintain the necessary standards to ensure safe working practices can vary enormously. There are a number of factors which can influence this:

- Conflicts between individual or group goals and the requirements of health and safety – for example, the pursuit of higher levels of output to attract bonus payments, working excessive numbers of hours, or simply patterns of social interaction which may cause distraction or loss of attention.

- Individual characteristics and suitability for the job – including physical or mental characteristics, knowledge and skills, temperament, personality, etc.

- The satisfaction of needs through achievements at work – the extent to which the characteristics of the job and the workplace meet the needs of individuals and provide a motivation to perform effectively.

All of these factors can – and should – be addressed directly by management in the interests of developing and maintaining a safe working environment.

MEANINGS AND DISTINCTIONS

The subject of health and safety is, like all subjects, full of its own language and terminology – we have already started to use some, such as hazards and risks. It is important to be clear about a number of the basic concepts of the subject and here we shall define and explain certain underlying principles.

Health, Safety, Welfare and Environmental Protection

Health and safety at work is a general term to cover a wide range of effects which may be created by activities and events which occur at the workplace. Exactly what is covered?

- Health relates to the physical condition of both body and mind, of all people at the workplace (workers, contractors and visitors) and their protection from harm in the form of injury or disease.

- Safety relates to the conditions at the workplace and applies to the pursuit of a state where the risk of harm has been eliminated or reduced to an acceptable level.

- Welfare relates to the general well-being of workers at the workplace and the promotion of conditions which help to provide for their needs in respect of health, comfort, social and personal well-being. This broader concept of welfare is not a specific concern of health and safety at work, but effective health and safety measures may contribute to the conditions which promote it.

- Environmental protection can be seen as comprising two types:

    – The workplace environment, which relates to the general conditions in the immediate area of the workplace itself – for example, levels of lighting, noise, heat, etc.

    – The external environment, which relates to pollution of, or damage to, the air, land, water and living creatures outside of the workplace, insofar as they may be affected by workplace activities.

    The second type is not generally considered to be part of health and safety at work, since its focus is not on the protection of people at the workplace. However, some of the issues with which it is concerned are shared with those of health and safety and there is a degree of common practice and methods between them.

Accidents and Other Events

It is useful to define several types of event commonly considered in relation to health and safety.

Incident: An event that gave rise to an accident or had the potential to lead to an accident (the term incident includes accidents and near misses (see below)).

Accident: This is widely agreed to mean an undesired event, giving rise to death, ill-health, injury, damage or other loss e.g. a worker is injured when he puts his hand into a machine from which a guard has been removed.

Near-miss – These are any form of event which could have resulted in injury or loss but did not in fact do so. Consider the following example: The worker realises that a machine guard is missing and pulls out his hand, just getting a smear of oil on his fingers.

These may be the same events with the same causes as the accidents illustrated before, but with a different outcome. They are significant in that lessons should be learned from them in order to prevent them re-occurring and, perhaps, causing harm the next time.

In many regions throughout the world, certain types of events are reportable to the enforcing authority. By enforcing authority we mean the executive branch of the government charged with enforcing health and safety legislation and standards. These organisations are also commonly referred to as competent authorities. In terms of reporting, the following four definitions are noteworthy.

Occupational accident: an occurrence arising out of, or in the course of, work, which results in fatal or non-fatal injury.

Commuting accident: an accident resulting in death or personal injury occurring on the direct way between the place of work and:

(i) the worker's principal or secondary residence; or

(ii) the place where the worker usually takes a meal; or

(iii) the place where the worker usually receives his or her remuneration.

Dangerous occurrences: a readily identifiable event as defined under national laws and regulations, with potential to cause an injury or disease to persons at work or to the public. These events typically involve serious potential for injury, even though no injury in fact resulted – though they usually involve some form of loss or damage to equipment. Examples of this type might include explosions when a factory is empty of workers or collapse of scaffolding during a night time gale.

Occupational disease: any disease contracted as a result of an exposure to risk factors arising from work activity e.g. occupational cancer arising from exposure to asbestos in the workplace.

Work-Related Ill-Health

It is easy to equate personal injury with accidents, but work-related ill-health may also be the outcome of a type of accident. Nobody sets out deliberately to create the conditions which cause asbestosis, dermatitis or work-related upper limb disorder.

The main differences between health issues and safety issues are timescale and the nature of the harm. Physical accidents happen very quickly, whereas health accidents tend to occur slowly, often over a long period of time, and equally health issues relate to illness whilst safety issues relate to injuries.

Work-related ill-health may be either physiological or psychological:

- Physiological problems are those diseases or injuries suffered as a result of long-term exposure to dangerous substances in the workplace (such as various types of dust or fumes) or to damaging working practices (such as repetitive movements or excessive noise).

- Psychological problems are usually related to stress and include such illnesses as depression. Stress may be created by short-term, or even instant, events, where the emotional shock of a particular incident or series of incidents (such as being involved in or witnessing violence) may cause problems for workers. It may also be the result of longer-term exposure to particular pressures at the workplace, including excessive demands on performance or bullying.

Hazards and Risks

A **hazard** is an article, substance or situation that has the **potential to cause harm or damage**.

The key word is **potential**. Not all hazards will cause harm all of the time. It depends upon circumstances. Typical workplace hazards include:

- Working at heights

- Noise

- Electricity

- Machinery

- Chemicals

- Poor lighting

- Manual handling

- Cluttered walkways

- Fire.

These are just a few examples. In a normal workplace there may be many more hazards.

A **risk** is the **likelihood of harm occurring**. The degree of risk depends upon the likelihood of harm happening and the severity of the outcome i.e. type of injury, numbers involved, etc.

Unfortunately, it is very often impossible to eliminate all hazards to avoid accidents. The next best thing, then, is to reduce to an acceptable level the risk of any hazard turning into an accident. For example, a trailing cable in the workplace constitutes a hazard and the associated risk is the chance of a trip or a fall over the cable, accompanied by a particular degree of injury. (Electricity is another hazard present in this situation, but for simplicity we will ignore this.) Ideally, the hazard should be eliminated by having the appliance close to the electrical socket, or the cable permanently fastened to the wall. However, with some types of equipment, say a vacuum cleaner, this is not possible. A solution, therefore, would be to reduce the risk by considering the positioning of the cable and perhaps providing warning signs.

The magnitude of the risk is an estimate of how likely it is that someone will trip over the cable, with an assessment of the likely severity of injury caused. The same hazard may therefore present different magnitudes of risk, depending on the arrangements:

Hazard	Position of Cable	Magnitude of Risk (likelihood x severity)
Tripping over cable and falling	Fastened to wall	Zero
	Trailing around edge of room	Low
	Trailing across the floor	Medium
	Trailing across head of stairway	High

The identification of hazards and the assessment of associated risks has become the cornerstone of modern health and safety law.

REVISION QUESTION 1

(1) Why may health and safety not be seen as a priority by the management of an organisation?

(2) Define:

    (i) An accident

    (ii) A hazard

    (iii) A risk

(3) What two types of hazard are there?

(4) What factors are assessed in determining the magnitude of a risk?

The suggested answers are given at the end of the unit.

THE MORAL, LEGAL AND ECONOMIC REASONS FOR HEALTH AND SAFETY

The responsibility for health and safety at work rests primarily on the shoulders of the employer. It must therefore be a prime concern of management to ensure that appropriate measures and practices are in place to create safe working conditions. This placing of responsibility on employers comes essentially from the focus given by most health and safety legislation. However, there are also compelling moral and economic reasons for employers to be concerned with health and safety:

- Employers (through management) provide the premises and equipment and put in place the working practices which workers use to produce the goods and services with which employers earn profits (or, in the case of government agency employers, remain in power). To that extent they can be said to gain from the conditions at the workplace. In return, they provide an income for workers, but also have a moral responsibility to provide appropriate working conditions. This forms the basis of the employer's responsibilities which we discuss below.

- Unsafe working conditions are likely to have an impact on production – through both loss of output and a lowering of worker morale and motivation – and on sales. Increasingly, society has expectations of a socially-concerned approach to management and the conduct of business, and the customer/client base of organisations may be adversely affected by the negative image surrounding a poor health and safety record.

- Apart from the financial cost of loss of output, employers may be liable for fines and/or payment of damages in respect of accidents at work.

Size of the Problem

The introduction of legislation, together with an extensive programme of publicity and advice on accident prevention, has brought about a consistent reduction in the number of both fatal and non-fatal accidents at work. However there continues to be an unacceptably high toll in terms of death, injury and financial loss associated with incidents at the workplace.

The following global statistics have been published by the International Labour Organisation (ILO) as part of their SafeWork programme (the actual figures are unimportant – it is simply to show the scale of the problem):

- There are 270 million occupational accidents and 160 million occupational diseases each year.

- Around 2 million people die every year from occupational accidents and occupational diseases.

- 4% of the world's gross domestic product is lost each year through the cost of injury, death, absence, etc.

- There are around 355,000 on-the-job fatalities each year – half of these occur in agriculture. Other high-risk sectors are construction and fishing industries.

Direct and Indirect Costs of Accidents and Ill-Health

We have seen that the costs of failures in health and safety at work across the economy as a whole are enormous. For the individual employer, they can also be very significant.

The costs may be divided into two parts:

- **Direct costs** – These are the measurable costs arising from an accident and/or any claim for liability under the civil or criminal courts. They include sick pay, repairs or replacement of damaged equipment and buildings, etc., product loss or damage, loss of production, public and/or product liability, fines, legal fees, increases in insurance premiums, etc.

- **Indirect costs** – These are costs which may arise as a consequence of the event, but do not generally involve the payment of money. They are often largely unknown, but it is estimated that in certain circumstances they may be extremely high. They include business interruption, loss of orders, cost of time spent on investigations, loss of corporate image.

We can examine these costs by reference to different classes of accident or other health and safety events.

Events Which Cause No Damage to Property or Injury to People

There are no direct costs associated with this type of event. However, near misses may incur minor indirect costs in relation to a temporary stoppage of work, with the extent of the losses depending upon the duration of the stoppage and that in itself depends upon the nature and severity of the event.

Events Which Cause Damage to Material, Plant or Equipment, But Do Not Injure Personnel

The direct costs of this type of event include:

- Value of the materials wasted

- Value of any finished products or work-in-progress lost as a result

- Cost of replacement or repair of plant and equipment

- Loss of production whilst repairs are made or replacements obtained

- Increased overtime costs incurred to make up for loss of production.

In addition, the following indirect costs may be incurred:

- Loss of time already spent on the job

- Loss of goodwill from customers following from delays in production and fulfilling orders – resulting in cancellations and further loss of orders

- Penalty clauses activated for failing to meet delivery dates, resulting in lower profits from sales.

Events Which Cause Injury to Personnel, But Do Not Damage Property

The direct costs of this type of event include:

- Costs of medical treatment – first aid, ambulance, out-patient treatment, in-patient treatment (bed, nursing, doctors, specialists, consultants, medication, etc.)

- Compensation payable to victim

- Fines imposed on conviction for breach of criminal law

- Loss of victims' own productive capacity and possible knock-on effects to others, causing overall loss of production before production schedules and work allocations are rearranged

- Increased overtime costs incurred to make up for loss of production.

In addition, the following indirect costs may be incurred:

- Loss of production time due to workers stopping to assist the victim(s) and discussing the incident

- Downtime on machinery due to switching off in order to provide assistance to the victim(s)

- Loss of staff from productive duties in order to investigate the incident, prepare reports, undertake hospital visits, deal with relatives, attend court proceedings

- Cost of training replacement(s)

- Difficulties in recruiting suitable replacements, and possible loss of existing staff, if health and safety record is poor

- Increased overheads if plant and men are idle

- Loss of goodwill from customers following delays in production and fulfilling orders – resulting in cancellations and further loss of orders

- Activation of penalty clauses for failing to meet delivery dates, resulting in lower profits from sales.

Events Which Cause Both Injury to People and Damage to Material, Plant and Equipment

The costs here are likely to be a combination of those liabilities arising separately for events involving only damage to plant and equipment and those involving only personal injury.

Insurance, Costs and Liabilities

Employers usually take out insurance to cover themselves against potential losses caused by such events as fire and theft. In many countries, employers are also required by law to have insurance against certain types of liability. However, many of the costs involved in respect of accidents at work are not covered by insurance.

Uninsured costs include all indirect costs as well as those relating to loss of production as a result of many types of incident. In addition, the insurance to cover loss in respect of certain events may be void where it may be shown that the employer has not taken adequate precautions to prevent the incident. It has been estimated that uninsured losses were between 8 and 36 times greater than insured losses.

The Need to Provide a Safe Place of Work, Safe Plant and Equipment, Safe Systems of Work, Training and Supervision, and Competent Workers

Safe Place of Work

You will appreciate that should an employer create a place of work, it follows that there should be some legal requirement on him to ensure that such a place of work is reasonably safe. What is considered "reasonable" may vary with the type of work. It follows that the employer should provide safe access to and from the workplace; it is no good the workplace itself being safe and yet having to climb a high ladder just to get to it!

Safe Plant and Equipment

Not only should an employer provide a safe place of work, but all the machinery, tools, plant, equipment and appliances which will be used by workers must at all times be kept in a well-maintained and safe condition. Exactly what this means will depend on the type of work being carried out. It is safe to assume that the greater the risk involved in the operation of particular types of plant and equipment, the greater the care that must be taken. Thus, the need to inspect, service and repair, and replace machinery in a steel-making factory would be far greater than that which would apply in an office. However, the same duty to maintain the plant and equipment used in proper condition applies to both and employers must be able to demonstrate that they have given reasonable thought to the health and safety implications of the machinery, etc., and taken reasonable steps to ensure its continuing safety, if they wish to escape liability in the event of an accident.

Safe System of Work

It is not sufficient to stop at the provision of safe premises and plant and equipment. There must be recognised safe procedures for the use of equipment and these should be rigorously maintained.

There are a number of aspects to this which must be considered:

- The system of work should be reasonably safe in all circumstances, so the procedures must cover all foreseeable possibilities – for example, the operation of drilling equipment in different types of weather, rather than just a set of rules which ensure safety when the weather is good.

- Workers must be fully aware of and competent in carrying out the safe system of work. Thus, there is an implied requirement that staff are properly trained and instructed in the procedures, and that all information necessary to ensure that the system is followed is made available. This may include the display of warning notices, and it may be necessary for them to be printed in a number of different languages to ensure that all staff and visitors are aware of what is necessary.

- The fact that a system of work has been in operation without incident for a period of time is not evidence of it being a safe system of work. In recent years, emphasis has been placed on the need for appropriate review, planning and control in ensuring that working methods are safe.

Training and Supervision and Competency of Staff

It is essential to ensure that staff are equipped with the knowledge, experience, skills and training necessary to carry out their work in a safe manner, without causing harm to themselves or others, and that they do indeed carry out the work in a safe manner.

This starts with the appointment of workers, where the employer must ensure that the person has all the necessary abilities to do the job safely i.e. he is competent. It would be courting disaster, for example, to engage a person who was unable to read and then put him to work on complicated machinery where there was a requirement to read and understand important operating instructions.

All staff need also to be provided with the specific knowledge required to operate safely in the particular workplace, using the particular plant and machinery according to the recognised safe systems of work. The provision of that knowledge through training, instruction and other forms

of information is a major responsibility of the employer. Training and instruction must be suitable for the individual worker.

Finally, employers should take reasonable practical steps to ensure that staff are following all the correct procedures and are actually operating safely. This does not mean that an employer stands and looks over the shoulder of each individual worker – this would clearly be unreasonable. However, it does imply that management must take active steps to check the situation.

We have noted that around 60% of workplace accidents are the result of human actions and are preventable. Clearly there are many instances of workers not following the agreed procedures and practices. In such situations, who is to blame – the employer, the worker or both?

With judicious use of supervision, an employer can reinforce adherence to procedures. If supervision is not used at all, it may create a culture in which safe working procedures are ignored.

TYPICAL FRAMEWORKS FOR REGULATING HEALTH AND SAFETY

As you would expect, the actual detailed legal duties placed on employers and workers does vary throughout each country in the world. Even so, many will have the same basic intention of protecting people at work. There is a general recognition that most of the responsibility lies with the employer – since he provides the work, the workplace, the tools, systems, methods, etc. Though the terminology can vary throughout the world, it is a common theme that the law has certain behavioural expectations of both employers and workers. This includes exercising reasonable care in order to protect others from the risks of foreseeable injury, health problems or death at work.

The International Labour Organisation (ILO) is a United Nations (UN) agency. The ILO has been active in the area of health and safety standards, the principals of which have been widely adopted. In 1981, the ILO adopted the Occupational Health and Safety Convention (C155). This sets forth a basic goal-setting policy for health and safety at both the national level and the level of the individual undertaking.

C155 is complemented by P155 – "the Protocol to the Occupational Health and Safety Convention 1981" which fleshes out some of provisions regarding reporting of occupational accidents etc. to national authorities.

The Occupational Safety and Health Recommendation 1981 (R164) supplements C155 and provides more detailed guidance on how to comply with the policies of C155. In particular, it identifies obligations that might be placed on employers and workers in order to achieve the basic goal of a safe and healthy place of work. These basic ideas are widely enshrined in national legislation.

The Employer's Basic Responsibilities

Article 16 of C155 identifies some basic obligations on employers:

1. Employers shall be required to ensure that, so far as is reasonably practicable, the workplaces, machinery, equipment and processes under their control are safe and without risk to health.

2. Employers shall be required to ensure that, so far as is reasonably practicable, the chemical, physical and biological substances and agents under their control are without risk to health when the appropriate measures of protection are taken.

3. Employers shall be required to provide, where necessary, adequate protective clothing and protective equipment to prevent, so far is reasonably practicable, risk of accidents or of adverse effects on health.

Article 10 of R164 expands on what this might mean in practice. It identifies at least the following practical obligations to meet the objective of Article 16 of C155:

(a) to provide and maintain workplaces, machinery and equipment, and use work methods, which are as safe and without risk to health as is reasonably practicable;

(b) to give necessary instructions and training, taking account of the functions and capacities of different categories of workers;

(c)   to provide adequate supervision of work, of work practices and of application and use of occupational safety and health measures;

(d)   to institute organisational arrangements regarding occupational safety and health and the working environment adapted to the size of the undertaking and the nature of its activities;

(e)   to provide, without any cost to the worker, adequate personal protective clothing and equipment which are reasonably necessary when hazards cannot be otherwise prevented or controlled;

(f)   to ensure that work organisation, particularly with respect to hours of work and rest breaks, does not adversely affect occupational safety and health;

(g)   to take all reasonably practicable measures with a view to eliminating excessive physical and mental fatigue;

(h)   to undertake studies and research or otherwise keep abreast of the scientific and technical knowledge necessary to comply with the foregoing clauses.

Thus it is a reasonable expectation that every employer should provide a safe workplace and generally look after the health and safety of workers. This kind of principle is nearly always enshrined in law – though the actual extent of the duty may vary. This means that if an employer is aware of a health and safety risk to workers, or ought to have known of its existence (in the light of current knowledge at the time), he will be liable if an worker is injured, killed or suffers illness as a result of the risk and he (the employer) has failed to take reasonable steps to avoid it happening.

Worker's Responsibilities and Rights

Article 19 of C155 identifies obligations placed on all workers and their representatives to cooperate with their employer in regard to fulfilling his safety obligations. Workers should:

(a)   take reasonable care for their own safety and that of other persons who may be affected by their acts or omissions at work;

(b)   comply with instructions given for their own safety and health and those of others and with safety and health procedures;

(c)   use safety devices and protective equipment correctly and do not render them inoperative;

(d)   report forthwith to their immediate supervisor any situation which they have reason to believe could present a hazard and which they cannot themselves correct;

(e)   report any accident or injury to health which arises in the course of or in connection with work.

Workers have a right to the provision of a safe workplace, as implied by the employer's obligations. The following additional rights are identified in Article 19 of C155.

> *There shall be arrangements at the level of the undertaking under which....*

(c)   representatives of workers in an undertaking are given adequate information on measures taken by the employer to secure occupational safety and health and may consult their representative organisations about such information provided they do not disclose commercial secrets;

(d) workers and their representatives in the undertaking are given appropriate training in occupational safety and health;

(e) workers or their representatives and, as the case may be, their representative organisations in an undertaking, in accordance with national law and practice, are enabled to enquire into, and are consulted by the employer on, all aspects of occupational safety and health associated with their work; for this purpose technical advisers may, by mutual agreement, be brought in from outside the undertaking;

(f) a worker reports forthwith to his immediate supervisor any situation which he has reasonable justification to believe presents an imminent and serious danger to his life or health; until the employer has taken remedial action, if necessary, the employer cannot require workers to return to a work situation where there is continuing imminent and serious danger to life or health.

The Consequences of Non-Compliance

A breach of health and safety legislation is usually a criminal offence – whatever part of the world you are in. As a result, a company may face heavy fines. It is not uncommon for countries to hold individuals within companies to be responsible and actually imprison them or levy a personal fine on them.

In addition, civil liability may also arise. As a result, compensation may be payable for injuries sustained. In terms of health and safety, the most important civil liability arises as a result of negligence.

Negligence is a relatively modern idea, but today it is probably the most important in terms of the number of cases and the amount of damages which may be awarded for serious injury.

Negligence consists of a breach of the legal duty to exercise reasonable care towards others. In essence, negligence is causing harm to someone to whom you owed a duty of care, as a result of something you did OR failed to do. Of course, the harm has to have been reasonably foreseeable – things are very different if no-one could reasonably have seen it coming.

In health and safety terms, the same concept applies to employers, who are under a duty of care towards their workers and others. As we have seen, that duty has a number of aspects, including the provision of a safe place of work, safe equipment and plant and safe systems. If an employer fails in respect of any or all of these responsibilities by doing something or failing to act in circumstances where the reasonable man would foresee that injury is likely to be caused, he has been negligent and will be liable to compensate an worker who is injured as a result.

Role of Enforcing Authorities and Other External Agencies

Governments make laws and courts decide on guilt and pass sentence on those who are guilty. In between the two we have various agencies who can enforce laws, investigate, provide advice and so on.

Typical agencies might include the following.

Enforcement Agencies

In many countries the government may delegate health and safety enforcement to a special agency. Such an agency is effectively the health and safety police. They may in some circumstances either be, or enlist the aid of, the police.

Fire Authorities

Fire authorities often have a role to play – either in enforcing specific aspects of fire legislation or simply acting as advisors to employers regarding fire safety.

Insurance Companies

In some countries insurance companies fulfil a major role in enforcing safety, thereby avoiding the necessity for the government to employ many enforcement staff. Inspections and audits they undertake of their clients' premises supplement those of the authorities, and in some cases are the only inspections which occur on a regular basis. They can exert considerable influence in raising standards, as they can refuse to provide insurance cover unless their standards are met.

The Role of International Standards and Conventions

Most countries have their own specific laws, developed over the years to tackle their own specific issues – sometimes in a unique way. There is of course no truly global harmonisation of health and safety legislation. However, countries often end up adopting similar basic approaches to protect the health and safety of their people; the detail may vary but, for example, most legislators agree that it is both desirable and possible to take measures to stop workers from falling a distance likely to cause significant injury.

A prime mover in the area of international standards in Health and Safety is the United Nations (UN), specifically, the International Labour Organisation (ILO). A large number of countries are members of the ILO – e.g. Albania, Bahrain, Chile, UK, USA. The two primary outputs of the ILO are "Conventions" and "Recommendations". These set international standards.

When ratified by member states, Conventions create binding obligations or objectives/policies to implement their provisions (which are goal-setting in nature). Of course, these have no legal effect unless ratified and implemented in the legal structure of each member state. ILO conventions are increasingly being ratified. Recommendations provide guidance on policy, legislation and practice. These are further supported by codes of practice.

The ILO has been active in the area of health and safety standards, the principals of which have been widely adopted. Some elements of the Occupational Health and Safety Convention 1981 (C155) and supporting recommendations have already been discussed earlier in this unit. These Conventions can form the basis of detailed legislation in each member country – the result being that basic minimum health and safety standards are adopted. The detailed provisions will still vary as each member state implements in a nationally appropriate way. As well as general Conventions on Health and Safety, the ILO has produced a great deal of sector-specific and subject-specific material e.g. C115 (Radiation Protection, 1960), C162 (Asbestos, 1986), C167 (Safety and Health in Construction, 1988) – together with supporting recommendations and codes of practice. Additionally, as well as Conventions for regulating health and safety, the ILO has produced frameworks for managing health and safety in the workplace (ILO-OSH 2001). More information is available on the ILO SafeWork website http://www.ilo.org/public/english/protection/safework/standard.htm

Other UN agencies have been successful in the promotion and global adoption of legislation on international transportation of dangerous goods. The UN produce model regulations which have no legal effect in themselves but which provide detailed recommendations on how to safely regulate dangerous goods movements. These model regulations are adopted by various agencies and ratified by national governments – giving legal force at the national level. Similar efforts are underway to make recommendations on global harmonisation of classifying

hazardous chemicals. These recommendations will then be available for adoption by national and regional governments.

Other agencies are also active. For example the International Organisation for Standardisation (ISO) is the world's largest developer of standards. ISO has been rather successful at promoting the adoption of ISO 9001 (the Quality Management Standard) and ISO 14001 (The Environmental Management Standard). Whilst these are not legal documents they have been widely adopted by large numbers of companies throughout the world since they demonstrate good management practice. The result is a common approach to managing quality and environment matters. At a technical level, ISO has been responsible for developing the safety standards to which machinery etc. should conform. These are then commonly referenced by national legislation on machinery safety, since compliance with the recognised standard demonstrates safety.

The Occupational Health and Safety Assessment Series (OHSAS) specification 18001:1999 is a result of collaboration between 13 internationally recognised standards organisations. It describes a health and safety management system, which is thoroughly compatible with ISO 9001 and ISO 14001.

SOURCES OF INFORMATION (INTERNAL AND EXTERNAL)

Health and safety is surprisingly complex. There is a wealth of information available which needs to be consulted. There are two chief sources of data – outside the organisation (External) and inside the organisation (Internal).

External

External data sources include:

- National legislation (e.g. regulations).
- Safety data sheets from manufacturers and suppliers.
- Government Enforcing Authority publications such as Codes of Practice and Guidance Notes.
- Manufacturers'/suppliers' maintenance manuals.
- National/International standards.
- Information from local safety groups.
- Information from trade associations.
- Information from journals and magazines.

Internal

Internal data sources include:

- Information from accident records.
- Information from medical records and the medical department (if you have one).
- Information from company doctors.
- Risk assessments
- Maintenance reports.
- Information from joint inspections with safety reps.
- Information from audits, surveys, sampling and tours.
- Information from safety committee minutes.

REVISION QUESTION 2

(1) Identify two responsibilities of workers identified in the ILO Occupational Health and Safety Recommendation 1981.

(2) What are the consequences for an employer of non-compliance with Health and Safety responsibilities?

(3) Identify two external and two internal sources of information about health and safety.

The suggested answers are given at the end of the unit.

FRAMEWORK FOR HEALTH AND SAFETY MANAGEMENT

The extent of the legal duties placed on employers are such that, in order to meet them, health and safety must be addressed systematically within the organisation. This means that it must be considered a function of management – no less important than the management of production, purchasing, sales, human resources, etc. – and, as for those other functions, appropriate arrangements must be put in place to ensure health and safety throughout the organisation.

The starting point is to express safety policy in terms of a clear formal statement. This should cover not only general policy, but also the internal organisation and arrangements necessary to put it into operation throughout all workplaces and all activities. However, health and safety management has to be a dynamic process within the organisation – the policy and arrangements must be monitored and reviewed continually to ensure that they provide the level of protection demanded by the law. Several organisations have published broadly similar standards on Health and Safety management. For example OHSAS 18001:1999 and also The ILO *Guidelines on Occupational Safety and Health Management Systems 2001* (ILO-OSH 2001) - both mentioned earlier in this unit.

Here we discuss the elements of the model described in ILO-OSH 2001 for the development and maintenance of effective systems and procedures. This type of management strategy is not unique to health and safety. It reinforces the fact that managing health and safety is part of good management practice.

The key elements of this are the same as for other management processes as follows:
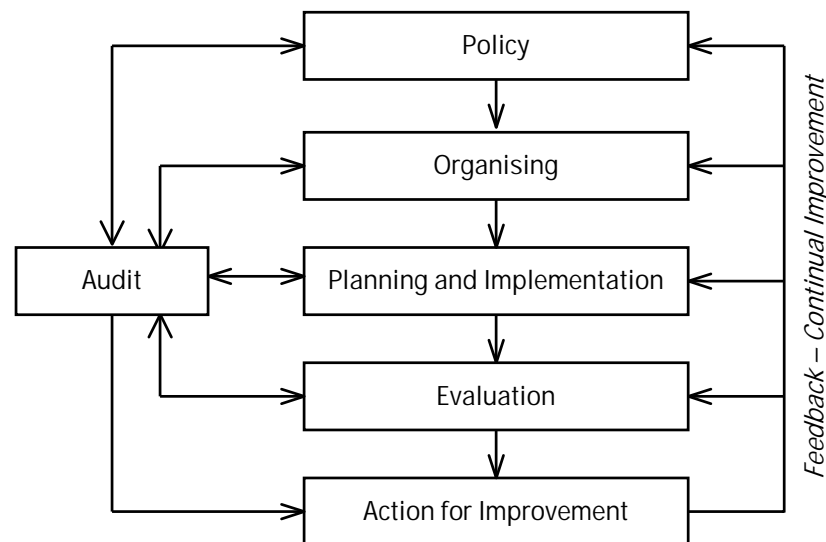
Health and Safety Management Model

Policy

The safety policy has to establish health and safety as a prime commitment of management at all levels of the organisation, but particularly at the top. Clear targets and objectives should be set for dealing with health and safety issues, and they should form the basis on which the management organisation and implementation is based.

Organising

There should be a framework of roles and responsibilities for health and safety, with duties placed upon individuals throughout the organisation, from senior management down to the shop floor. This will include organisational duties which may be required by law, as well as appointing specialist staff where appropriate and ensuring that general management roles and other arrangements (such as management meetings) address health and safety issues.

Planning and Implementation

This refers to the detailed specification of health and safety standards to be applied in all areas and aspects of work, and the measures taken to ensure that they are carried out. Central to this idea is the concept of risk assessment. On the basis of the risk assessment, specific systems of work and protective measures should be identified and implemented.

Responsibility for ensuring that the systems and measures are carried out effectively at all times will rest with management, although workers must also be aware of and accept their own responsibilities. This requires that appropriate information and training is provided for all staff.

Evaluation

Evaluation basically means monitoring, measuring and reviewing performance. It is not enough simply to put the systems and measures in place. Management must ensure they are working effectively and this can only be determined by holding some form of systematic review. The implementation of the health and safety policy should be monitored on a regular basis by collecting information about accidents and other incidences, and this information used to assess the appropriateness of the current organisational arrangements, the standards being applied and the way in which they are being operated.

The process of monitoring and review should be a clear management process within the organisational structure for dealing with health and safety. Employers may have to demonstrate that it has taken place in order to ensure that they are meeting their duties under the legislation.

Action for Improvement

Any defects identified by the review process must be set right as soon as possible by making whatever adjustments are necessary to the policy, organisation and arrangements for implementation.

Auditing

This refers to the process of collecting independent information on the efficiency, effectiveness and reliability of the total safety system in the organisation. Crucially, it reflects the need to ensure that all aspects of the system remain appropriate in the light of current developments in the field – in relation to both legislation and good health and safety practice. Thus, it is necessary to obtain information and advice from outside the organisation about these matters and to integrate this with the further development of internal systems and procedures.

Continual Improvement

Arrangements need to be made for the continual improvement of all the elements of the OSH management system. As well as taking account of internal data sources (from e.g. results of performance measurements, accident investigations etc.), the performance of the organisation should be compared with others in order to benchmark progress.

REVISION QUESTION 3

(1)   What are the organisational requirements for effective health and safety management?

(2)   What is the role of evaluation?

The suggested answers are given at the end of the unit.

UNIT SUMMARY

This unit has introduced you to the general principles of health and safety at work, which we will develop in detail in other units of the course.

The basis of health and safety lies in the potential for harm from hazards at the workplace. This is demonstrated by the high cost in terms of both personal injury and ill-health suffered by workers and others, and financial loss suffered by individual organisations and the economy as a whole through disruption to production.

Employers have particular responsibilities to protect their workers and others from harm at work or arising from work activities. A failure to comply with these duties may give rise to civil liability and a claim for damages, and/or criminal liability and fines, or even imprisonment. Workers also have duties to take reasonable steps to ensure health and safety at work.

Different countries have legislation in place which expressly identifies these duties. This may be based on international conventions. The legislation is often supplemented with practical guidance on how to comply.

To maintain compliance with health and safety legislation, employers must use a systematic management approach. This should include the allocation of roles and responsibilities for health and safety throughout the organisation, and the adoption of operational systems and protective measures in all workplaces. Arrangements must also be made to keep the effectiveness of both health and safety policy and practice under review.

SUGGESTED ANSWERS TO REVISION QUESTIONS

Revision Question 1

(1) Health and safety has to compete with other management priorities, particularly those associated with the production of goods and services which is the basic rationale of an organisation. It may be seen as an unproductive cost which conflicts with the requirement to keep costs low.

(2) (i) An undesired event resulting in personal injury, damage or loss.

(ii) A situation with the potential to cause harm or damage.

(iii) The likelihood that harm from a particular hazard may be realised.

(3) Unsafe conditions and unsafe acts.

(4) The number of people likely to be affected by the harm from a hazard, and the severity of the harm that may be suffered.

Revision Question 2

(1) Workers should:

(a) take reasonable care for their own safety and that of other persons who may be affected by their acts or omissions at work;

(b) comply with instructions given for their own safety and health and those of others and with safety and health procedures;

(c) use safety devices and protective equipment correctly and do not render them inoperative;

(d) report forthwith to their immediate supervisor any situation which they have reason to believe could present a hazard and which they cannot themselves correct;

(e) report any accident or injury to health which arises in the course of or in connection with work.

(2) Criminal – fines; Civil - compensation

(3) External data sources include: National legislation (e.g. regulations); Safety data sheets from manufacturers and suppliers; Government Enforcing Authority publications such as Codes of Practice and Guidance Notes; Manufacturers'/suppliers' maintenance manuals; National/International standards; Information from local safety groups; Information from trade associations; Information from journals and magazines

Internal data sources include: Information from accident records; Information from medical records and the medical department (if you have one); Information from company doctors; Risk assessments; Maintenance reports; Information from joint inspections with safety reps; Information from audits, surveys, sampling and tours; Information from safety committee minutes.

Revision Question 3

(1) There should be a framework of roles and responsibilities for health and safety allocated to individuals throughout the organisation, including the appointment of specialist staff and ensuring that general management roles and arrangements address health and safety issues.

(2) To ensure that the organisational arrangements, health and safety standards and operational systems and measures are working effectively and, where they are not, to provide the information upon which they may be revised.

NEBOSH International General Certificate

Unit 2 | Setting Policy for Health and Safety

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INTRODUCTION

In some countries health and safety law may be lacking or based on outdated legislation which is no longer entirely relevant to present economic conditions or to technologies currently in use. Despite such limitations, responsible employers will still use best practice to improve health and safety by eliminating those risks which are under their control.

The foundation stone of health and safety in the workplace is the organisation's health and safety policy. It is a document which defines the organisation's broad approach to health and safety and expresses its commitment, both in general terms and in respect of specific responsibilities, together with the practical arrangements that are required to be in place.

In many countries the provision of a health and safety policy is a legal requirement, and its contents and format are specified. Here we will give an example of the sort of things which should be considered in such a policy.

In this unit we shall examine the role of the health and safety policy in achieving a healthy and safe working environment. We will look at the components which should be included in it and the way in which they provide the framework within which management and staff carry out their duties and ensure adequate control of risks.

A specimen company health and safety policy is provided as an appendix to the unit to show the general form and content of the document. You will find it useful to examine other examples – especially your own organisation's policy – and there are many examples available on the Internet which you might look at.

The unit is designed to meet the following aims and learning outcomes as specified by NEBOSH for this part of the syllabus for the International General Certificate.

Overall Aims

On completion of this unit, you should understand:

- The importance of setting policy for health and safety

- The key features and appropriate content of an organisation's health and safety policy.

Specific Intended Learning Outcomes

When you have worked through this unit, you will be able to:

- Explain the purpose of a health and safety policy

- Assess the appropriateness of an organisation's health and safety policy in terms of structure and general content.

THE ROLE OF THE HEALTH AND SAFETY POLICY

The essential feature of a policy is that it sets out the general approach and commitment of an organisation to achieving particular objectives, which provide the guidelines for more detailed operational arrangements to be made with reference to the objectives. A health and safety policy does exactly that. It provides a framework of general health and safety responsibilities for staff, and of general operational arrangements to be taken to protect workers and others from harm as a result of activities in the workplace. Within this framework, specific responsibilities for carrying out particular duties will be allocated and specific preventive and protective measures will be taken regarding particular risks.

For example, the policy statement may identify the general responsibility of supervisors to ensure the health and safety of all workers under their control. From this statement, particular duties will be worked out relating to the instruction of workers in the specific safety measures which apply to their work (for example, following special procedures when dealing with particular machinery or wearing hard hats on site, etc.), ensuring compliance with those measures and considering whether they work in practice.

Another example of arrangements might be the way in which the policy identifies what should be done regarding the safety of outside visitors to the workplace. From this, particular procedures might be developed to ensure that visitors sign in on entering the site, keep to designated walkways, wear ear defenders to protect against noise in certain areas and sign out again on leaving.

All staff health and safety responsibilities and arrangements made to protect workers from harm will therefore come under the organisation's health and safety policy.

Note that there is no single correct format or approach to the development and content of a health and safety policy. Instead, it should be a reflection of the particular circumstances of the individual organisation. It should be prepared in the light of the hazards and risks which are faced or may be created in the course of the activities carried out at the particular workplace or workplaces of that organisation. Thus it will vary with the size of the organisation, the industry in which it is involved and the particular nature of the work carried out.

AIMS, OBJECTIVES AND KEY ELEMENTS

An organisation's health and safety policy is a comprehensive written statement of how it will deal with health and safety issues. In general terms, its objectives are to:

- Identify the roles and responsibilities of managers, specialist health and safety personnel and other workers

- Co-ordinate activities to identify, analyse and implement solutions to potential safety problems

- Define arrangements for promoting, planning and controlling all aspects of health and safety in the workplace.

The policy will consist of three basic parts:

General Statement of Intent

This will give a broad outline of the organisation's overall philosophy in relation to the management of health and safety. It will usually re-state the principles of the national legislation applying to the organisation in terms which are appropriate to its particular circumstances, and identify the broad responsibilities of both management and the workforce. It will also set targets.

The Roles and Responsibilities of Individuals

This part deals with people and their operational duties in relation to health and safety. It will outline the chain of command for health and safety management and identify roles and responsibilities for individual staff or groups and give the scheme of delegation. For example:

- Who is responsible to whom and for what

- How accountability is fixed to ensure that responsibilities are undertaken

- How policy implementation is monitored

- Specific safety responsibilities, including job descriptions covering the safety content of particular jobs

- A management chart showing the lines of responsibility and accountability in terms of health and safety management.

Arrangements, Systems and Procedures

This deals with the practical arrangements by which the general policy is to be effectively implemented. It will cover, for example:

- Safety training

- Safe systems of work

- Environmental control

- Safe place of work

- Machine/area guarding

- Housekeeping
- Safe plant and equipment
- Noise control
- Dust control
- Use of toxic materials
- Internal communication/participation
- Consultation with workers on safety matters
- Fire safety and prevention
- Medical facilities and welfare
- Maintenance of records
- Accident reporting and investigation
- Emergency procedures
- Workplace monitoring.

SETTING TARGETS

The first part of the policy statement will be concerned with identifying the general objectives of health and safety in the organisation's sites and workplaces, namely what it is trying to achieve.

General Statement of Intent

This spells out the organisation's overall approach to health and safety, and its aims in terms of health and safety performance. It should commit the organisation to achieving a standard at least as high as that required by the law, and will generally state its acceptance of the legal duties and responsibilities which apply to its particular circumstances.

The general statement of intent will identify the main Directors or Chief Officer who has the leading responsibility for health and safety, in order to indicate commitment to the policy at the very highest level. This person will sign the statement to demonstrate that commitment.

The statement should also be dated. This indicates when the current statement was prepared and provides a point of reference for periodic review and revision in the light of changing circumstances.

General Objectives

The main objectives of the policy should be clearly set out in the general statement of intent. These will relate to:

- Recognising that the effective and efficient management of health, safety and welfare is a management responsibility of equal importance to other management operational duties such as sales, marketing, production and similar matters. This provides a point of reference for any manager faced with a conflict between the demands of safety and the demands of production, etc.

- Recognising that the company will comply with its legal obligations in relation to the health, safety and welfare of its workers.

- The duty of management to see that all reasonable measures are taken to prevent personal injury in the processes of production, and in the design, construction and operation of all plant, machinery and equipment, and to maintain a safe and healthy place of work.

- The duty of all workers to act responsibly and to do everything they can to prevent injury to themselves and fellow workers. Although the implementation of policy is basically a management responsibility, it will rely heavily on the co-operation of the workers who actually produce the goods and services, and take the risks.

- The commitment to monitor health and safety on a continuous basis within the organisation and to review the policy in the light of any significant changes.

Targets

As far as possible the objectives should set quantifiable (measurable) targets for health and safety performance. They will include reference to such matters as:

- **Accident rates**

  The objective should be to see a continuous reduction in the number of accidents. Targets may be set in relation to past performance or the performance of other similar organisations, or the industry as a whole.

  The process of comparing performance in this way is known as "*benchmarking*". Thus, if fatal accident rates in an industry as a whole are, for example, one for every 100,000 miles driven, the target for a particular organisation may be to achieve that standard or have a lower rate.

- **Monitoring**

  The way in which monitoring compliance is carried out will vary according to the nature of the work – high risk activities demand much closer safety supervision than low risk ones. The policy should identify the requirements in specific terms, so that it is clear if all operations must be conducted under strict supervision or whether only 25% of operations have to be checked to ensure compliance.

- **Regularity of review**

  All aspects of the policy, but particularly the operational safety arrangements, must be reviewed to ensure that they remain effective in the light of changing circumstances. The policy should specify how often this has to be done.

ORGANISING FOR HEALTH AND SAFETY

The organisation aspect of health and safety management is to do with the distribution of responsibilities throughout the organisation, starting at the very top with the Chief Executive Officer and Managing Director, and working down through all levels and divisions to the operators on the shop floor. Each person within the company structure will have specific roles relating to health and safety – whether it is the workers' general duty to act in a safe manner at all times, or a fire marshal who is required to take certain actions in the event of an emergency, or a company safety manager charged with full-time responsibility for some or all of the organisation's safety arrangements. All these roles have to be co-ordinated and controlled by lines of accountability which ensure that the organisation's policy is properly implemented.

The organisation section of the policy statement should demonstrate, in both written and diagram form, how all this takes place.

Allocation of Responsibilities

Responsibility for actions and measures to be taken in order to prevent accidents and other safety-related incidents, and to protect people from harm, must be allocated to individuals or groups at every level. As we have noted, everyone has a part to play:

- Management at all levels – responsibility for ensuring that within their sphere of management control in general strategy and/or operational activities, all appropriate safety measures are in place and being carried out effectively.

- All workers – responsibility for acting safely at all times in the course of their duties at work.

- Specialist health and safety practitioners – responsibility for providing specialist knowledge and skills to support management and workers in understanding and implementing appropriate safety measures. Such people may be full-time safety managers or officers, or may be staff who have taken on particular responsibilities on a part-time basis, perhaps as volunteers, such as fire marshals or first aiders. There may be a legal requirement that employers appoint "competent persons" to provide this specialist input in relation to both general health and safety risks and the specific hazards and risks posed by particular work activities (such as handling substances hazardous to health, by which we mean chemicals). There may be regional variation in the meaning of this term, but a "competent person" is simply someone who has the right combination of underpinning knowledge and experience to enable them to do the job properly. This might be proved by having the appropriate educational qualifications in addition to experience in a particular industrial setting, or perhaps a lifetime's experience of a certain type of work.

The general roles and responsibilities which have to be allocated relate to:

- Key personnel (identified by name and/or a job title) who are accountable to senior management for ensuring that detailed arrangements for safe working are drawn up, implemented and maintained. This includes the need for "competent persons" to deal with, for example, risk assessments, the provision of safe systems of work and the control of contractors, etc., as well as dealing with emergencies, such as providing first aid, assistance with evacuation, fire-fighting, etc.

- The roles of both line and functional management regarding compliance with the safety arrangements.

- The provision of support for managers and key personnel throughout the organisation by functional experts – for example, safety advisers, engineers, medical advisers, designers, chemists, ergonomists, etc. – either employed directly by the organisation or brought in as consultants.

- The requirement to measure, monitor and review the organisation's health and safety performance.

Lines of Communication

The way in which the various roles and responsibilities are linked throughout an organisation is called the concept of accountability. When you are given a responsibility, you are charged with carrying out certain actions on someone else's behalf and you may be required to report on your actions and their outcomes to them – i.e. give an account of how you have discharged your responsibilities.

In organisations, the Chief Executive Officer or Managing Director has ultimate responsibility for all aspects of the organisation's activities. This includes health and safety. However, that person cannot do everything on his own. Consequently, responsibility for carrying out all the necessary activities is delegated down through a management hierarchy. In return, each person with delegated responsibilities is accountable upwards for the discharge of those responsibilities.

The linkages, showing the way in which management responsibilities are passed down and accountability flows up, are normally shown on an organisation chart. This identifies particular posts or roles in the organisation and how they relate to each other. A typical health and safety organisation chart may look like the one given below:
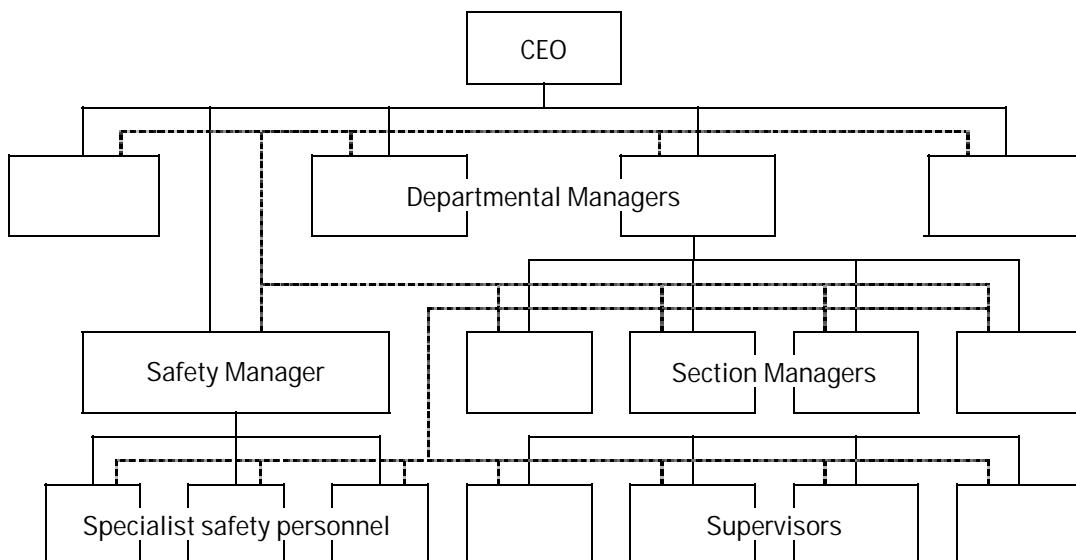
The solid lines show line management responsibilities flowing down through the structure.
The broken lines show functional responsibilities for health and safety going up and across the structure.

Health and Safety Organisation Chart

At each level in the hierarchy, responsibilities are passed down by requiring people at a lower level to carry out certain duties and act in particular ways. At the lower levels, these are commonly in the form of instructions, but also include general provision of information, advice and support, training, etc.

There is an unbroken and logical delegation of duties through line managers to supervisors who operate where hazards arise and most accidents occur.

In addition, there are linkages which cut across this hierarchical structure. They relate to the role of specialists in providing advice and guidance to managers and staff about the way in which they carry out their work activities in order to ensure safety. This is the way functional management operates. Those with particular responsibility for functions, such as carrying out workplace inspections or arranging for an evacuation, may have the authority to require compliance with their instructions, etc., in particular circumstances, and at all times will have the authority to provide information and give advice.

It is important to remember that the flow of communication along these linkages – in terms of instruction, information, advice, etc. – is what determines how effectively the structure works. It must indicate clearly exactly what each person must do to fulfil his/her role, and with whom responsibility lies for ensuring that it is carried out. Thereafter, any failure can be seen as a failure to manage effectively.

Feedback Loops

Management should not be a one-way process. It depends for its effectiveness on getting information back about how operations are proceeding in relation to the objectives – only then can a judgment be made about effectiveness. For example, if the objective is to produce 500 cars a week from a particular factory, the factory manager will be judged to be effective on the basis of how many are produced.

Similarly, safety management requires feedback about the effectiveness of policies and practices in order that adjustments might be made. This information may come from performance measures such as accident rates, but is also acquired through inspections and, most importantly, consultation with workers who actually do the work and/or have roles designed specifically to monitor situations.

Auditing and monitoring arrangements must be in place to ensure that feedback of information takes place as a natural part of the management system. This will include giving specific responsibilities to designated staff to carry out inspections and report findings to more senior management, as well as having procedures for consultation with workers and their representatives.

Role of Managers

It is generally accepted that there are three main tiers or levels of management in an organisation:

- **Senior management** – This level is concerned with strategy across the organisation as a whole, including setting policies and broad objectives, allocating resources (finance and personnel) and approving plans.

- **Middle or departmental/section management** – This level is concerned with the detailed plans to achieve the broad objectives and the organisation and direction of the resources

(finance and personnel again) to achieve operational effectiveness. In terms of health and safety, this includes:

– Instituting programmes and procedures for each part of the department/section to ensure safe systems of work are in place

– Communicating and consulting with supervisors and workers to provide clear information about what is required of them, and to receive feedback

– Maintaining records.

- **First-line management or supervisors** – This level is concerned with the technical operation of work activities and, in terms of health and safety, will work closely with operators to ensure that the programmes and procedures are carried out properly. This will involve instruction, monitoring, inspecting and providing information and equipment as necessary to ensure compliance.

REVISION QUESTION 1

(1) Why might the health and safety policy of two organisations, both undertaking similar work, be different?

(2) What are the three key elements of a health and safety policy?

(3) By whom should the policy be signed?

(4) What does a safety organisation chart show?

(5) What responsibilities do all workers have relating to health and safety?

The suggested answers are given at the end of the unit.

HEALTH AND SAFETY ARRANGEMENTS

These are the systems, procedures and other measures necessary to put the policy into effect. They should explain clearly how health and safety will be achieved in the organisation through the implementation, maintenance, monitoring and review of preventative and protective measures.

Planning and Organising

The basis of planning health and safety measures is the risk assessment. This is a systematic analysis and evaluation of the hazards in the workplace and the risks that they present. Risk assessments are often an explicit legal requirement. If they are not actually specified in law, they are usually implied. Only after a risk assessment has been performed may appropriate control measures be introduced to eliminate the hazard or reduce the risks to acceptable levels.

The policy statement will therefore identify the need for carrying out risk assessments. These will be specific to the nature of the work carried out.

Other aspects to planning and organising the operation of safety arrangements which the policy must address are:

- Systems for monitoring compliance with health and safety measures, including supervisory responsibilities and inspection

- Systems for the routine maintenance of safety plant and equipment

- Systems for reporting accidents and other incidents, including the level of detail required

- Systems for recording and documenting all actions taken and procedures implemented

- Systems for distributing information to those who require it, including training programmes.

The arrangements for planning and organising health and safety measures must explain the involvement of health and safety specialists, managers and worker representatives.

Controlling Hazards

This section will give details on the arrangements to be made relating to reducing the risk presented by workplace hazards. These will be technical, procedural or behavioural controls including the:

- Provision of written safe systems of work and, when necessary, the more rigorous "permit-to-work" systems

- Provision of written instructions for fire safety and fire prevention, including evacuation procedures, escape routes and assembly points or muster points

- Provision of written instructions for the control of contractors and supervision of visitors

- Procedures for cleaning and for waste disposal

- Provision of instructions for the use and maintenance of machinery, including machine guarding and emergency procedures in the event of breakdown

- Provision of suitable personal protective equipment and other safety equipment

- Provision of instructions concerning handling of hazardous substances used in, or resulting from, the production process.

The policy itself is likely to make only general reference to the hazards faced and the types of control measures to be used. The detail will be contained in separate, highly detailed procedure manuals, guides and sets of instructions which will be held by those responsible for ensuring their implementation, maintenance and review (by managers at different levels and safety specialists).

Consultation

It is good practice (and in many countries, a legal requirement) to consult and co-operate with workers and appropriate procedures should be in place to allow this to happen. Consultation is usually through representatives of workers, rather than through every single worker.

Many organisations actively support and encourage consultation. Recent research shows that workplaces with safety representatives have half the accident rate of workplaces without them. Well-trained safety representatives should be encouraged to participate in developing health and safety policies, measuring performance, investigating accidents and other incidents and generally helping to improve safety performance.

Everyone in the organisation should be encouraged to participate in safety matters, not just safety representatives. Workers at all levels can become involved, either individually or in groups, to assist in:

- Setting safety standards and targets

- Working out safe systems of work

- Taking part in risk assessments and safety inspections.

Good safety performance depends on everyone in the organisation co-operating on all safety aspects and taking "ownership" of safety policies.

Supervisors, team leaders and managers should also be encouraged to help set targets and standards for their own departments or functions. Forming special purpose problem-solving teams to help solve departmental safety problems can greatly increase worker awareness of safety and can help considerably to gain the much-needed "ownership" aspect of health and safety.

Communication

The means of communicating health and safety information to staff has to be made clear and will include:

- Use of written procedures – particularly regarding safe systems of work

- Provision of instructions – both written and oral, including the siting of clear written instructions and the use of signs, etc.

- Provision of appropriate training – both general training relating to safe conduct at the workplace and specific task-related training for safe working practices.

Monitoring Compliance and Assessing Effectiveness

All arrangements should be monitored to make sure that they are working, and being operated, as intended and that they are achieving their objectives. This process of monitoring, review, assessment and, when necessary, amendment applies to the systems for planning and organising controls as much as to the actual procedures and measures taken to control hazards.

The policy would have to spell out the general methods of monitoring:

- **Active monitoring** - involving testing, inspections and consultation procedures which look at how arrangements are operating in practice, and management control systems which ensure compliance with those arrangements.

- **Reactive monitoring** – involving the investigation and analysis of accidents and other incidents with a view to identifying the problems which caused them.

Active systems are clearly superior since they aim to identify deficiencies in current arrangements before any resulting accident, with its likely outcome of personal injury and/or financial loss.

The effectiveness of the arrangements should be assessed against the stated objectives of the policy statement; for example, in relation to accident rates, degree of compliance, numbers of safety failures identified on inspection, etc.

REVIEW OF HEALTH AND SAFETY POLICY

An organisation's health and safety policy should not be considered as rigid and unchanging once it has been developed and agreed. Instead, it should be subject to regular review, both as a whole and in its individual parts, as part of the arrangements for planning and organising.

There are particular circumstances which should give rise to reviews, focused either on the general policy or specific aspects of it, depending on the issues involved. Such circumstances include:

- Changes in the structure of the organisation, and/or changes in key personnel

- A change in the buildings or workplace

- When work arrangements change, or new processes are introduced

- When indicated by a safety audit or a risk assessment

- Following a government enforcement action or as the result of the findings from an accident investigation

- Following a change in legislation

- If consultation with workers or their representatives highlights deficiencies

- If requested by third party – for example, insurance companies, customers or clients.

The aim of the review should be to identify and resolve any deficiencies in the existing overall philosophy, the organisation of health and safety management and/or the arrangements made to ensure safe working conditions. The following checklist is useful to help write health and safety policies. The key questions to ask are:

- Does the statement express a commitment to health and safety and explain clearly the organisation's obligations towards workers?

- Does it say which senior officer is responsible for seeing that it is implemented and for keeping it under review and how this will be done?

- Have the views of managers and supervisors, safety representatives and the safety committee been taken into account?

- Were the duties set out in the statement discussed with the people concerned in advance and accepted by them, and do they understand how their performance is to be assessed and what resources they have at their disposal?

- Does the statement make clear that co-operation on the part of all workers is vital to the success of the health and safety policy?

- Does it say how workers are to be involved in health and safety matters – for example, by direct consultation or involvement in inspections?

- Does it show clearly how the duties for health and safety are allocated and are the responsibilities at different levels described?

- Does it say who is responsible for the following matters (including deputies where appropriate)?

    - Reporting investigations and recording accidents

- Fire precautions, fire drills, evacuation procedures

- First aid

- Safety inspections

- The training programme

- Ensuring that the legal requirements are met

- Does it identify clearly the safety procedures, systems and measures required for each workplace activity and are those arrangements effective?

STANDARDS AND GUIDANCE RELATING TO HEALTH AND SAFETY POLICY

Article 14 of the International Labour Convention Occupational Safety and Health Recommendation 1981 (R164) states:

Employers should, where the nature of the operations in their undertakings warrants it, be required to set out in writing their policy and arrangements in the field of occupational safety and health, and the various responsibilities exercised under these arrangements, and to bring this information to the notice of every worker, in a language or medium the worker readily understands.

National governments usually have specific guidance on what this actually means in practice in a given region.

REVISION QUESTION 2

(1) What forms the base for the plans for the systems, procedures and other measures required to put the health and safety policy into effect?

(2) State the three main forms of communicating health and safety information to staff.

(3) What are active monitoring systems?

(4) In what specific circumstances should a policy review be held?

The suggested answers are given at the end of the unit.

UNIT SUMMARY

An organisation's health and safety policy is unique in that it has to be written in such a way that it is dedicated to that organisation. Its content will vary according to the relative complexity and degree of risk associated with the organisation's activities.

Designing an effective health and safety policy is critical to the success of the health and safety management programme, as it states how active management will be executed and achieved. It involves an analysis of the organisation's activities and details of control measures. It has to reflect company culture and values in order to gain the confidence of workers and managers.

We have seen that the principal features of the policy are a general statement of intent, the organisation of the chain of command, responsibilities and accountability for health and safety, and the arrangements detailing procedures and systems for monitoring performance and overall implementation of objectives.

SUGGESTED ANSWERS TO REVISION QUESTIONS

Revision Question 1

(1)   Because the policy is a reflection of the particular circumstances of each organisation. Thus, any variations in size, nature and organisation of operations, etc., will mean that the health and safety policy will also vary.

(2)   The general statement of intent, organisation and arrangements.

(3)   A senior Director or the Chief Executive Officer, indicating the organisation's commitment at the highest level.

(4)   The hierarchy of roles and responsibilities for health and safety, and the lines of accountability between them.

(5)   To act responsibly and safely at all times, and to do everything they can to prevent injury to themselves and to fellow workers.

Revision Question 2

(1)   Risk assessments.

(2)   The three main methods of communicating health and safety information are the use of written procedures, provision of instructions and provision of appropriate training.

(3)   Active monitoring systems are those which seek to identify deficiencies in current arrangements before any resulting accident. They include testing, inspections and consultation procedures, as well as management controls to ensure compliance.

(4)   The circumstances which should give rise to reviews, either of general policy or specific aspects of it, are:

–   Changes in the structure of the organisation, and/or changes in key personnel

–   A change in buildings, workplace or worksite

–   When work arrangements change, or new processes are introduced

–   When indicated by a safety audit or a risk assessment

–   Following government enforcement action or as the result of the findings from accident investigations

–   Following a change in legislation

–   If consultation with workers or their representatives highlights deficiencies

–   If requested by a third party.

APPENDIX: SPECIMEN HEALTH AND SAFETY POLICY

The following specimen health and safety policy provides some guidance on the approach taken by many companies.

COMPANY HEALTH AND SAFETY POLICY

General Statement

The Company is fully committed to meeting its responsibilities under Health and Safety legislation, both as an Employer and as a Company. To achieve those objectives it has appointed designated member(s) of staff to be responsible for Company health and safety; to keep workplace health, safety and welfare procedures under constant review; to liaise with the enforcement agencies where necessary; and to keep the Company and its Board of Directors abreast of new legislation, in order to ensure ongoing compliance with the law.

The main responsibility for health and safety lies with the Managing Director and Board of Directors. The Company is bound by any acts and/or omissions of the Managing Director, any executive director or manager, giving rise to legal liability, provided only that such acts and/or omissions arise out of and in the course of Company business.

Company workers agree, as part of their contract of employment, to comply with their individual legal duties and will co-operate with their Employer to enable him to carry out his health and safety duties. Failure to comply with health and safety duties, regulations, work rules and procedures regarding health and safety, on the part of any worker, may lead to dismissal in the case of serious breaches or repeated breaches; such dismissal may be instant and without prior warning.

The Company will comply with its legal duties towards workers in order to:

- Provide and maintain plant and systems of work that are safe and without risks to health, a safe place of work, and a safe system of work.

- Provide such information, instruction, training and supervision as may be necessary to ensure the health and safety at work of its workers.

- Take appropriate preventive/protective measures.

- Appoint competent personnel to secure compliance with legal duties and to undertake reviews of the policy as necessary.

Signed: **Dated:**

Managing Director

Organisation – Duties, Roles and Responsibilities

Individual responsibilities for health and safety are allocated by management position and by designated posts within the organisation.

Managing Director

The Managing Director has final responsibility for ensuring that the Company fulfils its legal responsibilities, that policy objectives are achieved and that effective means are in place for the achievement of the policies concerned with health, safety, welfare and environmental protection. He will also ensure that Company policies are reviewed as appropriate in order to secure continuing compliance with existing policies, current legislation and any changes in the law. To these ends, he will ensure the allocation of the resources necessary to maintain sound and efficient health and safety arrangements.

Directors

All Directors will ensure that arrangements for the health and safety of their staff, employed within their function, are made known, maintained and reviewed whenever there is a change of operation or location.

Departmental Managers

Departmental managers are accountable to their Director for implementing the Company's Health and Safety Policy, encouraging and assisting in developing safety procedures and ensuring that established rules and safe working practices are adhered to.

With regard to the departmental activities under their general control, all such managers will ensure that necessary consideration is given at all times to the requirements of the Company Safety Policy and, in particular, to the following:

- Safe methods of working

- Induction training including health and safety matters

- Welfare facilities

- Fire precautions

- Hazards arising from the use of noxious substances, or exposure to noise, dust or fumes

- Carry out workplace inspections and advise as and where necessary to improve methods of working

- Investigate accidents and dangerous occurrences and recommend means of preventing recurrence

- Advise and assist with safety training of personnel.

Section/Team Managers

All managers will be specifically responsible for:

- Ensuring that all activities carried out by Company workers will not create a risk or hazard to customers, customers' property, and/or their workers.

- Ensuring that no operation carried out by contractors will place workers, nor members of the public, at risk.

- Ensuring that all workers are adequately trained and competent to carry out the work allotted to them without risk.

- Ensuring that where health and safety training needs are identified, arrangements for training will be made as appropriate.

- Ensuring that all Company procedures are adhered to at all times.

- Ensuring that close liaison with any contractors working within the department is maintained in all matters regarding health and safety.

- Ensuring that supervisors are properly trained and receive the support they need to perform their duties

In fulfilling these responsibilities, all managers will ensure that:

- This policy is reviewed in the light of their particular operational responsibilities.

- They know their own, and other persons', responsibility for implementing the Safety Policy.

- All accidents and dangerous occurrences are investigated fully and preventive actions are recommended in close liaison with the Safety Manager.

- Safe systems of work are implemented and adhered to with such safe systems of work being documented.

- They are aware of, and implement, all safe working practices and procedures.

- All necessary arrangements are made and maintained in respect of accident reporting, first aid, fire precautions, etc.

- All relevant legal records are regularly maintained and inspected.

Managers are also responsible for the health and safety of all workers for whom they have an operational responsibility.

Supervisors

Supervisors are accountable to their manager for the day-to-day implementation of the Company's general health and safety policies, the established schedules, and safe working practices and to provide workers with information about hazardous substances and precautions in general. They are in addition responsible for the introduction of remedial measures to reduce or eliminate unsafe acts or conditions. Their responsibilities also include informing, instructing, training and supervising workers in safer methods of work and for investigating accidents that occur in their area or to a worker who reports to them.

They will also liaise with the departmental manager concerning any queries raised by visitors or subcontractors on health and safety matters.

Competent Persons

The Company will appoint a number of competent persons to assist in undertaking the necessary measures to comply with legal duties. A person shall be regarded as competent when he has sufficient training and experience or knowledge and other qualities to enable him properly to assist in undertaking such measures.

The following members of staff have been designated competent persons for the responsibilities shown:

- Company health and safety: Safety Manager/Officer
- Procedures for emergencies: Fire Controller
- Administration of risk assessments: Safety Manager
- Vetting of subcontractors' health and safety
  policies: Safety Manager
- Auditing of health and safety on sites: Safety Manager

Safety Manager

The Safety Manager is responsible for the provision and dissemination of advice and information to the Managing Director, Directors and staff. He will maintain close contact with the enforcing agencies, and any health and safety consultants appointed and other organisations from whom information may be obtained regarding health and safety matters.

He will be responsible for the effectiveness of the safety policy, safety procedures and practices in relation to Company premises, carrying out regular audits and monitoring activities as necessary. He will also arrange for auditing of subcontractors' health and safety performance on Company premises. The results of such monitoring will be recorded and corrective action, if required, will be undertaken.

In fulfilling these general responsibilities, the Safety Manager has the specific responsibility for:

- Ensuring the Company is aware of legal obligations by interpreting and keeping management and workers informed of new and developing legislation and other standards.
- Advising management of their responsibilities for accident prevention and avoidance of health hazards.
- Through line management and supervision, advising where improvements in health and safety standards or practices are appropriate.
- Ensuring that regular health, safety and housekeeping inspections are carried out, covering buildings, plant, equipment, services, and fire arrangements, to ensure conformity with regulations and Company policies.
- Advising on possible hazards when considering the introduction of new machinery, new materials, new processes, or changes in existing ones.
- Ensuring that all necessary risk assessments required by legislation are carried out.
- Arranging for the provision of written safe systems of work, including where necessary, arranging for the development and use of permit-to-work procedures.
- Ensuring that any raw materials used in manufacture of the Company's products conform to legal health and safety requirements.
- Arranging for the provision of appropriate PPE based on risk assessment.
- Arranging for the provision of written procedures for contractors.
- Ensuring the provision of first aid, fire safety and emergency procedures.
- Ensuring the appointment of competent persons in accordance with legislative requirements.

- Maintaining legal safety records and making legal safety returns, in addition to maintaining health and safety records required by the Company.

- Overseeing and reviewing all accident investigations and preparing statistics to assist in monitoring health and safety performance.

- Ensuring that all workers of the Company receive a copy of this policy statement, including new entrants receiving it as part of their induction programme.

- Liaising with all managers recruiting new workers or changing the job descriptions of existing workers in respect of their capability with regard to health and safety.

- Identifying health and safety training needs and advising on suitable training programmes.

In addition, where Company workers are given access to, and work within the premises of other organisations or domestic premises, the Safety Manager will liaise with the relevant manager, if required, to ensure that none of the activities performed by workers or contractors will put at risk the health and safety of the workers of those organisations and/or members of the public. Likewise, through close liaison with the users and landlords of any shared premises, he will ensure that Company workers are not put at risk by any activities being undertaken within or on the shared premises.

First Aiders

First aiders will be appointed for all Company premises. They will be responsible for the taking of prompt and appropriate action following any accident, whether to a worker or not.

First aiders will be responsible for the maintenance of the contents of all first aid kits and ensure that only items specified will be kept in the kits.

Workers' Responsibilities

All workers will ensure that:

- They are fully conversant with this Safety Policy.

- They will co-operate with the Company in meeting its legal duties.

- They will take reasonable care of themselves and others who may be affected by their acts or omissions.

- No one intentionally or recklessly interferes with or misuses anything provided in the interest of health and safety.

- All accidents, dangerous occurrences and near misses are immediately reported to their manager.

- They are familiar with all fire safety precautions applicable to the area in which they are working.

- All equipment provided for personal safety shall be used and maintained in a condition fit for that use, and any defects reported immediately to management.

- Where a worker identifies any condition which in his or her opinion is hazardous, the situation will be reported immediately to their line manager.

- When local management cannot resolve a hazardous situation they must get in touch with their local Health and Safety Representative whose name is displayed upon all Notice Boards.

- During the course of their normal duties, workers will use equipment and facilities that are fit and proper for the intended purpose in a safe, correct manner, as provided within the following categories:

  - Arranged, provided and/or otherwise approved by the Company.

  - Provided by the customer with specific authorisation that they may be used by workers of the Company.

  - Provided for unrestricted use by members of the general public.

Arrangements and Procedures

The following arrangements and procedures shall be put in place to ensure the health and safety of all workers, and others, whilst at work and as affected by working activities.

Risk Assessments

All premises and activities subject to risk assessments must be assessed in accordance with the relevant legislation using the Company documentation provided.

Such assessments will be repeated whenever any of the following factors occur:

- Change in legislation

- Change in control measures

- Significant change in work carried out

- Transfer to new technology

- Original assessment is no longer valid.

Assessments will be recorded and the documents kept by the Safety Manager. The results of all such assessments will be given to and be available for inspection by all workers.

All assessments will identify necessary protective and preventive measures. The Company shall make, and give effect to, any appropriate arrangements for the effective planning, implementation, monitoring and review of any preventive or protective measures identified as a result of risk assessments.

Specific Operational Policies and Procedures

All Company policies and procedures issued in the interests of health and safety will be regarded as supplementary to this Policy. They include those relating to:

- Provision of PPE

- Written safe systems of work

- Fire safety, fire prevention and emergency evacuation procedures

- Control of contractors and use of permits-to-work.

Specific procedures will be maintained for ensuring that the following requirements are met:

- That all buildings, plant and equipment meet legal requirements, that any remedial action required is carried out without delay and that any unsafe equipment is safely immobilised.

- That all new equipment introduced into any location conforms with legal requirements.

- That all subcontractors who are to work on or in any of the Company's premises or sites are made aware of all safety procedures and any hazards applicable to the areas in which they are to work.

- That all fire fighting appliances, detection systems and alarms are inspected regularly and tested and a log retained of the results.

- That the fire procedure is displayed and reviewed at frequent intervals with regular tests of the procedure.

- That no new chemicals/substances will be purchased or brought into the premises until their hazards have been assessed.

Visitors to Company Premises

Visitors to any location may not be aware of the risk associated within the site, therefore all visitors must:

- Sign in on arrival

- Be accompanied by the person who they are visiting, who in turn is responsible for the visitor's safety and ensuring that visitors are aware of any hazardous process or situation they may be exposed to

- On leaving the premises, sign out at Reception.

Reporting and Investigating of Accidents and Dangerous Occurrences

All accidents, no matter how minor, will be reported on a Company Accident Report Form with copies being sent to the Safety Manager.

- All accidents, dangerous occurrences and near misses will be reported immediately to the manager responsible for the site as soon as possible after the event.

- All accidents, dangerous occurrences and near misses will be investigated within 24 hours by the relevant manager.

- The Safety Manager will at periodic intervals analyse the accident statistics and issue a report to all managers identifying trends and common causes.

Where a worker of another company or organisation is involved in an accident, a copy of the Accident Report Form will be sent to his/her employer.

Training

To comply with the general duty to provide such information, instruction, training and supervision as is necessary to ensure the health, safety and welfare of staff, health and safety training will be provided as follows:

- At inductions

- Repeat training at regular intervals

- On transfer or promotion to new duties

- On introduction of new technology

- On changes in systems of work

- When training needs are identified during risk assessments.

Managers at all levels will be included in the health and safety training programme.

Records of all health and safety training will be maintained by the Safety Manager.

Consultation

Consultation will take place via a committee of safety representatives.

Any worker with a health and safety concern must inform his/her supervisor initially. If, after investigation, the problem is not corrected in a reasonable time, or the supervisor decides that no action is required and the worker is not satisfied with the explanation, the worker may then refer the matter to a member of the Health and Safety Committee who may make representations to the supervisor concerned. This must be in writing.

The advice of the Safety Manager/Officer should be sought if agreement cannot be reached with the supervisor.

If still dissatisfied, the safety representative may seek an early meeting with the appropriate Manager. Failing resolution at this stage, the matter may be entered on to the Agenda of the next meeting of the Health and Safety Committee at the Chairman's discretion.

Review

Notwithstanding the above, this Policy will be reviewed on an annual basis.

NEBOSH International General Certificate

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INTRODUCTION

Here we will look at the way in which responsibility for health and safety at work is spread among the different people involved, and how organisations structure those responsibilities through management and consultation procedures.

As we discussed earlier, duties of employers and workers are usually stated in the legislation. The details vary between regions so what follows is a general discussion of typical expectations the law may have for the various people concerned.

As you will be aware, the main duties for ensuring the protection of people at work rest with employers. In practice, the responsibilities arising from these are allocated to the management of the organisation, with different management levels assuming different roles in terms of developing health and safety policy and ensuring appropriate practice throughout the organisation. Specialist health and safety personnel may also be required to ensure that the organisation has both the expertise and staff resources to carry out the employer's duties in full.

Employers are not the only people who may have responsibilities in relation to health and safety. Workers invariably have at least a general duty to ensure their own and others' safety by the way in which they carry out their work. It is at least good practice (if not always a legal requirement) that employers consult their staff on matters of health and safety, and organisational arrangements should be made to ensure this. In addition, worker representatives may have an important role in monitoring health and safety matters, and the representatives may have certain rights and entitlements in order to carry out that role effectively.

This unit is designed to meet the following aims and learning outcomes as specified by NEBOSH for this part of the syllabus for the International General Certificate.

Overall Aims

On completion of this unit, you should understand:

- The health and safety roles and responsibilities of employers, managers, workers and other relevant parties.

Specific Intended Learning Outcomes

When you have worked through this unit, you will be able to:

- Outline the health and safety responsibilities of the various parties involved with work activities.

- Explain the benefits of consulting with workers on health and safety issues and the means to achieve effective consultation.

ORGANISATIONAL ROLES AND RESPONSIBILITIES

The general duties placed on organisations as employers requires that the practical responsibility for health and safety is delegated through the organisation by means of management roles. As already identified in unit 1, the chief international standard relevant here is the International Labour Organisation's Occupational Safety and Health Convention 1981 (C155), together with its Recommendation (R164) and supporting codes of practice. Here we discuss broad responsibilities of various parties in the organisation identified in these standards and also supplement with good practice.

Responsibilities of Employers

The prime responsibility for health and safety at work lies with the employer. This covers responsibility to workers and extends to others who may be affected by the work activities.

What is an employer? In most cases this is obvious by reference to the contracts of employment of workers. Some difficulties may arise in larger organisations where, for example, certain works managers and supervisors, etc. may have authority to "hire and fire" staff, but their powers will normally derive from their own employer and be defined by the scheme of delegation.

Note that we are not concerned here with use of independent contractors, who will not be "employed" under a contract of employment, but will have a client-contractor relationship with the organisation. We will deal with responsibilities under this relationship later in this unit.

Responsibilities to Workers

As we discussed earlier in Unit 1, though there are regional variations, employers have a general duty to ensure the health, safety and welfare of their workers. This broad duty usually includes at least the following items (see Article 10 of R164):

- Provision/maintenance of safe plant/equipment and a safe system of working (which includes all the co-ordination of activities/equipment/substances/people, as well as the methods of doing the job safely).

- Provision of adequate instruction, training, supervision and information necessary to ensure the health and safety at work of workers.

- Provision and maintenance of a safe workplace (including a safe way of getting into and out of that place of work). This is often extended to cover the working environment and the provision of "welfare" facilities (e.g. drinking water, sanitation, etc.).

These duties form the main setting within which employers must put in place detailed systems and measures for the protection of workers, and to ensure by means of organisation and management of the undertaking, that the arrangements are both suitable and are properly followed. The extent to which an employer should go to deliver on these duties (i.e. what is considered "reasonable") is usually a function of region (and culture) and also a function of the cost of risk reduction program (time/effort/money) in comparison to the magnitude of the risk presented by the work. Most people would agree that it would be unreasonable to incur an enormous financial cost for a risk reduction program that results in only a marginal increase in safety. However, for some very high risk activities, even such a marginal increase in safety may be worth the large cost. In some cases the law may even demand that certain measures must be taken whatever the cost, which in practical terms restricts such activities only to those organisations with sufficient resources.

In making the necessary arrangements, employers are not usually allowed to charge workers for any form of protection "reasonably" required to do the job for which they were hired.

Responsibilities to Other Persons

As well as duties to their workers, employers have a responsibility to others who are not their workers but who may be affected by the business activities, e.g. visitors, contractors, members of the public, etc. This of course means taking measures to protect the health and safety of such people which at the very least might include warning them about potential hazards.

It is useful to identify different types of non-workers. The term "visitor" is often used. Visitors may be classed as either invitees or licensees – those who have been deliberately invited to be there or have an implied right (such as delivering post or customers making an enquiry). These are lawful visitors. Unlawful visitors are those whose presence is both uninvited and unwanted – such as someone breaking in to the premises to steal equipment. Lawful visitors may have different or additional protection in law. Members of the public are those who do not fit into these categories, nor are they workers.

The easiest way to make a distinction between a visitor and a member of the general public is to make entry to the premises or site the demarcation point, so that once a member of the general public enters the premises or site, that person becomes a visitor. Once inside the workplace, the standard of care or protection required for visitors is generally the same as that provided for workers. However, an employer may be expected to do more for vulnerable groups such as the very young or disabled people, or pregnant women, in order to achieve the same standard of protection. Outside the workplace, the general public has a right to protection from risks to their health and safety arising from the manner in which the undertaking is conducted – such as risks from fire, explosion, collapse of building or scaffolding, or release of harmful substances into the air.

The responsibilities to visitors, etc., may under certain circumstances apply to unlawful visitors. It is usually expected that measures will be taken to deter or prevent unlawful entry, e.g. by the provision of security guards, fencing, warning signs, outdoor lighting, etc. Construction sites and railway lines pose particular problems, especially where children are concerned. Extra precautions should be taken here because it is recognised that children are naturally attracted to such high risk areas.

Where warning signs are displayed they should be specific to the circumstances and be clearly visible to all visitors (for example, by prominent notices on perimeter fences, gates, etc.). They should indicate the nature of the danger and state what the visitor must do to avoid harm. However, warning signs may not be of use to protect children or the visually impaired.

It is common practice to give all visitors to the workplace written information on emergency procedures. This is often in the form of a small card or on a visitors' slip. Account must be taken of where the visitor is going and what the purpose of the visit is.

It may be necessary to supplement any general information given with other more specific information relating to their particular situation. This responsibility may extend beyond the immediate workplace – for example, at high-risk workplaces like oil refineries and chemical works, it may be necessary to inform the local population of the hazards arising from work activities and what action to take in the case of an incident. Road works and other activities which have an effect on the general public, as well as requiring prominent signage, may be publicised in local newspapers and pre-work notices erected at the site.

An employer has a right to expect that any visitor on his premises will understand and guard against any special risks connected to the purpose of the visit, so far as the employer leaves him free to do so. So if the employer appoints a competent electrician to do some work but due to that contractor's carelessness, he or she is electrocuted, then the employer would not be liable. However, this will of course depend on the precise circumstances and the local prevailing laws.

Responsibilities of Directors and Senior Managers

In most medium and large organisations, the "employer" is the organisation itself, and the responsibility for fulfilling the employer's duties for health and safety will fall on the management of the organisation. Senior management – comprising the Board of Directors and senior management team (including the Chief Executive) – has particular responsibility for setting general policy and objectives for the organisation as a whole and is accountable for the fulfilment of that policy and achievement of objectives. This applies to health and safety as much as to any other aspect of the organisation's goals, such as making profits or protecting the environment.

The particular responsibilities placed on directors and senior managers, as applied to health and safety, are as follows.

Directors

All directors, both collectively and individually, have ultimate responsibility for ensuring the proper conduct of the company. In particular, they must ensure that:

- The Company fulfils its legal responsibilities for health and safety – ensuring that the organisation's policies are reviewed as appropriate in order to secure continuing compliance with existing policies, current legislation and any changes in the law.

- The organisation's policy is properly defined and reflected in appropriate strategic and operational objectives, and that arrangements are in place both to evaluate performance in relation to these objectives and to appraise the objectives themselves.

- The necessary resources are made available to maintain sound and efficient health and safety arrangements.

- Responsibilities for health and safety are properly assigned within the management structure and accepted at all levels, and that appropriate arrangements are made at senior management level – for example, through the appointment of a health and safety director or senior manager.

- Appropriate leadership is given by senior management in relation to both the importance of health and safety arrangements and their continual improvement.

The Managing Director has particular responsibilities in respect of his/her position as the leader of the board of directors. Each director will also have personal responsibilities in respect of his/her areas of responsibility within the organisation and relationship with senior managers and other workers.

Senior Managers

Usually the senior management team will be accountable collectively to the Board of Directors and individually to particular directors in their own specialist areas, for the strategic objectives and plans through which company policy and overall objectives are achieved. In regard to

health and safety, they must ensure that effective arrangements are in place throughout the organisation for achieving the organisation's written statement of policy.

They will have particular responsibility for:

- Drawing up plans for, and monitoring the implementation of, the organisation's health and safety policy.

- Allocating resources for health and safety procedures and measures, and for associated training programmes.

- Ensuring that lower levels of management give health and safety the appropriate priority by reference to their responsibilities (as outlined below).

In carrying out these responsibilities, senior management will work with lower levels of management – middle management and supervisory staff. They will therefore need a detailed understanding of the responsibilities of the lower levels and, indeed, will themselves have the same responsibilities in respect of all workers for whom they have an operational responsibility.

Responsibilities of Middle Managers and Supervisors

All managers, where they have operational responsibility for other staff or for systems and procedures of work, will be specifically responsible for ensuring that:

- Health and safety policy is monitored and reviewed in the light of the particular circumstances applying in their working areas.

- Safe systems of work are implemented for all working procedures, and practices are properly documented and are adhered to.

- Appropriate safety equipment is supplied, properly maintained and used at all times.

- All workers are adequately trained and competent to carry out the work allotted to them without risk.

- No activities carried out by company workers will create a risk or hazard to other workers, to property, to customers or to visitors and the general public.

- No operation carried out by contractors will place workers or members of the public at risk.

- All necessary arrangements are made and maintained in respect of accident reporting, first aid, fire precautions, etc.

- All accidents and dangerous occurrences are fully investigated and preventive actions are recommended in close liaison with the Safety Manager/Officer.

- All relevant legal records are regularly maintained and inspected.

- Where health and safety training needs are identified, arrangements for training will be made as appropriate.

Middle Managers

This level of management has responsibility for departmental and section operations, and such managers have to take an overview of the detailed health and safety systems and measures. This includes ensuring, either personally or through the next tier of management (supervisors), that:

- Appropriate safe methods of working are in place for all workplace activities within their department/section, and are kept under review

- Fire precautions are implemented and understood by all staff

- Hazards arising from the use of toxic substances, or exposure to noise, dust or fumes, are eliminated or minimised

- Workplace inspections are regularly carried out and advice and support is given, as and when necessary, to improve methods of working

- Appropriate safety personnel are available at all times

- Effective health and safety training is given to all staff, in particular during induction training

- All accidents and dangerous occurrences are investigated and means of preventing their recurrence are identified.

Supervisors

This is the lowest tier of management within a large organisation and is the level at which detailed operational activities, at the level of the job, are controlled. Supervisors are therefore responsible for the day-to-day implementation of health and safety policies and must ensure that:

- Established procedures and safe working practices are implemented at all times

- All workers are provided with all necessary information and instruction to enable them to operate safely, with particular reference to hazardous substances and precautions in general

- Remedial measures are introduced with immediate effect to reduce or eliminate unsafe acts or conditions

- All accidents and other incidents that occur in their area are properly investigated and documented.

Responsibilities of Health and Safety Practitioners

In order to comply with the sometimes extensive legislative requirements applying to employers, all organisations will need – at the very least, from time to time – to have specialist health and safety practitioners to provide advice and to carry out certain responsibilities. In large organisations and those dealing with particularly hazardous work, it is likely that there will be a large number of such staff employed in a full-time capacity, often forming their own department under a designated director and/or senior manager. In smaller organisations the same responsibilities may be carried out on a part-time basis by designated managers or others who have been specially trained in the areas for which they are responsible. Most organisations also use external consultants to help in certain circumstances.

The range of responsibilities may be extensive, depending upon the nature of the organisation and the work activities carried out. They include the following:

- Supervision of the organisation's health and safety programme

- Promotion of a health and safety culture through the organisation

- Ensuring the organisation is aware of legal obligations and recommended Codes of Practice

- Interpreting and keeping management and workers informed of new and developing legislation and other standards.

- Ensuring that all necessary risk assessments required by legislation are carried out

- Advising management of their responsibilities for accident prevention and avoidance of health hazards

- Ensuring that any raw materials used in manufacture of the organisation's products conform to legal health and safety requirements

- Providing regular health, safety and housekeeping inspections which cover buildings, plant, equipment, services, and fire arrangements, to ensure conformity with regulations and organisational policies

- Advising, through line management and supervisors, where improvements in health and safety standards or practices are appropriate

- Advising on possible hazards when considering the introduction of new machinery, new materials, new processes, or changes in existing ones

- Arranging for the provision of appropriate personal protective equipment (PPE) based on risk assessment

- Arranging for the development and, where necessary, use of permit-to-work procedures

- Arranging for the provision of written safe systems of work

- Arranging for the provision of written procedures for contractors

- Maintenance of legally required safety records and making legally required safety returns, as well as maintaining health and safety records required by the organisation

- Overseeing and reviewing all accident investigations and preparing statistics to assist in monitoring health and safety performance

- Identification of health and safety training needs and advising on suitable training programmes

- Ensuring the provision of first aid, fire safety and emergency procedures.

First Aiders

An employer should provide an adequate and appropriate number of people whose role will be to take charge of:

- First aid equipment and facilities, ensuring it is readily available at all times

- Any situation where an ill or injured worker requires attention from a medical practitioner or nurse

- Calling for professional assistance in the event of an accident or injury.

These people may not have to be trained first aiders, although basic training is recommended. In addition, the employer may have to appoint first aiders.

The main functions of first aid are:

- Preserving life

- Minimising the consequences of an injury until medical help is obtained

- Treatment of minor injuries which would not receive or do not need medical attention.

First aiders are those who have been trained to render first aid to ill or injured workers at work – they usually have to hold some kind of certificate proving that they have been trained to a particular standard. In certain circumstances, additional specialised training may be required, depending on the nature of work and the specific hazards and risks within a workplace – for example, in the use of oxygen for resuscitation, or combating the effects of dangerous chemicals. However, such first aiders should not render any treatment other than emergency first aid and then only when specifically trained in those procedures.

The numbers of such trained people required in a workplace will depend on such factors as risk, layout of premises and the number of workers. It may also be appropriate to consider the needs of non-workers, such as customers. In addition, certain other specialist people may be required, with specific responsibilities, when dealing with explosives, underground working, and the control of major accidents and emergencies.

Responsibilities of Workers

As mentioned earlier, in Unit 1 the law usually expects that when a worker is at work, he or she must:

- Take reasonable care for his own health and safety and that of others who may be affected by his acts or omissions at work

- Co-operate with his employer so far as is necessary for the employer to fulfil his legal duties.

Notice that both acts and omissions are included. Thus, failure of a worker to wear protective clothing, for example, or to check machinery which he is responsible for checking, might well render him liable to prosecution, as would exposing others to any danger by playing childish games or taking unsafe short-cuts in his working methods.

A worker is usually considered to be "at work" throughout the time when he is in the course of his employment, but not otherwise. This includes time when the worker is not actually working – for example, during breaks and rest periods – but of necessity or by approval remains at the workplace. In some countries, travelling to and from work is also included. A person who is self-employed is at work throughout such time as he devotes to work as a self-employed person.

Legal provisions commonly include a specific duty not to intentionally or recklessly interfere with or misuse anything provided in the interests of health, safety or welfare. This kind of provision covers any person (not just workers). Interference with fire-fighting equipment or first aid equipment would fall into this category.

Persons in Control of Premises

A further class of person with duties is whoever actually controls premises. In many cases this is also the employer of course. However, many companies rent properties whose services, entry, etc., are controlled by somebody else (a landlord). Several companies may even share the same building. It is a reasonable expectation (and often a legal duty in some regions) to ensure that the premises are safe and without risk to health. A duty is placed on each person who has, to some extent, *control* of the premises, or of the way into or out of them, or of any plant or substance in them. Control may be decided under the terms of the tenancy or other contract for the premises – so the person who has the obligation to repair or maintain the premises, or to

look after points of entry and exit, or to make the place safe (in relation to plant or substances), is identified as the person who has control.

So we see that where business premises are rented or leased, the employer may not be the responsible person in respect of *certain* health and safety duties – those relating to the premises themselves, as opposed to the work carried out. Instead, responsibility may lie with another person (or body) who is in control of the premises. Thus the landlord may be responsible under the terms of the tenancy agreement for common areas of the shared occupancy building (such as the entrance hall, lift lobbies, external fire exits and plant rooms) whilst the individual employers (or self-employed persons) would remain responsible for all aspects of their own workspaces.

REVISION QUESTION 1

(1)   Outline typical duties of employers to workers.

(2)   Outline common duties of workers.

(3)   What are the responsibilities of employers to people who are not their workers?

(4)   Where business premises are rented, is the employer responsible for health and safety matters relating to points of entry to and exit from the workplace?

The suggested answers are given at the end of the unit.

RESPONSIBILITIES OF THE SELF-EMPLOYED

Self-employed people are under very similar duties as employers in regard to their health and safety responsibilities to themselves and to others.

Self-employed people are individuals who work for gain or reward other than under a contract of employment, whether or not they employ others. Thus they owe a duty to themselves (because they employ themselves) and also to others. So, they should:

- Take reasonable measures to protect their own health and safety whilst they go about their business (also called an "undertaking"), and

- Take reasonable measures to protect the health and safety of others who may be affected by the work they do. This might just extend to providing non-workers with sufficient information about the undertaking as might affect their health and safety – for example, by identifying potential hazards.

These are very general duties, so in practice the self-employed may well find themselves doing many of the things that an employer would do (but on a smaller scale). For example, this might include identification of hazards, assessment of risks and taking the appropriate protective measures.

THE SUPPLY CHAIN AND GENERAL DUTIES OF SUPPLIERS, MANUFACTURERS AND DESIGNERS

As we might expect, manufacturers, designers and suppliers of plant/equipment usually have some legal responsibilities, which are similar to those of the employer towards others who are not his workers. The duties may well extend to everyone within the supply chain – including importers – and responsibility may rest with any or all of them for defects or other failures in the materials supplied, depending on the nature of the defect or failure. Article 12 of the ILO Convention C155 places an obligation on national governments who ratify it to make appropriate legislation to control designers, manufacturers and suppliers of articles and substances.

Articles

The term 'articles' includes any plant or equipment designed for use or operation (whether exclusively or not) by people at work.

Everyone involved in the design, manufacture and supply of articles, insofar as it relates to their own role in the supply of the article, should:

- Ensure that articles are so designed and constructed as to be reasonably safe and without risks to health at all relevant times (e.g. during use, maintenance, cleaning at work).

- Carry out a reasonable amount of product testing to ensure that it is indeed safe. This is an obvious point but is often missed.

- Make sure that those supplied with the article are provided with adequate information about the safe and proper use of it, including its limitations.

- Keep those supplied with the article up-to-date if additional risks associated with it become known. This kind of thing is often seen in consumer goods with product recalls due to a discovery of defects affecting the correct operation of some safety device. To do this, some form of customer record must be kept so that you can find your customers again.

Substances

Substances are natural or artificial chemicals (including micro-organisms).

Manufacturers and suppliers of chemicals should behave in the same way as equipment suppliers; that is, ensure that their product is, so far as possible, safe (taking account of the natural properties), obtain sufficient test data (e.g. corrosivity, toxicity, flammability) on the substance in support of that safety, and pass all relevant safety information to the customer. As with machinery, if the supplier comes across new information about additional significant risks, then he should make sure that this finds its way to the customers who purchase it. The most important places for this kind of information are the container label and the material safety data sheet (MSDS).

RELATIONSHIP BETWEEN CLIENT AND CONTRACTOR

Contractors are people engaged by a client to perform a task including accepting a large degree of responsibility for direction and supervision of the work. Instead, they will carry out that work themselves (as self-employed persons) under their own direction or arrange for other people under their control to carry it out. This form of working arrangement is common in the construction industry and is becoming increasingly important in many areas of high skill and expertise, such as information technology.

It is clear that there is a legal need to ensure that all reasonably practicable measures are taken by employers and people in charge of premises to reduce the risk to contractors. Contractors themselves, however, have duties both as employers to their own workforce and as competent people in their own fields of expertise.

It is probably fair to say that the responsibility for risk control is shared:

- The **client** is responsible for the workplace and environment, and as the employer to his own workers

- The **contractor** is responsible for the job, and as the employer to his own workers.

This is a fairly simple approach as there are many areas of overlap and tight procedures are required to ensure all possibilities are addressed.

Effective Planning and Co-ordination of Contracted Work

It is essential for clients and contractors to work together in terms of health and safety. This can often involve potential contractors in discussions concerning health and safety issues prior to awarding the contract.

Planning

The client-contractor relationship starts with a specification of the details of the task(s) that the contractor will be required to carry out. Clearly this is the responsibility of the client. Depending on the nature of the tasks, there may be specific health and safety issues to be addressed – the identification of foreseeable hazards and assessment of the risks involved, and the adoption of suitable control measures to eliminate or reduce those risks. The contract specification should make it clear who is responsible for them.

One approach is for the client to lay down health and safety standards and conditions for the tasks in general terms, and for the contractors to provide both the risk assessment for the work that they are going to carry out, and also a method statement of how they intend to do it safely. This arrangement may be written into the contract.

During the Work Itself

The client has a general responsibility for the workplace where the contractor is working on the client's own business premises, which is the general case for most forms of contract work. Thus, arrangements for ensuring the contractor complies with the established safe working practices in place must be made; for example by:

- Having a signing in and out procedure

- Ensuring that the contractor provides a named site contact

- Carrying out site induction training for all contractor workers.

Where necessary, activities may have to be controlled by using a permit-to-work system.

The client will also need to ensure that the contractor is working to the agreed safety standards and some form of checking on performance and review of procedures will probably be necessary. Any incidents involving contractors may have to be investigated and should always be reported. Attention must also be paid to the possibility of changes of circumstance; for example, new personnel being brought in.

It is important to remember that contractor work can have an effect on workers and vice versa. The passing on of information regarding work that may affect others is a vital part of safe working with contractors.

Selection of Contractors

To ensure that the contractor chosen is capable of doing the work required safely, it is good practice to introduce procedures which will identify and cover key points during the selection process. The following approach is commonly used:

- Decide what level of competence is required by the contractor, remembering that competence is the right combination of knowledge and experience to do the job.

- Ask the contractor to supply evidence of that competence, e.g. copy of his safety policy, examples of risk assessments, qualifications of staff, worker training records, membership of professional organisation or certified body, use of a professional safety advisor, maintenance and test records for equipment, and system for management of sub-contractors.

- Ask the contractor for names of previous or current clients and check with them on his performance; also for details of accidents, insurance claims, and prosecutions or other enforcement action taken against him and check these out.

- Check confirmation that he has adequate resources (financial, manpower and equipment) to deal with such a contract.

- Supply information regarding the job and the site, including site rules and emergency procedures.

- Ask the contractor to provide a safety method statement outlining how he will carry out the job safely.

SHARED RESPONSIBILITIES FOR JOINT OCCUPATION OF PREMISES

It is a fairly obvious point that, in the case of shared occupancy of business premises, such as where a multi-storey building is used by several different companies, the various employers concerned must co-operate with each other and co-ordinate their arrangements for health and safety (see for example Article 17 of ILO-C155 and Article 11 of ILO-R164). This is because the activities of one company may have a direct affect on the other businesses in the same building. In particular, employers should:

- Co-operate and co-ordinate with the other employers concerned so far as is necessary to enable them to comply with any legal duties, and especially in relation to fire precautions. A poor attitude towards fire safety by only one of the businesses greatly increases the risk to the other occupants.

- Take all reasonable steps to inform the other businesses concerned of the risks to their workers' health and safety posed by the way each of them conduct their own undertaking. This may relate to activities which are on-going or to activities which only take place at certain times or are even one-off events.

REVISION QUESTION 2

(1)   Outline the areas of responsibility placed on people in the supply chain for the articles and substances which they supply to workplaces.

(2)   Outline the responsibilities of the client and the contractor where a contractor is working in the client's own workplace.

The suggested answers are given at the end of the unit.

CONSULTATION WITH WORKERS

In many countries there is a legal duty placed upon employers to consult with their workers in matters to do with health and safety. Article 20 of ILO-C155 and Article 12 of ILO-R164 give specific standards on this – the aim is fostering cooperation between employer and worker. Even where there is no legal requirement, it is good practice in the interests of safety that workers or their representatives should be able to consult with the employer on all aspects of occupational safety and health associated with their work, if necessary through a specialist consultant brought in from outside the organisation by the employer.

We note that the workers themselves are the people most likely to come across a situation which they believe might present an imminent and serious danger, so a co-operative method for reporting up through the management chain must be available, as well as a means for the employer to communicate downwards.

Duties to Consult

An employer does not, of course, have to consult with workers on everything. Consultation is appropriate in at least the following circumstances:

- The introduction of any measure affecting the health and safety of the workers concerned

- The appointment of people nominated to provide health and safety assistance, and assist in emergency procedures

- Any health and safety training or information the employer is required to provide to the workers

- The health and safety consequences of the planning and introduction of new technologies in the workplace

- Provision of any relevant information required on health and safety legislation.

Consultation involves employers not only giving information to workers, but also listening to and taking account of what workers say before they make any health and safety decisions.

Employers may consult workers either directly or through worker representatives. Such representatives may even have specific additional rights under law, such as time off with pay for training. It is common practice to form a safety committee to raise and pursue safety matters within the company – identifying deficiencies and advising management on remedies. The committee may be made up of worker representatives as well as management and safety professionals.

The duty to consult and, in particular, disclose information, is usually limited to health and safety matters. Even if it is a health and safety matter, information disclosure about specific individuals is generally prohibited (to protect the individual) as is information which might damage the business, etc.

Non-Formal Consultation Forums

Whilst safety committees provide an effective means of addressing health and safety issues within the organisation as a whole, they are not so effective in addressing quickly and purposefully those issues which relate to particular parts of the organisation. Nor are they

designed to encourage widespread participation in developing health and safety procedures and measures. Two measures which do provide this option are as follows:

- **Safety circles**

  Safety circles are small groups of workers, not necessarily safety representatives or members of safety committees, who meet informally to discuss safety problems in their immediate working environment. The idea is based on "quality circles" and allows people to share ideas and suggest solutions. Problems and solutions would be referred to the safety representative or safety committee for action.

- **Works and office committees**

  These committees are made up from shop floor representatives, supervisory and management staff who meet once a week (normally) to discuss general matters which affect the way the business is running. Matters for discussion might include shift patterns, maintenance and breakdown procedures, and production targets. It is difficult to discuss any of these without involving health and safety requirements; and although not an objective of such meetings, health and safety policies and arrangements would come under examination. Again, any health and safety problems identified would probably be referred to senior management through the safety representative or safety committee.

REVISION QUESTION 3

(1)   How may employers consult workers?

(2)   What are safety circles?

The suggested answers are given at the end of the unit.

UNIT SUMMARY

The organisation of health and safety through the roles and responsibilities of particular people and groups within organisations is based on the duties of employers to their workers and to others who may be affected by their work activities. An employer should:

- Provide and maintain:

    – Safe plant and equipment/substances and safe systems of work

    – Adequate information, instruction, training and supervision

    – Safe workplace, including means of entry and exit

    – Safe working environment and adequate welfare facilities.

- Set a safety policy

- Consult with workers

- Conduct his undertaking in such a way as to ensure that people not in his employment who may be affected are not exposed to risks to their health and safety.

These duties are mostly fulfilled by allocating responsibilities to management at different levels, and through the appointment of specialist health and safety practitioners, on either a full-time basis or as a part-time addition to existing management or operational roles.

Workers have a general duty to take reasonable care while at work, in both their acts and their omissions, for their own safety and for that of others, and should co-operate so far as is necessary with their employers or any other person in order to comply with any legal duty. In addition, they must not intentionally or recklessly interfere with or misuse anything provided in the interests of health, safety or welfare.

Where business premises are rented or leased, responsibility for those parts of the premises which are not directly workplaces under the control of the employer may rest with the landlord/owner or the employer, depending upon the terms of the tenancy/lease and who is decided to control those parts.

In premises which are shared by several employers, those employers should co-operate with each other in the development of health and safety policy, and co-ordinate their systems and procedures, in relation to those aspects which affect others.

The designers, manufacturers, importers and suppliers of articles and substances used at work should ensure that all such materials supplied have been designed and manufactured so as to be safe and without risk to health, and have been researched, tested and examined as necessary for this purpose. They should also provide users with adequate information, updated as necessary, as to the safe use of the materials at work in respect of the purpose for which the materials have been designed and tested, and of any conditions for their use.

SUGGESTED ANSWERS TO REVISION QUESTIONS

Revision Question 1

(1) The general duties of employers are:

– Provision/maintenance of safe plant/equipment and a safe system of working

– Provision of adequate instruction, training, supervision and information necessary to ensure the health and safety at work of workers

– Provision and maintenance of a safe workplace (including a safe way of getting to and from that place of work).

(2) The two general duties of workers are:

– To take reasonable care for their own health and safety and that of other persons who may be affected by their acts or omissions at work

– To co-operate with the employer so far as is necessary to enable the employer to fulfil his legal obligations.

(3) Employers must make adequate provision to protect third parties from harm as a result of their work activities by:

– Conducting their undertakings in such a way as to ensure that people not in their employment who may be affected by their activities are not exposed to risks to their health and safety

– Giving people who are not their workers sufficient information regarding the undertaking as might affect their health and safety; for example, details of potential hazards.

(4) It would depend on the terms of the tenancy agreement. Responsibility lies with the person who may be said to control the particular aspect of the premises.

Revision Question 2

(1) All people involved in the design, manufacture and supply of articles and substances, insofar as it relates to their own role, should:

– Ensure that the articles and substances, are reasonably safe and without risks to health at all times at the workplace

– Carry out such testing as may be necessary for the performance of the above

– Take reasonable steps to ensure that the recipient of the article or substance is provided with adequate information about the article/substance (this might cover intended use, limitations, inherent hazards as well as how to use it properly)

– Keep the recipient up to date if new information comes to light regarding additional (significant) risks arising from the article/substance.

(2) In general terms, the client would be responsible for the workplace and environment, and the contractor for the job, with each being responsible as the employer to his own workers.

Revision Question 3

(1)   Directly, or through representatives.

(2)   Safety circles are small groups of workers who meet informally to discuss safety problems in their immediate working environment.

NEBOSH International General Certificate

Unit 4 | Promoting a Positive Health and Safety Culture

Contents

INTRODUCTION

The culture of an organisation has been described as the observable features of the way in which it works – its structure, rules, management style, ethics, attitudes, etc. – which may be seen by an outsider. We can describe the approach to health and safety as representing a distinct part of that overall culture, and look at the features which demonstrate that approach as representing a positive or negative culture.

In this unit we will look at how we can identify the state of health and safety in an organisation and assess the way in which it is influenced by factors both within the organisation and outside of it. In doing so, the unit is designed to meet the following aims and learning outcomes as specified by NEBOSH for this part of the syllabus for the International General Certificate.

Overall Aims

On completion of this unit, you will have knowledge and understanding of:

- The concept of health and safety culture and its various components

- How to assist in the development of a positive health and safety culture within an organisation.

Specific Intended Learning Outcomes

When you have worked through this unit, you will be able to:

- Describe the concept of health and safety and its significance in the management of health and safety in an organisation

- Assess the effectiveness of an organisation's health and safety culture by use of relevant climate indicators

- Recognise the factors that could lead to deterioration in health and safety culture

- Advise on methods for improving the health and safety culture of an organisation

- Outline the internal and external influences on an organisation's health and safety standards.

DEFINITION OF "HEALTH AND SAFETY CULTURE"

The culture of an organisation refers to the deep-seated values underpinning the whole organisation – both the way in which work is carried out (the formal systems of management and working practices) and also the informal interactions between people and codes of social behaviour, such as the accepted customs, conduct, dress codes and language, etc., used in the organisation. In management thinking it is recognised that the culture is basic to the success or failure of an organisation in meeting its goals.

Organisational culture is not something that is written down or even easily stated. Rather, it is a subtle mixture of formal and informal rules, relationships, values, customs, etc., which, taken together, describe the distinctive "feel" of the organisation. On one level, this is to do with how the organisation gets things done – its own particular way of dealing with work and other events which happen. On another level, it reflects the way in which people involved with the organisation (its management and workers, outside organisations, customers, etc.) perceive it – for example, how friendly it is, how well it meets their needs, how they like dealing with it, etc.

There are a number of characteristics from which it is possible to develop an understanding of an organisation's culture. The main ones are set out below. As you read through this list, think about any organisations you know, either in a work capacity or through having dealings with them (for example, complaining about a problem), and consider how different they are.

- The organisation's goals – particularly its **mission statement** – and the extent to which they are clear, communicated to and accepted by all levels of the organisation.

- The dominant **patterns of behaviour** applying to work and social interactions within the organisation, and between the organisation and people outside – in respect of both what is expected and whether actual behaviour lives up to those expectations.

- The **distribution of authority** and decision-making through the organisation – whether it is concentrated at the top or spread downwards to allow managers at section or shop floor level to make their own decisions, and to what extent the views of workers are taken into account.

- The **structure of the organisation**, which is shown by organisation charts and is closely related to the distribution of authority – how formal and rigid it is, whether there are lots of levels, or if it is open with few levels.

- The **nature of leadership,** which refers to the way in which power and authority is exercised – whether it is authoritarian or democratic.

- The **values of the organisation** – particularly in terms of how it responds to the needs and aspirations of its own staff.

- The **entrepreneurial spirit** of the organisation, as revealed by the level of enterprise, innovation, competitiveness, flexibility and drive for excellence within the organisation.

- How open it is **to change** – particularly whether it is **active** (anticipating and planning for change) or **reactive** (coping with change as and when it arises).

These are quite general points, but we can make them more specific by looking at the concept of a health and safety culture.

Safety Culture is just a "safety" feature of the organisation's culture. It is about the same subtle mixture of formal and informal rules, relationships, values, customs, etc., which when

taken together describe the distinctive approach towards health and safety in an organisation. We can think of it as how it deals with health and safety and the way in which workers think about it.

We could look again at some of the organisational characteristics we listed above and consider them from the point of view of health and safety (and you should think of how any organisation you are familiar with might be described in this way):

- The extent to which the organisation's health and safety policy is clear, communicated to and accepted by all levels of the organisation.

- The dominant patterns of behaviour applying to health and safety – in respect of both what is expected and whether actual behaviour lives up to those expectations, in both formal work situations and in informal situations.

- The extent to which workers are actively involved in health and safety decision-making.

- The values of the organisation –in terms of how it responds to health and safety needs, and of the attitudes of its own staff.

- The priority given to health and safety in the organisation, and the drive and commitment shown by management.

- Whether the organisation is active in anticipating and planning for health and safety, or reactive in coping with events as and when they occur.

Many of these features are vague and not easy to identify or measure exactly – we tend to use general descriptions, such as there is a strong or positive health and safety culture in one organisation, but it is poor or negative in another. However, it is possible to draw up a picture of the culture by looking at certain indicators – for example, accident rates or complying with safety rules. It is also possible to influence the culture by changing the general characteristics listed above – to make it more positive or possibly to make it more negative. We will look at these issues in detail in the rest of the unit.

CORRELATION BETWEEN HEALTH AND SAFETY CULTURE AND PERFORMANCE

The UK's Institution of Occupational Safety and Health (IOSH) defines the health and safety culture of an organisation as "the characteristic shared attitudes, values, beliefs and practices of people at work concerning not only the magnitude of risks that they encounter but also the necessity, practicality, and effectiveness of preventive measures."

Whilst these features are not easy to pin down, it is relatively easy to identify the relationship between them and safety performance. When an experienced safety practitioner carries out a safety audit or inspection of a company, he/she can often assess the standard of safety performance on a fairly superficial walk-round and the first impressions gained.

An organisation with a positive health and safety culture will consist of competent people with strongly-held safety values which they put into practice. This will go through the whole organisation – from top to bottom. It starts with a firm statement of policy which will be reflected at all levels in the attitudes of management and workers, and the working practices and safety measures applied. There will be clear firmness of purpose to control hazards and risks, and to make the workplace a safe place for all concerned.

By contrast, where there is a negative safety culture, management and staff are likely to adopt only the minimum safety arrangements necessary to comply with the law, and then only under compulsion, or even to ignore the requirements completely. This latter case is unlikely, but many organisations do only approach health and safety in a very half-hearted way. Their performance may be described as not being concerned with hazards and risks, and there is an acceptance of danger in the workplace – altogether an unhealthy approach!

TANGIBLE OUTPUTS OR INDICATORS OF A HEALTH AND SAFETY CULTURE

We noted earlier that many of the features which make up what we would call the health and safety culture are difficult to measure – they are general feelings about how the organisation's health and safety policy is accepted, the dominant patterns of behaviour, etc. However, there are several identifiable and measurable features which may indicate the extent to which the general characteristics are present. From them, we can make a judgement about an organisation's health and safety culture. They may be divided into two classes:

- Active indicators – which show how successfully health and safety plans are being implemented, mainly through the level of compliance with systems and procedures.

- Reactive indicators – which show the outcomes of breaches of health and safety systems and procedures, mainly through accidents, etc.

Level of Compliance with Rules and Procedures

The basic principles of control over health and safety are the adoption of safe working practices and the application of various protective measures. So working on a grinding machine may be made as safe as possible by, among other things, following the prescribed procedure for feeding items into the machine and always using the machine guard.

The extent to which these rules and procedures are followed at all times is a good indicator of the attitudes towards health and safety in practice. It is all very well having agreed policies, but how they are actually implemented is the key factor.

A high level of compliance would show that there is a positive health and safety culture. We could conclude that safety policy is clear and understood, that the dominant behaviour patterns revolve around safe working practices, and that health and safety is central to the values of the organisation. However, that is not necessarily the case. It may be that compliance is being strictly enforced against the will of workers – it is a management priority and the values are not shared by the workforce (who, perhaps, feel it is unnecessarily restrictive) – or it may be that workers themselves are more safety conscious than management and are imposing their own codes of compliance in defiance of management demands to cut corners.

Thus, compliance may not of itself indicate a strong health and safety culture, although it is a positive indicator. On the other hand, low levels of compliance would indicate a serious problem and one that demands investigation as to why policy is not being followed – by both management and workers.

Monitoring compliance levels has to be done with care. It can be achieved by looking at some of the reactive indicators discussed below, but is far better assessed by formal and informal checks. However, this requires management itself to have a commitment to health and safety, both to carry out checks and to react to problems identified. One particular problem is that where action is based on numbers of reported breaches of procedures and practices, there may be reluctance among lower management levels to report such events properly because it reflects badly on them. The role of safety representatives then becomes very important in providing an independent monitor.

Complaints About Working Conditions

The level of problems reported to more senior management by supervisors, safety representatives and health and safety practitioners may indicate the level of compliance with the rules and measures, or of the extent to which those rules and procedures are considered appropriate. Either way, a high level of complaints would indicate a poor health and safety culture.

Accidents

The number of accidents in an organisation clearly has something to say about the state of health and safety within that organisation. Accident data is readily available – it has to be collected (often by law) and is required as the basis of risk assessment (as we shall see later) – and statistical analysis can provide information about trends and comparisons with other similar organisations. However, whilst a poor accident record may indicate a need to address particular safety issues, it does not necessarily mean that the health and safety culture is also poor. Similarly, the absence of accidents is not on its own a clear indicator of a positive culture.

Accidents do happen. What is important is why they happen. Thus, accident reports have to be clear about the causes of accidents, not simply their outcomes in terms of injuries caused. In this case near misses are just as important. If they show a regular pattern of similar causes, that may indicate a cultural problem in so far as the causes are not being dealt with properly. Accidents and their causes represent a learning opportunity for the organisation – to prevent them from happening again. If that challenge is not being picked up it may be because health and safety is not being given sufficient priority.

Other ways of analysing accident data may also indicate problems. It may be that a certain level of accidents is normal in an organisation or a particular type of work – not necessarily a high level, but an average of one or two incidents a month, say, on a large construction site. If this level is exceeded then there may indeed be a problem. However, a lower level may also indicate a problem in that accidents are not being reported.

If there is a very low incidence of accidents in the workplace it is important to know why. Many organisations have very low levels of risk (compare office work with mining), and slack attitudes to safety may not necessarily result in accidents, or even near misses.

Absenteeism and Sickness Rates

Health and safety is not concerned solely with accidents, and relying on accident data to build a picture of an organisation's health and safety culture may be misleading. Health problems may also be caused by conditions at the workplace and the extent to which they are recognised and addressed may be an indicator of the strength of that culture.

It is not an easy area in which to make clear judgements. Ill-health may take some time to become evident and it is not always obvious that it is caused by activities at the workplace. In addition, conditions which are made worse by the work situation, rather than caused by it, are not easy to spot.

Monitoring absences and sickness rates is one way of gathering information about potential problems. The information required is likely to be collected by the organisation for its human resource management (personnel) function, and the identified causes of ill health may provide indicators which point to health and safety problems. Certain problems may be easily identified

where there are established links between illnesses and particular types of work – for example, back problems among those workers who have to undertake a lot of lifting or among computer keyboard operators (which today includes most office workers). Other problems which have been shown to be linked to the workplace in certain situations may also indicate a problem, such as stress, asthma, headaches, etc. In addition, the incidence of common ailments among workers in similar situations would indicate a cause for concern.

It is not just the incidence of these types of problems which shows the state of the health and safety culture. It is also the willingness of management to monitor, investigate and take action where appropriate.

Staff Turnover

A high staff turnover is a general indicator of problems in the workplace. There may be many reasons for it – low pay, poor morale, lack of direction, lack of training, lack of opportunities for advancement, etc. Some of these may have implications for the health and safety culture, so it is important that management is clear about the underlying causes and what they may imply for health and safety.

Exit or leaving interviews are often used by employers to find out why workers want to leave and the results may provide indicators of the state of health and safety in the organisation. For example, such reasons as excessive workloads or lack of training may indicate conditions which give rise to high levels of stress, or a lack of appreciation and skills in respect of safety procedures. Low morale may also be of concern since this is often associated with an apathetic attitude towards safety.

FACTORS PROMOTING A NEGATIVE HEALTH AND SAFETY CULTURE

We assume that workers do not usually set out to endanger themselves or others through their work. A negative health and safety culture would appear to be in conflict with this assumption and would not serve the interests of either employers (with the consequent financial costs of accidents, etc.) or of workers. So why might there be incidences of a lack of compliance with safety rules and procedures and high rates of (preventable) accidents?

All such incidences point to failures of either management or workers in their commitment to health and safety. It may be argued that it is management's responsibility to ensure workers' commitment, so a problem relating to the health and safety culture is a management issue. While this is undoubtedly true to a large extent, we cannot ignore the attitudes and motivation of individuals and groups in the workplace.

In this section we consider some of the situations which might exist in an organisation and may give rise to a negative health and safety culture, leading to the types of problem we saw earlier. Usually these situations can be resolved by management. In a later section, we will look at the role of human behaviour in influencing the way in which health and safety is approached.

Organisational Objectives

All organisations have a range of goals and objectives. In the private sector, the prime objective is to make profits and provide a financial return to the owners of the business. In the public sector, it will be to provide services which meet the objectives of the political party which is in power and gives direction to the various public bodies. In setting the detailed objectives and plans which flow from this, management will define an approach to productivity and performance which will enable the prime objective to be achieved.

However, these objectives are not the only ones which organisations have. There will also be objectives about the way in which the goods and services required are produced – the ethical values which underpin the approaches adopted. All organisations will have a safety policy, outlining their commitment to health and safety.

These objectives may conflict with each other. The requirements of complying to the safety policy may mean that productivity targets are not achievable and profits may suffer as a result, or that services cannot be delivered to the desired number of people. Where safety objectives are seen as secondary to production objectives, then health and safety is under threat.

A negative effect on the health and safety culture may be seen in two ways:

- Management at all levels will pursue the objectives which are seen as of prime importance and downplay safety considerations where they conflict with the requirements of getting the job done as efficiently as possible. This may lead to changes being made to safety rules to permit faster production, safety improvements only being made after incidents, and accident reporting may be poor.

- Workers will lose faith in the protection offered by safety policies and practices where they are seen to be expendable, and view management as untrustworthy and unethical in its operation. They may also seek advancement and increases in pay through demonstrating similar values to management, and thus themselves cut corners and take more risks.

Management Decision-making

It is management's role to plan, direct, organise and control activities in the workplace in pursuit of the organisation's objectives. The decisions that are made in carrying out these functions dictate both operations in the workplace and the way in which workers behave. The standard of decision-making is therefore of considerable importance, as seen from two perspectives:

- From the point-of-view of more senior management, where effectiveness in the pursuit of organisational objectives is the requirement.

- From the point-of-view of subordinates, where the clarity, consistency and effectiveness of the direction given is the requirement – clarity implies effective communication, such that workers understand and appreciate what is required of them, consistency implies some degree of certainty relating to what is being asked of them; and effectiveness implies that what they are asked to do actually achieves the objectives.

Failures in any of these areas can cause major problems, undermining trust and creating uncertainty as to how to proceed. You will probably be familiar with the unrest caused by inconsistencies in deciding pay rises or promotions, etc. The following circumstances give rise to distrust and doubt about management decision-making in general, but apply equally to decisions about safety:

- Where there are no rules or no precedents, decisions may appear to be arbitrary and inconsistent.

- Refusal to delegate decision-making leads to demotivation and a fall in the sense of responsibility in subordinates.

- Constant overturning of decisions made at lower levels of management by senior management undermines the authority of operational managers and makes it unclear as to which instructions workers should follow.

- Delays in making decisions lead to confusion and doubt.

- Decisions influenced by conflicting goals between management and worker show a lack of understanding of the workers' needs.

- Lack of consultation prior to decision-making leads to confusion about requirements and desired outcomes, and makes workers feel ignored and their needs unimportant.

- Decisions apparently motivated by the personal ambitions of individual managers, or by some other hidden agenda, undermine trust and make workers feel exploited.

- Inconsistency between what managers demand and their own behaviour ("do as I say, not as I do").

Any or all of these features can affect the culture of an organisation and, where they influence health and safety, can have very negative effects – creating a lack of clear direction and commitment to the objectives and procedures which underpin health and safety.

Organisational Change

It is a fact that during periods of change, accident rates increase. Why should this happen?

Most organisations experience some degree of change all the time. Where the change is only small, we are all quite accustomed to it and can take it in our stride, although perhaps we need a

short period of time to make the necessary adjustments – for example, where new staff are appointed and bring different approaches or styles of management to work. Of more significance to the culture of an organisation is where large changes occur which demand quite drastic adjustments.

These types of change are where there is a reorganisation of existing structures and working practices, and they come from such events as the adoption of a major new system of work (such as computerisation) or as the result of company-wide events, such as relocations, mergers, downsizing, etc. Where these occur, management must treat its staff with sensitivity if they do not want to have damaging effects upon the culture of the organisation.

There are two types of problem which arise from reorganisations:

- Resistance to change – based on the challenges the change represents to the established ways of doing things, the threat to the interests of particular individuals or groups (at any level within the organisation) and the uncertainty it creates.

- The need to maintain operations during the period of change – where the workloads of staff may be increased as a result of operating both old and new systems during the changeover period and/or there being fewer staff after the change to operate the new systems.

These problems may combine in certain circumstances to make worse the issues faced by the organisation.

The accepted approach to managing change is to involve all staff who may be affected by it from the beginning. This has the effect of allowing them to express their worries and fears, to have an input into the changes and to accept both the need for change and the changes that are to be introduced. Failure by management to allow for adequate consultation can lead to demotivation and even obstruction as the changes are implemented. This can have a big effect on health and safety.

It may also be the case that management priorities during the change period will not be focused on health and safety, particularly where a reorganisation is accompanied by job losses, some of which may affect management as well. This may have an adverse effect on the normal controls and practices and cause a negative shift in the organisation's health and safety culture.

Uncertainty

Human beings by nature seek security and stability, and an uncertain environment generates feelings of insecurity. This may be a result of any of the factors we have reviewed above, for example lack of clarity and confusion over what objectives to pursue, over management decision-making, and over the outcome of organisational change.

One of the main impacts of uncertainty is that lacking a clear framework for deciding on courses of action, individuals will make their own decisions in the light of the circumstances as they see them. This can have very negative consequences for health and safety, which requires people to follow accepted rules and procedures. Thus, the whole common agreement about the approach to health and safety may be threatened.

The impact of uncertainty can also be explored by reference to Maslow's analysis of needs as the motivating force for behaviour. You should be familiar with this important model and the way in which people are believed to have multiple needs which are arranged in the form of a graded system or hierarchy, as shown in the following figure.
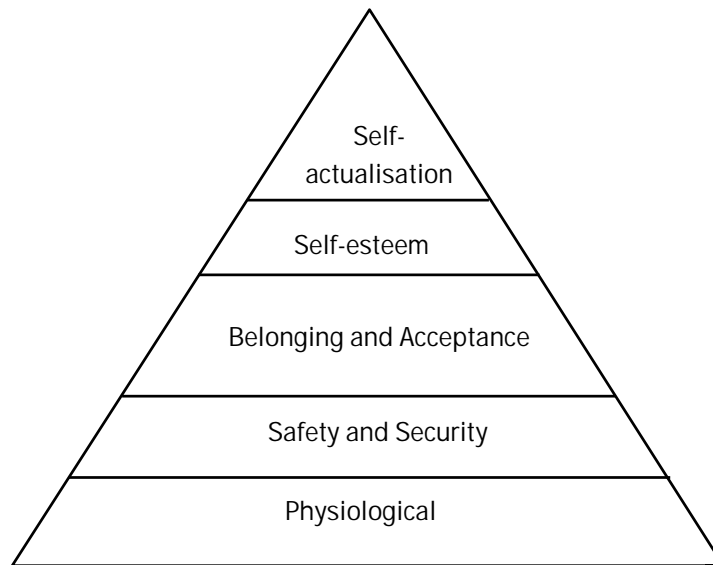
Maslow's Hierarchy of Needs

The model states that when a particular level of need is adequately satisfied, it ceases to dominate and influence behaviour. The next level of need then becomes the important motivating factor:

- The most basic human needs, such as hunger, thirst and sex, must be satisfied first

- Once satisfied, people turn their attention to safety and security needs, such as providing shelter to protect themselves from the weather or other dangers

- The next level relates to satisfying social needs, such as belonging to and being accepted by a social or work group

- Once these needs are met, they are replaced with a need for self-esteem, such as the desire for high status within a group

- The ultimate need resides at the top of the hierarchy – the need for self-actualisation, which refers to the need for a person to fulfil his or her potential.

Any change in the circumstances of the individual may alter the needs which are being met and thus cause lower levels of need to come to dominate behaviour. Uncertainty over accepted objectives, roles and course of action, or even over job security, can influence all levels of need:

- At its worst, the uncertainty may represent a threat to the security of an individual's job or the maintenance of existing levels of income.

- Any disturbance to the individual's working group and relationships, particularly when organisations are restructured, may alter the individual's belonging and acceptance needs as new and uncertain social relationships have to be formed.

- New working practices will almost always involve acquiring new skills and an individual's sense of self-esteem may be threatened by the uncertainty about being able to cope with learning the necessary skills. In reorganisations there may be uncertainty over how the new structures will displace traditional social rank, affecting the individual's status within the organisation and role and recognition within his/her social groups.

- At the level of self-actualisation, any change may cause uncertainty about continuing opportunities for personal fulfilment through the challenges of the job. This is often the result of a lack of control over the future, which itself can cause resentment.

REVISION QUESTION 1

(1)   Define health and safety culture.

(2)   What is the difference between active and reactive indicators of a health and safety culture?

(3)   Why are low accident rates not a good indicator of a positive safety culture?

(4)   Why do accident rates increase during periods of organisational change?

The suggested answers are given at the end of the unit.

INTERNAL INFLUENCES ON HEALTH AND SAFETY

No organisation exists in isolation, because what they do and how they do it are all affected by the environment in which they operate. In order to understand the approach to health and safety in an organisation, we have to understand the nature of the forces in that environment which shape it.

By the term environment we mean not just the physical surroundings of the organisation, but also the economic, social, legal, political and technological influences. Also the organisation will be influenced by the market in which it operates and the nature of the competitive forces it faces. The nature of the organisation itself is also important, including the resources it has, the nature of the product or service, the type of management; they are all among the factors which control the type of organisation it is.

One means of showing this environment is by drawing a series of concentric circles, with the organisation in the centre and various "levels" of environment radiating out from it (see figure below).
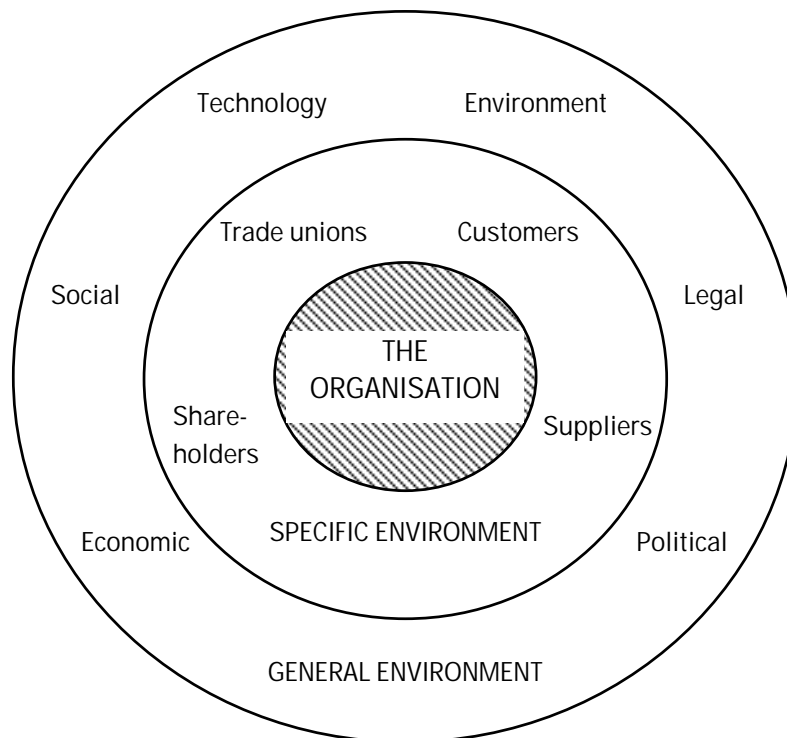
The Environmental Context of Organisations

- At the centre we have the organisation and factors which we can describe as being "*internal*". These would include resources, the workers themselves, the nature of the product(s) and the methods of production, management structure and style, technology, etc. In essence, these factors can be controlled and determined by the organisation.

- Immediately surrounding the organisation is the "*specific external*" environment, namely those factors which are external to the organisation but relate directly to it. They might include the nature of the industry, competitors, customers and suppliers. It could be said that these influences arise from the immediate *market* within which the organisation operates and therefore they cannot be controlled directly.

- In the outer ring is the "*general external*" environment which will affect all organisations. Influences here include the political environment, the economy generally, society at large, etc.

We will now look at how the internal environment influences the approach to health and safety in general and the health and safety culture of an organisation. In the next section we shall look at the influence of the external environment.

Management Commitment

It is all very well having policies for achieving objectives, but it is another thing to see them through and make them central to the values and operational performance of an organisation. The key requirement is commitment on the part of those responsible for the direction of the organisation, that is the management.

Commitment has been defined as "a declared attachment to a doctrine or a cause". However, management has many causes to promote, not least being production and performance. The level of commitment to health and safety as a cause is crucial to the culture of health and safety in the organisation. It sets the tone for the organisation's attitude to safety and indicates to workers what is expected of them.

Management priorities come from the top. Thus, the concern for health and safety shown at board level and by senior management will condition the commitment given throughout the organisation. That commitment will be demonstrated at all levels of the organisation by:

- The proportion of resources (time, money, people) and support allocated to health and safety management, and

- The status given to health and safety management.

Production Demands

The type of industry and the demands which it makes on production and working practices is a major factor in health and safety.

There is obviously going to be a big difference between, for example, a mining operation and the office of an advertising agency. The hazards at the workplace and the degree of risk present are completely different. In the first case, it would be surprising if there was not a very strong culture of health and safety – all working operations have to be carried out with safety in the leading position, particularly if there is a history of injuries, ill-health and death which the workers remember. In offices, few of these conditions exist and therefore health and safety is likely to be seen as less of a priority. Between these two extremes there are many different situations where the nature of the work will of itself dictate the extent to which health and safety is seen as a central issue.

Where health and safety is not a key issue, the culture of the workplace will not have a strong health and safety focus. The issue has to be promoted actively, a subject we shall return to later.

A further aspect of the production process is the extent to which, in a particular organisation, it places demands on management and workers to cut corners on health and safety issues in the pursuit of targets. This can apply equally to both our examples from above, and is particularly strong in organisations facing intense competition. Thus, the need to increase output in mining or manufacturing industries can easily lead to the disregard of safe systems of work which may

slow down the speed at which workers can operate. In offices, it tends to be the pressure of deadlines which creates unsafe working practices, often associated with long hours and high levels of stress.

Communication

Organisations depend on obtaining and transmitting information in order to achieve the co-ordinated action necessary to achieve their goals. The way in which this communication is carried out – both formally and informally – and its effectiveness has a huge influence on the way organisations operate, not least on the way in which health and safety is approached.

We shall look at communication activities in relation to promoting health and safety in the workplace in more detail later in the unit. Here we shall note the role of, and systems for, communication in organisations.

Among the types of communication which operate within organisations there is always the official channel, which is often referred to as "formal" communication; while communication which is unofficial, unplanned and spontaneous, may be classified as "informal". All types may carry information about health and safety.

Formal communication channels and systems may be seen as being between different levels in the structure of an organisation (known as vertical communication – both up and down) and between persons or groups at the same level in the structure or across divisions (horizontal communication).

- **Downward communication** is the flow of information from a higher level to one or more lower levels in the organisational structure. It is often concerned with passing directions about the performance of tasks or about the procedures and practices of the organisation. In terms of health and safety, this is the main channel through which management seeks to develop understanding of safety needs in general and the specific requirements associated with particular jobs. The types of communication employed include face-to-face meetings (private or public, formal and informal, between individuals and groups) and a variety of written communications, such as memoranda, bulletins, newsletters, notice boards, manuals, etc.

- **Upward communication** is the flow of information from a lower level to one or more higher levels in the organisational structure. It is usually concerned with reporting progress, problems, new developments and situations which require attention, making suggestions for improvements, seeking clarification, and questioning. The types of communication involved include written reports and memoranda, meetings with superiors (individually or in groups), suggestion schemes and attitude surveys. In addition, specific formal systems for dealing with staff problems through grievance procedures, and for joint consultations with trade unions, may be brought into play.

- **Horizontal communication** is the flow of information between individuals at the same level within a particular section or department, or between individuals or groups at different levels in different sections or departments. This is often concerned with the provision of information and advice from specialists outside the immediate work unit, as well as co-ordinating activities, sharing information and resolving conflict or problems. The types of communication involved include formal meetings, reports, memoranda and face-to-face meetings.

Informal communication involves a wealth of social conversations which take place in the workplace and these can be very significant in conveying information around and among staff. Often, it is the main way in which detailed information circulates about the way systems and procedures work in practice, as opposed to the official line – although the "grapevine" can be a problem in providing false or incomplete information.

Health and safety may be addressed through all of these channels, with safety representatives and safety committees being an important part of the formal systems.

Competence

The term competence is used in relation to general work-related abilities and specific technical knowledge and skills. This whole area is receiving great attention due to need for skilled staff at all levels of organisations, and applies as much to health and safety as to work-related abilities. There is also a general duty on employers to ensure that staff are generally competent to work safely, and to appoint "competent" persons to undertake specific health and safety roles.

There is a strong pressure on employers to provide their staff with the necessary health and safety training to achieve the level of competence required throughout the organisation. This training must be appropriate to the nature of the individual's health and safety role – whether as a worker who has to understand working practices and safety measures, or safety representatives or first aiders, etc., who require skills in their own particular areas.

Worker Representation

Worker representation (and consultation generally) is an important element of the communication system within organisations, representing a channel for upward communication. Through their representatives, workers can exert considerable influence on health and safety at work, both regarding the formulation of policy and monitoring management performance. The effectiveness of this influence will depend to a large extent, as with all upward communication, on the willingness of management to listen.

EXTERNAL INFLUENCES ON HEALTH AND SAFETY

The external pressures which shape an organisation's approach to health and safety come from a wide variety of sources. We described them earlier as coming from the specific environment of the organisation (those with a direct connection with the organisation) and those from the general external environment, whereby more general concerns have an impact on a particular organisation. It is now common for all these various groups and individuals to be known collectively as the "**stakeholders**" of the organisation. (The term also usually includes workers, although they may be considered to be part of the organisation's internal environment. We shall look at workers through the examination of human behaviour in the next section.)

Societal Expectations

The attitudes and expectations of society change over time and also vary between different countries (or even regions within countries). Organisations, as part of those societies, have to reflect those attitudes and expectations at all times.

Western societies have become increasingly conscious of health and safety in the last thirty years or so, and the expectation is that their concerns will be addressed by organisations in the way in which they treat their own staff, how they conduct their business and in the goods and services which they produce. To a large extent, these concerns have been acted upon by legislators in introducing the extensive law which covers health and safety at work. However, the law often lags behind public opinion, or does not fully reflect it, and organisations must appreciate how they may be required to go beyond mere compliance with the law in order to satisfy public opinion.

Note that the expectations in respect of health and safety (as well as the law) are often considerably lower in many developing nations. There is, therefore, less pressure on companies in those societies to adopt stringent safety measures. The apparent exploitation of this by some multi-national companies has led to public pressure on them in developed countries to adopt similar standards throughout all their locations.

Public pressure, can be exerted in many ways, from consumer boycotts to direct action by pressure groups organised to promote particular causes; they can be very influential in changing public opinion.

Legislation and Enforcement

In the area of health and safety this is probably the most important influence on organisations. They must comply with the law or they will not be allowed to continue operating.

Organisations must ensure that they understand and comply with the legal requirements placed on them at all times. This can be a great burden because the law on health and safety is extensive in Western countries and is updated frequently. There is also a wealth of information and guidance coming from governments which has to be assessed in order to ensure that good practice is being adhered to.

Enforcement agencies can have a direct influence on what goes on in organisations through the use of direct action, such as inspections of the workplace. Action may take the form of imposing specific remedial instructions with a specified timescale in which to comply. In some regions these are far more common than the use of prosecutions to secure compliance with the law.

Insurance Companies

In recent years, insurance companies have come to have a strong influence on organisations in respect of health and safety. The explanation lies in the requirement for employers to have public and product liability insurance. Insurance companies are increasingly concerned to ensure that their clients take every precaution against being sued for damages arising from accidents or ill-health suffered as a result of their activities. With the public being more willing to pursue such claims and the size of awards rising all the time, it is now common for insurance companies to insist on risk assessments being carried out to their own specifications, or even to conduct their own inspections. Companies with poor accident records have seen their insurance premiums increase steeply and there is always the threat that organisations may not be able to obtain insurance at all unless they comply with insurers' demands for health and safety procedures and control measures.

Trade Unions

In regions and industries where trade unions exist they have often been very active in promoting standards of health and safety, both on a national or industry-wide stage and at the local level of individual firms.

Their contribution has included:

- Supporting their members' legal actions and setting precedents and standards

- Acting through lobby and pressure groups and thus influencing legislation

- Carrying out and sponsoring research in workplace safety issues

- Publicising health and safety matters and court decisions

- Providing seminars on health and safety topics.

Other Stakeholder Groups

The above groups represent the main external stakeholders with a direct influence on health and safety in an organisation. However, you should be aware of the indirect influence that other groups may have:

- **Shareholders** – these are the owners of the business and their interest in the organisation is primarily to get a financial return on their investment. As such, they have ultimate authority over the board of a company and can strongly influence the direction and policies of an organisation. They are unlikely to have a direct interest in health and safety, but demands for action in other areas may have an impact on it. (For example, the negative public relations image experienced by some companies over certain accidents has had an impact on their stock market share prices and this has led to shareholder demands for action on health and safety.)

- **Competitors** – In recent years in many industries there has been a growing interest in what the competition is doing. Overall business performance as shown by sales, profitability, growth and innovation are important to competitors. It is increasingly common practice for businesses to establish *benchmarks* based on various performance indicators of other companies, especially companies in the same industry. These are used to help shape strategies and policies. In terms of health and safety, it is important to be seen to be as

effective, if not more effective, than one's competitors to avoid any negative public relations as a result.

The Economy

Finally we must recognise the economic realities in which organisations have to operate. The state of the economy, both in general and as to how it affects a particular industry, conditions to a large extent the prices of both the resources that organisations use (labour and materials) and the goods and services they produce. This in turn affects the way in which work activities are carried out; for example, through demands for cost cutting, higher productivity, etc., as well as what resources are available for health and safety. Whilst absolute duties under the law must always be complied with, where the duties are qualified their cost can be a factor in determining what is reasonably practicable.

THE INFLUENCE OF HUMAN BEHAVIOUR

One simple way of classifying accidents would be to divide them into those directly attributable to human actions and those brought about by non-human causes, such as by machines or working conditions.

A large proportion (greater than 50%) of accidents are directly attributable to some kind of human action. We must look at how personal and human factors influence both safe and unsafe working practices. It is not sufficient to dismiss an accident as being due to carelessness or ignorance. In order to comply with legislation (all of which is essentially a control on behaviour), we have to understand why people behave the way they do at work and how this behaviour influences their performance.

The Individual, the Job and Organisational Factors

"Human factors" is a term used to refer to the way in which the job, the individual and the organisation interact to influence people's health and safety-related behaviour.

The Individual

People bring to their job their own personal mix of physical characteristics, knowledge and skills, attitudes, habits and personality, any or all of which may be strengths or weaknesses depending on the demands of the work task. These individual characteristics influence behaviour in complex and significant ways, so it is important that individuals are appointed to jobs and roles to which they are individually suited.

Some of these characteristics are fixed and cannot be changed, or at least not changed easily or in the short term; for example, physical characteristics and personality. Others may be altered, adapted and enhanced through learning. This applies to an individual's knowledge and skills, attitudes and habits; these are all attributes which contribute significantly to competence in the job or role. People can therefore be developed in their jobs to become more effective.

The Job

Jobs and roles comprise a series of tasks, both physical and mental. The tasks should be designed to take account of the limitations and strengths in human performance. This applies both in general, that is combining a series of tasks into a job in a coherent way which are capable of being performed by any individual with the right general characteristics; and also in particular, by adapting jobs where possible to meet the capabilities of the job holder. Matching the job to the person in this way allows for the most effective contribution to business results.

The concept of matching jobs to the person involves two aspects:

- *Physical match* – Which covers the design of the general and immediate workplace and working environment to assist both performance of the manual tasks involved and to ensure safety during such operations.

- *Mental match* – Which covers the design of the "brainpower" parts of the job (those involving information processing and decision-making on the part of the job holder).

Mismatches between job requirements and people's capabilities frequently provides the potential for human error.

Organisational Factors

Within an organisation, jobs are allocated and individuals perform their tasks. The organisation itself is therefore an important factor in conditioning the behaviour of individuals and groups at the workplace. The two key elements are the management of the organisation and its culture:

- The style of management dictates the way in which people work, for example the priorities which are seen as important (speed, quality, working safely, etc.), the type of controls operated and the degree of individual responsibility allowed, the way in which people are motivated, the support offered to individuals through instruction and training, etc.

- The organisation's culture sets the tone for the individual and group behaviour, such as the priorities which they see as important, the involvement and attachment people have to the organisation, their ability to influence its operations, etc.

Both these factors are central to health and safety. Both management and the culture should promote worker involvement and commitment at all levels, emphasising that deviation from established health and safety standards is not acceptable.

Attitude, Aptitude and Motivation

These three factors are the main elements which determine how individuals perform.

Attitudes

An attitude is a person's point-of-view or way of looking at something, and it gives him or her a tendency, readiness or predisposition to act or react in a particular way in a given situation.

We are not born with attitudes; they are learned. They come from our personal reaction to information and events, which gives us our beliefs and feelings about a particular subject. Many are formed when we are very young and some, particularly feelings, are so strong that they stay with us and affect us for the rest our lives.

The formation of attitudes is strongly influenced by those around us and the conditions or situations in which we find ourselves. The range of influences is complex, but it includes the following:

- The groups to which we belong, most notably in early life the family, but also friendship groups, work groups, etc.

- Education

- Life experiences, particularly the most profound personal ones, such as bereavement, etc., but also those experiences which we observe (say, on TV) or read about.

We are aware also that our attitudes change over time as a result of the influence of the above factors. For example, it is very often the case that young people have more liberal attitudes than older people, but as they enter work and acquire family and financial commitments and responsibilities, they tend to become more "conservative".

Whilst attitudes do not necessarily condition behaviour they are a significant contributor to it. Management will want to ensure that attitudes are positive towards the key objectives in the workplace, including health and safety. However, attitudes can be deep-seated and difficult to change; for example, older workers are often reluctant to accept change on the basis that "it has always been done this way" and new working patterns and practices represent a challenge to their accepted attitudes towards their work.

The most successful methods of achieving attitude change in adults have been those which involve a relatively high level of involvement by the individuals concerned in some form of small group decision-making process. This process not only creates an opportunity to explore and assess new attitudes, but also allows individuals to test them out among others. This may lead to a (public) commitment to attitudes which strengthens the intention to produce changed behaviour. Being part of a group may also reduce fear of attitude change, especially if other members of the group will be similarly affected.

Other methods of attempting to change attitudes and behaviour might include the use of threats and (monetary) rewards. These may well change behaviour, but they are less likely to alter attitudes and beliefs. The use of threats may result in apparent changes, but they are "yielding" to the new expectations rather than a commitment to the new beliefs. In the short term a manager may get the behaviour wanted, but it is unlikely to last.

Aptitude

Aptitude refers to an individual's ability in relation to something, such as their knowledge and skills, and general ease of learning and understanding.

People have different aptitudes. For example, some people have an aptitude for using computers or for manipulating numbers or for using words effectively, whilst others do not seem to have these abilities. Whilst it is undoubtedly possible for everyone to learn them, it appears that it comes easier to some more than others.

Aptitude testing is used widely to decide the suitability of individuals for particular types of job and, whilst this may exclude some who may be perfectly able to learn the necessary knowledge and skills, it is a useful indicator for helping to fit individuals into the most appropriate jobs.

Motivation

Motivation is what makes an individual act the way he or she does. It is a tendency of an individual to take action to achieve a particular goal.

The question of what motivates workers to perform has been the subject of a great deal of research and there are a number of theories; for example:

- Maslow's hierarchy of needs, which we outlined earlier, asserts that people have a number of different needs arranged in a hierarchy and as each is satisfied, the need to satisfy the next level up becomes the motivating factor.

- Herzberg's identification of motivating factors (recognition, responsibility, achievement, advancement, the work itself) which, when present, increase satisfaction from work and provide motivation towards superior effort and performance. These are distinct from other factors (which he termed "hygiene" factors) which increase dissatisfaction when absent, but when present do not result in positive satisfaction and motivation. These include type of supervision, salary/wages, working conditions, company policies, rules, etc.

- Expectancy theory, which deals with the complex relationship between the expected outcomes from a particular course of action, the desirability of that outcome and the effort required in order to achieve the outcome.

So there is no simple answer to what motivates people. As individuals we are all motivated by different things. In general, it is thought that these go beyond simple punishment and reward, although they may still feature, and that material rewards are not wholly effective as motivators. Far more important are such factors as the opportunity for power, pleasant working conditions,

satisfaction in a job well done, good social relationships and a feeling of belonging. However, motivation is affected by the job involved, the circumstances at any one time and the individuals involved.

In terms of health and safety, we can see this by looking at the motivation of a person to wear personal protection equipment (PPE) at all times. This may be by being aware of the positive benefits of avoiding injury or the fear of disciplinary action. However, it is more likely to be done if the worker earns recognition from others for doing so (or avoids criticism for not doing so).

Perception of Risk

Perception is the process by which we use our senses to compare the information we receive with our existing knowledge and attitudes, in order to give meaning to events, situations and other people. This process is highly subjective and hence the way in which different people perceive the same situation can vary enormously. This can be very important to health and safety where a hazard or risk may not be recognised as such.

The way in which people perceive things not as they actually are, but in other ways, is known as distortion. This can arise from two main sources:

- From not noticing certain things at all, perhaps due to a failure of our senses; (for example, failing to notice the smell of leaking gas), but more likely due to such factors as selectivity and familiarity. If we were to absorb every item of information our senses perceive and try to make sense of each part of this massive input, we would almost certainly overload our brains. Thus, we tend to be selective in those things which we consciously notice, often ignoring the familiar. For example, failure to notice that a foreign object is lying across electrical connections or that a scaffolding joint is not secured may all occur because of the everyday familiarity of the other features in the situation.

  There are ways in which we can overcome this in order to catch someone's attention and alert them to danger; for example, safety notices, warning signs, and fire alarms all use strong, large visual images or loud sounds, often repeated.

  Failures in our senses can also be caused by fatigue, overwork, stress, etc.

- From interpreting them in a different way, based on the person's knowledge and attitudes about the event or situation. This may be because the person has little or no prior knowledge about the hazard and therefore does not understand the danger or make the connection between an event and its consequences. This is the case with young children encountering situations for the first time and not understanding the risk posed by, say, an electrical socket. It also applies to inexperienced workers.

  Different interpretations may also arise from allowing other factors to cloud judgements about the event or situation. Thus, managers in the workplace may see risks in a different light to workers due to their different priorities, and workers may see risks differently at different times when, for example, bonus payments are involved. Research has shown that there is a clear distinction between how we perceive risks to personal safety, general dangers to health, and dangers to society. Individuals who engage in hazardous sports and activities may be very reluctant to take even a small risk in the workplace.

Distortions which affect our perception of risk can be minimised with increasing knowledge and experience, and vigilance. Vigilance is associated with the culture of the organisation; where

health and safety is a priority it is likely to be an automatic habit, but where there is a negative view of health and safety measures then the opportunities for distortion are high.

Errors and Violations

It is useful to make a distinction between these two types of incident which may lead to accidents.

- An **error** is an action or decision which was not intended, involving a deviation from an accepted standard and leading to an undesirable outcome. Examples include oversights, lapses of concentration and mistakes, such as failing to carry out the actions of a task, operating the wrong switch, etc. Some errors are not readily apparent and their implications may not be known for some time.

- A **violation** is a deviation from a rule, procedure, instruction or regulation. It may be a conscious act or, occasionally where the rule, etc. is not clear, it may be unconscious. This is a significant cause of many accidents and injuries at work, not so much by a deliberate flouting of safety procedures as "bending the rules" to make life easier or save time. Examples include not using machine guards because they slow down work, not taking breaks from using computers, etc.

Violations are often the result of different perceptions of risk, as described above. People rarely put themselves or others in danger recklessly, particularly where they are aware of the proper procedures and rules. Instead they are likely to weigh up the risks involved and decide that the gain from the violation is worth the risk.

Effects of Age and Experience

Accident rates tend to vary with the experience of the workers. The more experienced the worker, the better the safety record. This is not hard to understand, since with experience should come a better understanding of risks and greater appreciation of safety measures. This points to a need for good induction procedures when new workers are introduced to a workplace.

Note that it is experience which is most important, not necessarily age. Young people, perhaps starting work for the first time, are obviously the most inexperienced, but older people starting work in a new environment are also likely to lack understanding of the particular risks associated with that environment. In addition, younger workers are less likely to suffer death or permanent disablement due to injury at work as older workers, perhaps due to their greater agility (both physical and mental).

Influence of Peers

In a workplace environment, individuals usually work together in groups. Even if the work does not require people to work together in this way, individuals will form informal social relationships with the other people they come into contact with in the workplace (their peers). The influence of groups on the behaviour of individuals, and how they relate to the organisation as a whole, have been the subject of a great deal of research and writing by management experts over many years.

All groups, whether they are formal work groups within the organisation or informal groups (for example, a group of friends who go out together in the evening after work), establish a pattern of

attitudes, behaviours, values and beliefs, etc. which are known as group norms, and to which members are expected to conform. The pressure to conform can be very strong and comes from the need for approval and acceptance (and the converse need to avoid disapproval and rejection). Thus, such norms are very powerful influences on behaviour. A famous study in the 1930s, known as the Hawthorne Study, discovered that the production norms to which the workers were conforming were established informally by the workers themselves and were remarkably resistant to change by formal expectations of management or even increases in bonus rates for higher outputs.

Group norms develop through the informal processes of social interaction to support the shared goals of the members of the group. Even within formal work groups, the goals may not necessarily coincide with the organisation's goals for the group; they are likely to include the organisation's formal goals, but may well extend beyond them into meeting other needs. For example, a particular group within an office may be quite happy to meet whatever production targets are given them, but always organise their work to enable them to finish early on the last day of the week so they can meet after work together. In order for the organisation's own values and expected behaviours to be adopted by the group, they must be accepted as appropriate to the needs of the group.

This has considerable implications for health and safety in that it would appear that, in order for individuals to conform to the organisation's policy and practices, these policies and practices have to be accepted as part of the norms of the groups to which they belong. If the norms favour good health and safety practices in the workplace, an individual within that group will normally react or respond by accepting those same values. However, if the group norms dictate that, for example, wearing protective clothing or following safety codes is foolish, individuals will be reluctant to conform to the organisation's policy, or if they do, may seek to find ways around it.

REVISION QUESTION 2

(1) List the main internal and external influences on the approach to health and safety in an organisation.

(2) What is perceptual distortion and how may it arise?

(3) What is the difference between an error and a violation?

(4) How do an individual's peers exert influence over his/her behaviour?

The suggested answers are given at the end of the unit.

EFFECTING CULTURAL CHANGE

There are a number of key means by which the approach to health and safety within an organisation can be developed and improved. They apply whether there is a negative culture which has to be changed or a positive culture exists and has to be maintained.

Management Commitment and Leadership

We have noted before that management sets the tone for health and safety within the organisation. Without management commitment it is unrealistic to assume that workers will by themselves adopt the necessary systems and procedures to ensure safety throughout all aspects of the organisation. (They may, though, be in a position to force management to take the issues involved more seriously than they do, through the exercise of their legal rights to consultation and through the actions of their union safety representatives.)

Management commitment starts at the very top of the organisation. Senior managers must provide the leadership necessary to inspire and motivate managers at all levels to pursue health and safety objectives as rigorously as other production-orientated objectives. This may be done by establishing clear priorities and targets which arise from the organisation's safety policy and ensuring that they are met throughout the organisation.

An important factor in demonstrating management's commitment is **management visibility**. If management are never seen on site or seen to be taking an active interest in safety issues, then there will be an assumption that they are not interested in the job or in health and safety. Individual managers must believe that their commitment to health and safety is of the utmost importance in setting the tone for the company's attitude to safety, which will be accepted by workers as part of their culture. This visible commitment can be demonstrated by:

- Being seen and involved with the work, taking an interest and correcting deficiencies:

    - Having an open door policy regarding health and safety issues to encourage workers to raise issues of concern

    - Encouraging ownership and personal responsibility/participation in health and safety.

- Promoting changes to improve health and safety:

    - Reviewing the status of health and safety committees and health and safety practitioners, and encouraging a high visibility for them within the company

    - Producing regular reports of health and safety performance and acting on them.

- Providing sufficient resources to carry out jobs safely:

    - Ensuring that there are enough people, time and money to carry out the job safely

    - Providing appropriate personal protective equipment.

- Ensuring that all personnel are competent to carry out their work by providing appropriate training, as and when necessary, in all aspects of the job, including safety.

- Enforcing the company safety rules and demonstrating their own observance of them, matching their actions to their words by ensuring that defects are corrected as soon as is reasonably practicable and not allowing double standards to operate.

Use of Competent Personnel

One of the reasons for poor health and safety is the lack of competent personnel within the organisation who will set high standards and lead the drive for safe working conditions and practices.

It has to be acknowledged that management may often lack the detailed knowledge and skills necessary to plan and implement safety procedures in all aspects of the workplace. However, there is an obligation on employers to acquire that knowledge and skills by appointing specialist health and safety practitioners, either as full-time workers (which is likely in high risk industries) or by arranging for existing workers to be trained to take on the role, or by bringing in external advisers. Such people can often act as a catalyst to stimulate action on health and safety.

Effective Communication within the Organisation

We should start here with a definition:

> Communication is the process whereby an individual or group conveys, consciously or unconsciously, information to another individual or group, and where necessary triggers a response. The information may be facts, feelings or ideas.

Note two points from this which are often overlooked.

- Communication can take place whether we are aware of it or not. This is important because information can be transmitted in an unconscious way, particularly by how it is communicated, for example the choice of medium, unintended meanings in words, or non-verbal cues such as body language.

- Communication is usually intended to trigger a particular response, such as to get someone to do something, understand something, etc. The measure of effectiveness in such circumstances is the degree to which the desired response is achieved.

There is a basic process which holds true for any type of communication – among individuals or groups, formal or informal, etc. It can be shown as in the diagram below.
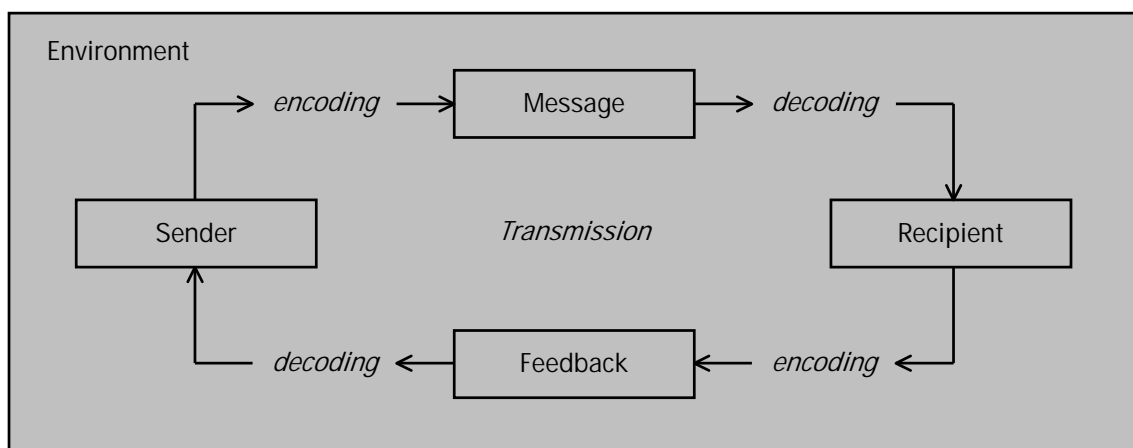
The Process of Communication

We will outline each of the parts of this process before going on to look at methods of communication and their effectiveness.

- The "sender" will originate the message, which only exists as information in the sender's mind.

- Before the message can actually be transmitted, it must be "encoded", that is translating the intended meaning which exists in the sender's mind into the words, gestures and symbols, etc., which will actually be conveyed. Major problems can arise and much depends on the sender's skill in putting his/her meaning into effective words, etc., which the receiver will understand. This involves making assumptions about what the receiver will understand, the appropriateness of certain words, gestures and symbols in the situation, the sender's expectations and past experience, relationships (particularly in terms of status) between the sender and receiver, and even the emotional state of the sender.

- "Transmission" is the form of communication itself, maybe written, oral, non-verbal (gestures and symbols); and the medium by which it is delivered, such as a letter, e-mail, telephone, face-to-face meeting, etc. To a large extent, this part of the process is bound up with the encoding part, but it is useful to distinguish them in order to identify the slightly different concerns associated with the transmission part itself. Careful consideration has to be given to the appropriateness of different media for the type of message, and we shall consider this below.

- The "receiver" is the person or persons to whom the message is directed. Note, though, that there may be unintended receivers, such as people who overhear a conversation or can see an exchange through an office window, or those who read a letter, etc., left on a photocopier or unprotected on a word processing system.

- The receiver has to "decode" the message as transmitted in order to understand it. Effective communication takes place where there is a common understanding of the message between the sender and the receiver, but the decoding process can result in misunderstandings where the word, gestures or symbols are not interpreted as intended by the sender.

The pattern of "sender→encoding→transmission→decoding→receiver" fully describes the communication process, but is only one part of it. Often there is a reverse process of "feedback". Where a particular communication does not allow for feedback, it is known as "one-way communication". Not surprisingly "two-way communication" is where there is a provision for feedback. There is no necessity for communication to be two-way; for example, memoranda, newsletters, brochures, etc., are invariably one-way and are concerned with providing information, making announcements, etc., without engaging in any dialogue. Two-way communication provides the opportunity to check that there is common understanding between transmitter and receiver, but increases the possibility of problems in the encoding and decoding parts.

The last part of the process is the "environment" within which the transmission takes place. This both conditions the way in which the system operates and can have an impact on the process itself, in either a positive or negative way. There are two aspects to consider:

- The broader organisational and management context and culture within which communication takes place, which may affect both the chosen form of words, gestures, etc. and the medium, in relation to both what is available and regarded as appropriate.

- Interference in the process itself through what is usually called "noise", including interruptions in the encoding or decoding process (such as fatigue or distractions) and in

the transmission itself, such as static on a telephone line (from which the term derives). Noise is invariably a barrier to effective communication.

Forms of Communication

There are two main types of communication:

- Verbal communication, which is the use of words to communicate, either in written or oral form (and we will consider each of these separately below), and

- Non-verbal communication, which includes communication by pictures and by behavioural and presentational cues (commonly called "body language").

Written Communication

Written communication is the main form of communication in most organisations and includes reports, messages, letters, guidance and procedure manuals, newsletters, brochures and notices, etc.

Written communication has a number of very significant advantages:

- It provides a permanent record of the message, one that can be referred back to and checked

- Writing allows for more careful compilation of the message, with the opportunity to think it through, clarify and ensure easier understanding

- Written materials can be widely distributed with ease, using printing and copying facilities to reach people unable to attend personal communications.

On the other hand, it does not come without certain disadvantages (although not all of these apply if sent by electronic means):

- Producing the quality of written materials to which receivers have become accustomed is not cheap, and with the temptation to distribute very widely, the costs of printing, paper, postage, etc., can be expensive

- Written communications can tend to be impersonal

- Misunderstandings are difficult to clear up and the timescale for feedback can be quite long (compared with oral communication); also, wide distribution and the permanency of the record can increase any problems.

Oral Communication

Communication via the spoken word takes place on an individual level in face-to-face conversations or on the telephone, and among groups of people in meetings. This is just as important a form of communication in organisations as that by the written word; after all, people spend a large proportion of their time interacting with others.

Oral communication has certain advantages:

- It is immediate in that information can be provided as and when wanted, often in response to questions

- The opportunity for immediate feedback and questioning should ensure that understanding is maximised

- It is more personal and direct, with the personality and feelings of the participants being allowed into the communication process.

On the other hand, there are disadvantages:

- It is time-consuming and costly, particularly where a number of people have to be brought together, and can be difficult to stop or finish.

- The temporary nature of the communication can lead to problems in recall of precisely what was said, particularly on technical matters (although the production of written materials as a record of the communication after the event can overcome this).

- On the other hand, there may be more opportunities for misunderstandings owing to the direct nature of both the communication and the feedback opportunity. Possible problems include the lack of preparation in dealing with questions (leading to casual responses which may not be correct), overlooking certain items either in the initial message (forgetting to cover them!) or in responses to questions, problems with checking meaning after the event, and status differences between manager and subordinate (or even tutor and student) causing reluctance to ask for clarification.

One of the main features of oral communication is that it is nearly always two-way. So, it is worth noting that it involves the ability to engage in a dialogue. Thus, effectiveness depends not just on the quality of the spoken word by the sender, but also on the quality of listening and the way in which feedback takes place.

Non-Verbal Communication – Graphical Symbols

Symbols are widely used in safety communications, particularly for signs indicating hazards or instructions about safety procedures and measures, such as fire escape routes, the use of personal protection equipment, types of hazardous chemicals, etc. They have the advantage of being free of language and very direct, with no additional information being necessary. However, they depend upon a common agreed understanding of their meaning and this is not always clear to those who have never seen the symbol before.

Non-Verbal Communication – Body Language, etc.

It is almost impossible to engage in both written and oral communication without also transmitting messages by means of the various signals given out by our behaviour or other factors in or surrounding the communication. They are so important that research has suggested that they are crucial in ensuring the effectiveness (or otherwise) of the communication.

The types of non-verbal cues that convey information are:

- Body language – gestures, eye movements, expressions and general posture which provide much of the information about people's feelings

- Voice – the pitch and tone, etc., of how a message is conveyed

- Space – the way in which the physical environment is laid out may affect the effectiveness of an oral communication, for example by ensuring comfort and lack of intrusion into personal space

- Personal presentation – clothing, grooming, etc., can give signals about a person which can support or detract from the message being conveyed

- Written presentation – the physical layout and structure of words on a page can be crucial in making its meaning easier to follow, apart from the clarity of the words and sentences themselves.

What is important to effective communication is the consistency between the non-verbal cues and signals, and what is being said. (There is less chance of such problems happening with written communication.) It has been suggested that there are six possible ways in which these points can be combined, the first four of which reinforce the verbal communication and the last actually negates it:

- Repetition – for example, pointing as well as giving directions

- Complementing or adding to – for example, looking embarrassed when confessing to a mistake

- Accenting or emphasising – for example, pounding the table when making a point

- Regulating the communication – for example, nodding your head to indicate that someone else should speak

- Substituting for speech – for example, shrugging your shoulders instead of speaking

- Contradicting – for example, showing anger whilst saying "I'm not angry".

Effectiveness of Different Methods of Communication

The need for effective communication is paramount in health and safety. It is vital to get the message over about general attitudes towards safety and also to ensure that specific procedures and practices are properly understood.

There are a number of different methods used in organisations to achieve this and the main ones are reviewed below. Note, though, that all forms of communication can be used to convey information about health and safety, and you should not limit yourself to just those outlined here.

- **Worker handbooks**. These are used to set out the organisation's health and safety policy (among other important information about the objectives of the organisation and conditions of employment). All workers will be given a copy on joining the organisation and updates will usually be circulated to inform staff of any changes. This is a key document for all staff, but it is of general interest only, not being specifically related to the jobs that people do. It is likely that safety policy will be covered in induction training to ensure that the main points are understood by those who will not want to read through the whole formal policy statement.

- **Procedure manuals and handbooks**. These provide detailed written instructions about operational matters, covering both operating procedures and, where appropriate, health and safety issues. They are the "bibles" for many jobs and are often used as the basis for specific job training. If they are well-written and comprehensive, they should be effective in setting out what is required. However, it is rarely sufficient to rely just on such written documents to ensure safety.

- **Safety briefings**. These are aimed at the specific job safety requirements and deal with the detail of hazards and the safety procedures and practical measures designed to provide protection. They will be tailored to the immediate needs of staff and should provide opportunities for questions and demonstrations. The limitations of such briefings are those of spoken communication in general, and a procedural manual is often useful as support.

- **Toolbox talks**. These are a development of safety briefings and involve detailed examinations of specific problems and issues in the place of work. They are practically

based, and work through the health and safety requirements for the tools, equipment, materials and procedures which are used every day or for particular jobs.

- **Memoranda**. These are written notifications which are used to provide specific information about a single issue, such as updating procedures, drawing attention to lapses in practice, etc. There is no opportunity for feedback or questioning, so their use is really limited to issuing clear and precise instructions. They may not be effective if the message is not absolutely clear, and some managers tend to cover several issues within the one memo, which can lead to confusion.

- **Notices, posters and films**. These are all used to provide safety "propaganda", drawing attention to particular hazards and risks, or to particular safety practices and measures. They depend for their effectiveness upon being "eye-catching" and also having some specific relevance to those they are aimed at. Posters and notices can add to and support the general health and safety culture of the organisation and are often an indication of management's commitment to it. However, too many can obscure the messages which are being conveyed, and the use of general notices (or even dedicated safety notice boards) does not guarantee that they will be seen and acted upon.

- **Signs**. These are required in many instances; for example, for fire escape routes or the labelling of hazardous substances. They act as reminders about particular things and should not be used as the primary means of communicating information. Thus, safety briefings on a construction site should cover all the necessary requirements about wearing hard hats, etc., with the safety signs reinforcing the message.

Consultation Procedures

We have already discussed the subject of worker consultation on health and safety matters, and the importance of participation and involvement in implementing organisational change. In addition, worker involvement in discussions and decision-making provides an opportunity for management to use the first-hand experience of workers when considering working practices and procedures.

The procedures used in consultation may be formal and informal committees and working groups, as well as structured team briefings.

Committees and working groups

Formal meetings of committees, sub-committees and working groups are important channels of communication and are widely used in both public and private sector organisations. Indeed, they can be crucial to organisational effectiveness where there is a duty to involve specified people in the decision-making process. Committee systems have both a constitutional basis in that certain types of meeting are often required to take place (for example, safety committees), and also a legitimate functional role in that they provide a framework for hearing a range of views prior to decision-making.

The main functions of formal meetings are to:

- Provide members with an opportunity to exchange views and information

- Make recommendations for action to a higher organisational level

- Generate ideas or solutions to problems

- Make policy and other decisions for the organisation.

Membership of such committees and groups should reflect the various interests involved, including employers and workers, and health and safety practitioners who will be expected to provide the specialist knowledge.

Team briefings

The use of a team briefing is a specific technique aimed at combining the features of upward and downward communication in the formal spreading of information through the organisation. It may be used for all types of organisational information and policies, and safety is often one of the subjects. The approach is to cascade information down (as in a waterfall) through the organisation by means of face-to-face meetings which also allow for a degree of discussion and upward feedback by means of questioning. Briefing groups usually comprise 10 to 20 members of staff, with the briefing being led by their immediate manager/supervisor.

The system works from the top of the organisation downwards in gradual stages through the various levels, with information and policies being explained in terms of their relevance to each working group. The briefings also give workers the chance to respond to management information or announcements that may have been "passed down", and allow management to measure workers' thoughts, views and feelings about aspects of organisational life.

Training

Training has been defined as *a planned process to modify attitude, knowledge or skill behaviour through learning experience to achieve effective performance in an activity or range of activities*. It is concerned mainly with short term performance of the job or task in hand. It provides the preparation to undertake specific requirements by, usually, the development of particular skills – so, for example, it may include training to use a new piece of equipment or a new computer application, or to improve letter writing or report writing skills. It may also be linked to development plans, for either the individual and/or the organisation, in which case it may be applied to assist with career growth and the building of skills which may or may not be immediately required, but will be in the future.

Training is perhaps one of the key weapons in health and safety management as it can be targeted at developing the necessary understanding and skills in individuals and groups. Its success depends on identifying training needs and the changes in behaviour required, and setting outcomes which can be demonstrated after the training has been given.

The benefits which flow include:

- New workers, both new recruits to the organisation and those changing jobs within it, are able to accept the requirements of the job, including safety aspects, and become effective quickly.

- The correct and safe method of carrying out a task is learnt from the beginning and, as there is less risk of passing on bad and unsafe practices, machinery and equipment are used more effectively. This means there is less likelihood of accidents occurring in the early stages of a worker starting a new job.

- Well trained workers who understand the processes in which they are involved and are skilled in operating them are more productive and work to higher standards. They also tend to stay longer with the employer, ensuring future reliability and continuity.

There are a number of key points relating to safety training which we will discuss below.

Induction Training

A new recruit could be hit by a fork-lift truck on the first day of employment, or a fire could break out soon after his/her arrival. Safety training is therefore a priority from the outset.

The immediate concern will be to set out the general instructions and procedures to be followed for safe movement around the workplace and what to do in the event of a fire or accident. Only after that should training move on to the hazards of the specific workplace environment in which the recruit will be working. This should precede instruction in the tasks themselves, ensuring that working safety is given emphasis. Later sessions should progress to the joint responsibilities of management and workers for safe working practices and give more detailed attention to the causes and prevention of accidents and fire.

Special attention should be given to the safety training needs of young and inexperienced people. Young people under the age of 18 are particularly vulnerable to accidents and should be taught to act safely and obey safety rules from the very first day they join the company.

The induction training for managers will have to be more detailed in order to provide them with more information on:

- Company safety policy and plans

- Legal duties of the company

- Specific legislation covering company activities and premises

- Risk assessment, safety auditing and inspections

- Hazards associated with the company's processes, products, services, premises, waste, risk management and accident prevention

- Grievance procedures and disciplinary procedures relating to health and safety

- Worker motivation and involvement in health and safety aims.

Job or Process Change

Whenever there is a change to the job or tasks which workers are expected to perform, the employer must arrange for them to receive appropriate training. This applies when individuals change jobs or when there is a change in the nature of the job through the introduction of new procedures or processes, or new technology.

This is necessary in acquiring the new knowledge and skills essential for effective performance, and also relates to the implications of the change for health and safety at the workplace. In some ways, experienced workers may be in more need of this than new recruits as they may feel that, being experienced, they are aware of all the hazards and risks and know what to do.

Particular needs arise when workers are promoted into management roles, usually as supervisors. The change in their role relating to health and safety is quite large and involves taking responsibility for workers' compliance with the rules and ensuring appropriate instruction is given.

We also have the situation where the skills necessary for effective performance for an existing job or role change. A good example might be that of first aiders, who must keep their knowledge and skills up-to-date and should go on regular refresher training courses.

Changes in Legislation

Health and safety is heavily regulated by the law and employers must ensure that they comply with its demands at all times. This means that as laws are updated or new legislation is passed, they must set up procedures for implementing the new requirements.

There are two points to note:

- We must monitor developments to ensure that they are aware of impending changes and can take the necessary action

- We must provide structured training to all staff, both management and workers, who will be affected by it.

REVISION QUESTION 3

(1)   Why is encoding such a key element in the communication process?

(2)   Is feedback essential for effective communication?

(3)   What are the main advantages and disadvantages of both written and oral forms of communication?

(4)   How are graphical (picture) symbols used in safety communications?

(5)   How may safety briefings be supported?

(6)   What are the main functions of committees and working groups?

(7)   What should be the first priority in induction training?

(8)   Apart from induction, when should training always be provided?

The suggested answers are given at the end of the unit.

UNIT SUMMARY

In this study unit we have outlined the concept of culture within an organisation and then moved our focus onto safety culture. We have examined how to identify and measure cultural indicators and demonstrated the importance of communication and commitment in promoting and maintaining a positive safety culture. We also considered how a negative safety culture could be induced by bad or indifferent management and by organisational change.

The safety culture is a product of a variety of influences, some internal to the organisation and some external. The internal influences are dominated by management commitment and style (including the form of communication), although this is off-set by the role of competent personnel and worker representatives. The nature of the industry and the demands that makes on production is also an important factor. The influences from outside the organisation are dominated by the need to comply with legislation, but there are also strong pressures from trade unions, the insurance companies and the public at large. The prevailing economic conditions provide a general background to what may be regarded as practicable.

The safety culture is also a product of the people who work within the organisation and the way in which they behave. We examined the influences on human behaviour, and again noted there were internal factors, such as personality, attitude, aptitude, motivation and the perception of risk; and external factors, principally the influence of groups, but also including the nature of the job and the organisation itself.

The development and promotion of health and safety can be seen as requiring management commitment. The means by which health and safety measures are introduced and cemented into the fabric of the organisation are through the use of effective communication, specialist practitioners and training.

SUGGESTED ANSWERS TO REVISION QUESTIONS

Revision Question 1

(1) Your definition should cover the main points of the definitions given in the unit:

– From IOSH: "The characteristic shared attitudes, values, beliefs and practices of people at work concerning not only the magnitude of risks that they encounter but also the necessity, practicality, and effectiveness of preventive measures."

(2) Active indicators show how successfully health and safety plans are being implemented, mainly through the extent of compliance with systems and procedures.

Reactive indicators show the outcomes of breaches of health and safety systems and procedures, mainly through accidents, etc.

(3) A low incidence of accidents may conceal a high number of near misses, or even a lack of reporting. In low risk organisations, a very low rate of accidents would be expected and any accidents may be a cause for concern. It is not the accident rate itself which indicates the state of health and safety in the workplace, but why those accidents take place.

(4) A lack of focus on health and safety by management and staff, increased pressure of work on individuals during the change period, uncertainty over the outcome of change causing demotivation.

Revision Question 2

(1) The main internal influences are management commitment, the demands of production, the form of communication, levels of competence and worker representation

The main external influences are public opinion and expectations, legislation, trade unions and insurance companies.

(2) Perceptual distortion, as applied to risk, occurs where the risk is not recognised for what it is. This may occur because of a failure to notice the hazard or a failure to interpret it as a risk.

(3) An error is an action or decision which was not intended, involving a deviation from an accepted standard and leading to an undesirable outcome. A violation is a deviation from a rule, procedure, instruction or regulation.

(4) Through the influence of groups and group norms.

Revision Question 3

(1) In order for the communication to be effective, the message at the centre of the communication must be understood by the receiver in the way intended by the sender. The process of encoding (and then decoding) involves putting the message into words, gestures and symbols, etc., which the receiver will understand, so this is central to the effectiveness.

(2) No. Feedback opportunities may help, but are not essential. Most written communication is one-way and this does not, in itself, make that form of communication ineffective.

(3)   The following table shows the advantages and disadvantages of the two forms of communication.

	Advantages	Disadvantages
Written	Permanent record More careful compilation Widely distributed with ease	Expensive Impersonal Lack of feedback may lead to misunderstandings
Oral	Immediate provision of information Immediate feedback Personal and direct	Time consuming and expensive Impermanent Opportunities for misinformation

(4)   Predominantly in signs.

(5)   By the use of procedural manuals and by reinforcing signs.

(6)   The main functions of formal meetings are to:

–   Provide members with an opportunity to exchange views and information

–   Make recommendations for action to a higher organisational level

–   Generate ideas or solutions to problems

–   Make policy and other decisions for the organisation.

(7)   To set out the general instructions and procedures to be followed for safe movement around the workplace and what to do in the event of a fire or accident.

(8)   Whenever there is a change to the job or tasks which workers are expected to perform, and when new legislation is introduced.

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INTRODUCTION

A common thread in legislation throughout the world is the concept of risk assessment. In some regions like the European Union, there is an explicit legal requirement to conduct "suitable and sufficient" risk assessments. Even in regions where there is no explicit reference, it is always implied. Implicit in any attempt to protect the health and safety of workers is the process of identification of hazards and the people at risk, a broad assessment of the magnitude of that risk and some consideration of what action to take to reduce that risk. The nature of the assessment will depend on the relative complexity of the risks, the processes involved, the number of personnel exposed, the legal requirements and the current safety procedures.

In this unit we will look at the risk assessment process in detail and at the different criteria that should be taken into account. We also examine the classification of hazards, risks and incidents which form the basis of the assessment procedure. In doing so, the unit is designed to meet the following aims and learning outcomes as specified by NEBOSH for this part of the syllabus for the International General Certificate.

Overall Aims

On completion of this unit, you should understand:

- The process of risk assessment

- Risk assessment recording and reviewing procedures.

Specific Intended Learning Outcomes

When you have worked through this unit you will be able to:

- Explain the aims and objectives of risk assessment

- Distinguish between high frequency/low severity events and low frequency/high severity events

- Identify hazards by means of workplace inspections and analysis of tasks

- Use accident and near-miss data in risk assessments

- Use a simple risk assessment technique to determine risk levels and to assess the adequacy of controls.

DEFINITIONS

We need to be clear at the outset about the meaning and use of two key terms.

Hazards

A **hazard** is an article, substance or situation that has the **potential to cause harm or damage**.

The key word is **potential**. Not all hazards will cause harm all of the time. It depends upon circumstances. Typical workplace hazards include:

- Working at heights

- Noise

- Electricity

- Machinery

- Chemicals

- Poor lighting

- Manual handling

- Cluttered walkways

- Fire.

These are just a few examples. In a normal workplace there may be many more hazards.

Hazards are not limited to situations where there is an immediate possibility of harm. They also relate to situations where harm may occur as a result of long-term exposure to the situation.

Risks

A risk is the **likelihood of harm occurring**. The degree of risk is based both on likelihood and severity of outcome (type of injury, numbers involved etc.).

Again, risk may relate to the immediate consequences of the hazard and the long-term effects.

Note that hazards will always exist, to some degree, in the workplace. It is possible to eliminate them in certain circumstances, but generally they are part and parcel of work. The risks arising from them, on the other hand, can be controlled in such a way that the likelihood of harm from the hazard is reduced to an acceptable minimum or even eliminated completely.

OBJECTIVES OF RISK ASSESSMENT

A risk assessment is a careful examination of what could cause harm to people, so that you can determine whether you have done enough or should do more to prevent harm. So, the overall aim of a risk assessment is to ensure that no one suffers harm as a result of workplace activities.

Within this basic model we can identify three main reasons for assessing and managing risk, as described below.

Human Harm

The strongest reason for risk assessment is to prevent harm occurring to people as a result of workplace activities.

Many workplace activities are inherently dangerous, or may be so given the right (or wrong) combination of circumstances. However, no one expects to risk life and limb, or their physical or psychological health, as a consequence of going to work. There is therefore a moral duty on employers to take appropriate steps to ensure the safety and health of their workers, and others. Risk assessment is the main means by which this can be effectively planned.

Legal Effects

Employers have legal obligations in relation to health and safety which, if they do not fulfil them, may give rise to severe penalties, including fines or imprisonment. A proper risk assessment may provide evidence that an employer has taken the proper steps to fulfil those obligations.

Economic Effects

Employers will want to minimise the often substantial financial costs of accidents in the workplace. The costs include not only the direct costs of damage to machinery and equipment, and compensation payments to those injured, but also a big range of indirect costs, such as loss of output, loss of orders, increased insurance premiums, etc.

ANALYSING INCIDENTS

As we have seen, the aim of risk assessment is to create conditions at the workplace which will minimise the possibility of incidents arising. An understanding of the types of incident will help to identify where and how risks arise, and what their consequences are.

Distinction Between Different Types of Incident

In Unit 1, we defined a number of terms in common use relating to different event outcomes. It is true to say that these terms may be defined slightly differently between organisations. For example, OHSAS 18001:1999 defines "Incident" slightly differently from that defined in ILO-OSH-2001. In such cases, it is therefore wise to state our terms of reference. Here we recap on these definitions.

Activities at work can give rise to incidents, which are any events the outcome of which may (but not necessarily) cause harm to people and/or loss. Accidents are a particular type of incident and they may result in loss, personal (minor) injury, serious injury or death. Where no such outcome results, the incident is classified as a near miss. Certain types of incidents, including accidents, may also be reportable to the authorities.

The relationship between these various occurrences is shown in the diagram below.
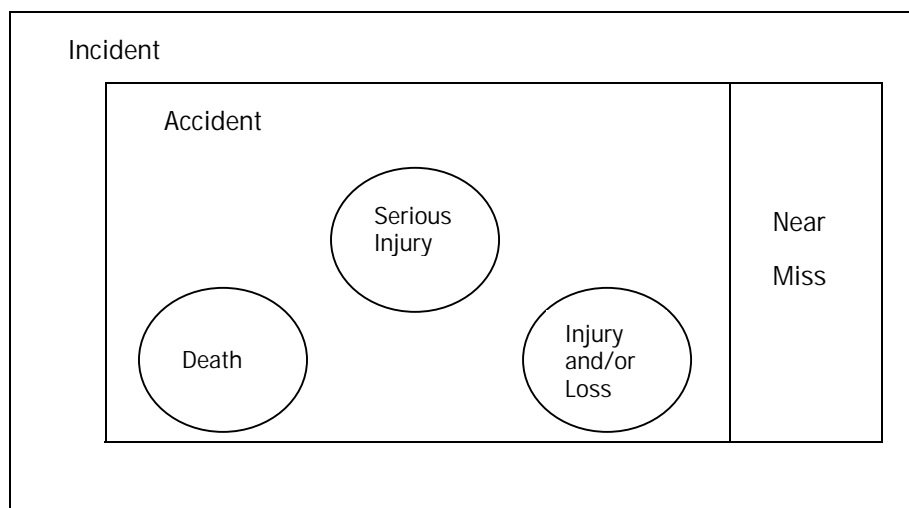
Events, Incidents and Accidents

Ill-Health

More working days are lost (and, indeed, deaths are caused) because of illness arising from conditions at the workplace. Certain work-related diseases and ill-health occurrences are often reportable to the government enforcing authorities. Here is a typical list:

- Poisonings

- Skin diseases, such as occupational dermatitis and skin cancer

- Lung diseases, including occupational asthma, pneumoconiosis and asbestosis

- Infections, such as leptospirosis, hepatitis, tuberculosis and tetanus

- Other conditions, such as occupational cancer.

However, it is not always possible to know to what extent a condition is due to activities within or outside the workplace. Employers cannot be held responsible for ill-health arising from the personal lifestyles of their workers (such as smoking, diet, alcohol and other drug abuse, lack of exercise or dangerous sports). An ill-health condition caused by an activity other than work can, though, be made worse by an industrial situation. It can be difficult to establish precisely from where the problem originates; even so, a healthy workplace and a healthy environment should be provided, even for workers who live very risky lives away from work.

Accidents

Accidents are **undesired** and **unplanned** events which may cause personal injury, damage to property or equipment, or loss of output, or all three.

Employers may be required to notify the enforcing authority without delay if a member of the public or the workforce is seriously injured or killed.

Dangerous Occurrences

Even non-injury incidents may have to be reported. There is often a legal requirement to report those events involving serious potential for injury, even though no injury in fact resulted, as though they frequently involve some form of loss or damage to equipment. Examples of this type might include a vehicle overturning or the collapse of scaffolding. Such items are referred to as "dangerous occurrences".

Near Miss

Near misses (or near hits) are incidents which do not result in injury or loss. They may well fall into the categories that must be reported to the authorities, and it is important not to neglect them in reviewing safety records, since they may indicate hazards and risks which are not being adequately protected against. Whilst they do not result in loss, they may have done.

Damage Only

Damage-only incidents are where there is no resulting injury or ill-health to people but where property or buildings and equipment may be damaged.

Incident and Accident Ratios

Simple statements of the number of incidents or accidents do not of themselves provide much meaningful information. More important in assessing conditions in the workplace are such questions as:

- Are incidents and accidents increasing or decreasing?

- How often do they occur?

- What is the proportion of reportable accidents to accidents in general, and what is the proportion of near misses to accidents causing injury or loss?

- Where do accidents happen?

- Which workers are injured and how are they injured?

In order to get this type of information, we have to investigate accidents and incidents in more detail and there are a number of ratios commonly used for this purpose. Ratios are statistical measurements which compare two types of numerical information and allow the expression of one number in terms of the other. Thus, comparing the number of reportable accidents with the

total number of accidents occurring, allows us to identify the proportion of accidents which result in serious injury or death. This is obviously more useful than simply knowing the numbers of reportable accidents.

Preparing statistics in this way gives far more detailed information about the patterns of incidents and accidents occurring in the workplace, and is very useful before carrying out a risk assessment. It should highlight areas of concern which may deserve particular investigation and may require additional control measures.

It also allows comparisons to be drawn between various industries, between different employers operating in the same industry, and between workplaces under the same employer. This information provides a general guide to safety performance, although care has to be taken where the basis on which the statistics were prepared may not be the same, or the workplaces themselves are not directly comparable.

Another limitation of statistical analysis is the extent to which the numbers involved allow meaningful conclusions to be drawn. This is known as "statistical significance". Often the numbers for an individual workplace are too low to allow meaningful comparisons with the much larger numbers involved across the industry as a whole.

Probability

Probability measures the chance that a given event will take place. It is a fairly simple idea which we can illustrate by considering throwing a dice. The chance of throwing a six from one dice is as follows:

$$\frac{\text{Number of possible outcomes where the result is a six}}{\text{Total number of all possible outcomes}} = \frac{1}{6}$$

So, the probability of throwing a six from one dice is one in six, or one sixth.

It is possible to use probability ratios for any incident where there is information about the numbers of both the incident itself and the total number of events within which the incident occurs. Thus, we could establish the probability of an accident causing serious injury as follows:

$$\frac{\text{Number of accidents resulting in serious injury}}{\text{Total number of accidents}}$$

Frequency Rate

Frequency ratios compare the number of incidents or accidents with some relevant measure of the working time over which they occur. The measure of working time is often the number of hours worked, but could be number of miles driven, or number of operations, etc.

The frequency rate for accidents at the workplace could be calculated as follows:

$$\frac{\text{Number of lost - time accidents} \times 100,000}{\text{Number of man - hours worked}}$$

This shows the average number of accidents per 100,000 hours worked.

Note that a "multiplier" is used (in most cases 100,000, which roughly equates to a working lifetime) in order to provide a suitable value; if it was calculated per hour worked, the figure would be so low as to be meaningless. Using a multiplier makes the final figure larger and therefore more understandable. The multiplier must always be stated when using statistics and allowance must be made when making comparisons if the multiplier is different.

Other frequency ratios include:

- The average number of man-hours between accidents, calculated as follows:

$$\frac{\text{Number of man-hours worked}}{\text{Total number of accidents}}$$

Some companies record and publish the number of days since the last accident.

- The average number of injuries per 1,000 workers, calculated as follows:

$$\frac{\text{Number of work-related injuries} \times 1,000}{\text{Average number of persons employed}}$$

Severity Rate

Severity rates compare some measure of the result of accidents with either the total number of accidents or some relevant measure of the working time over which the accidents occur. The measure of the results of accidents may be expressed in human terms (usually as the number of working days lost) or as a financial cost.

The severity rate for accidents at the workplace could, therefore, be calculated as follows:

$$\frac{\text{Total number of days lost} \times 1,000}{\text{Total number of man-hours worked}}$$

This shows the average number of days lost per 1,000 hours worked (1,000 being the multiplier).

An alternative would be to show the average number of days lost per accident, as follows:

$$\frac{\text{Total number of days lost}}{\text{Total number of accidents}}$$

It is possible to establish the financial cost to the employer for the losses arising from accidents, in terms of both damage to plant and equipment and of personal injury. In measuring such losses, both indirect and direct costs should be considered:

- Direct costs are mostly easy to calculate; for example, number of days absent from work, cost of liability claims or agreed damages, etc. However, some are problematic, particularly in valuing damage to plant or machinery where a number of different charging bases could be used (such as new-for old replacement, second-hand value, book value, etc.).

- Indirect costs are generally more difficult to put a value to. These include such items as loss of production time, sales, contribution to overheads, worsening industrial relations, etc.

Relationship Between Frequency and Severity

Remember that risk is the likelihood of an accident occurring and the severity of the outcome. Thus, by combining the frequency and severity ratios we can establish a measure of risk:

Risk = Frequency × Severity

This risk measurement can be applied to any hazard by just considering particular types of accident or accidents arising from a particular cause. Thus, we could calculate the risk associated with the use of electrical equipment in a workplace by considering the average number of accidents occurring from the use of electrical equipment per 100,000 man hours worked and the number of days lost as a result. This could be compared with the risk associated with falls and trips, etc. in the same workplace to establish which represents the bigger risk. Putting a financial figure to the resulting loss makes the risk measurement even more significant to the employer.

This type of risk measurement allows us to evaluate what level of importance should be given to hazards and what should be done to prevent risk. If we know how much it will cost us, we will find it easier to decide how much we ought to spend on preventive measures.

The most common accidents are usually those with the least cost (relatively high frequency, but low severity). They should therefore be easy to predict. However, whilst every effort should be made to prevent them, the effort and costs involved in prevention may be out of all proportion to the savings made; we do not want to spend a huge sum of money for only a very slight benefit. They will therefore be a low priority and it may even be appropriate to treat them as an operating loss.

Medium risks will be those which occur less frequently, but have a relatively high cost. These are likely to be the highest priority since the savings made for investment in preventive measures will be the greatest.

The least common accidents are usually those with the highest cost. They are very difficult to predict, but the outcome is so severe that the risk is high. Such risks may not be given the highest priority due to their infrequency, but must be given attention because of the potential outcome.

Accident Triangles

Accident triangles display the relationship between numbers of accidents with different outcomes. Research shows that this relationship forms a triangle with the most serious outcomes being the least (at the top) and those with progressively less serious results forming the base.

There are a number of different triangles used to display these relationships, depending on the way in which accident outcomes are classified. The version proposed by Heinrich in 1950 is shown in the figure below; it shows the number of less serious accidents in relation to one occurrence of the most serious.

Heinrich's Accident Triangle
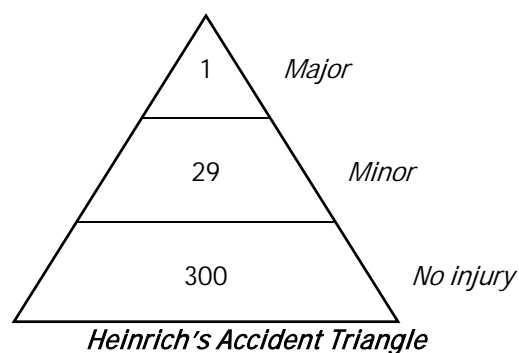
It would be a useful exercise to calculate the accident triangle for your own workplace. What should be obvious is that the larger figure of near miss incidents is a much better measure of accident potential than the actual injuries.

REVISION QUESTION 1

(1)   Why is the distinction between hazards and risks so important to health and safety management?

(2)   State the purpose and objectives of risk assessment.

(3)   What is the basic calculation for risk?

(4)   What do accident triangles show?

(5)   What limitations are there on the use of accidents statistics to draw comparisons with other workplaces or the industry as a whole?

The suggested answers are given at the end of the unit.

CATEGORISATION OF ACCIDENTS

One of the difficulties in attempting to compare accident statistics lies in the different methods used to classify the type of accident.

By Cause of Accident

All accidents at work are caused, either directly or indirectly, by human failing.

The performance of machines is predictable, whilst the performance of people is not. Although they may break down, machines never feel unwell, never forget, never play the fool, and can be fitted with built-in, fail-safe safety devices. If they fail it is most often due to some defect in their manufacture or their operation or their maintenance; all of which are also the result of some human failing.

Accident reports should make clear all the circumstances involved in the accident and detail the following information:

- Nature of the act which gave rise to the accident, for example:

    – Operating equipment without proper authority

    – Working in an unsafe manner, such as failing to use or tampering with safety devices, or using tools or equipment in a dangerous manner

    – Using defective tools or equipment.

- Physical or material causes, for example:

    – Improperly guarded or defective equipment

    – Insufficient illumination or ventilation

    – Inappropriate working clothes.

- Human factors contributing to the accident, for example:

    – Information on the age, gender and occupational experience of the operator or person involved

    – Time, place and circumstances of the accident

    – Parts of the body injured.

Information about the causes of accidents is essential for analysing why accidents happen and forms an important part of risk assessment.

By Cause of Injury

This form of classification is far easier to handle. Accidents often have multiple causes and it would be extremely difficult to develop simple to understand categories for the presentation of statistical information about them. This is not the case when we classify accidents by the way in which injury is caused.

The following breakdown is the most common. It is based on the system proposed at the first International Conference of Labour Statisticians organised by the International Labour Organisation in 1923.

Slips/Trips/Falls

There are three types of falls: falls on one level, falls on stairs and means of changing levels, and falls between levels (that is, from various heights).

While slips, trips and falls (STFs) at the same level may appear trivial, they are nonetheless the single most common cause of non-fatal major injury to workers. STFs may be due to poor footwear or the condition of the floor; it might be uneven or slippery, etc.

Falls from Height

Falls from a height have consistently been the most common cause of fatal injury to workers (closely followed by being struck by a moving or falling object). They are most common in the construction industry.

Examples of people falling from heights include falling from trees, buildings, scaffolds, ladders, machines and vehicles. As well as falling off an object, this category includes falls through fragile materials, such as roofs. Also included are falls into depths, such as into wells, ditches, excavations or other holes in the ground.

Falling Objects

Falling objects can be due to:

- Slides and cave-ins, involving earth, rocks, stones, snow, etc.

- Collapse of buildings, walls, scaffolds, ladders or piles of goods

- Poorly maintained fixtures and fittings in or outside a building coming away, including bricks or mortar, racks, roof tiles, etc.

Collision with Objects

With falls from a height, this category of accident continues to be the most common kind involving fatal injuries to workers.

Collisions may be the result of:

- Striking against motionless objects (except impacts due to a previous fall)

- Striking against moving objects

- Being struck by moving objects (including flying fragments and particles), excluding falling objects.

Trapping/Crushing Under or Between Objects

These types of injury may be the result of being:

- Caught in an object; for example, in machinery of some kind (a relatively common cause of agricultural accidents)

- Caught between a motionless object and a moving object

- Caught between moving objects (except flying or falling objects).

Manual Handling

Manual handling injuries occur wherever people are at work, such as on farms, building sites, in factories, offices, warehouses and hospitals. These accidents occur due to:

- Lifting objects

- Pushing or pulling objects

- Handling or throwing objects.

Most injuries are to the back, but hands, arms and feet are also targets.

Contact with Machinery/Hand Tools

This category includes both power and non-power machinery and covers a wide scope, including anything from a scalpel to power presses, circular saws, photocopiers or combine harvesters. Accidents happen not only in the use of such equipment, but also in its cleaning and maintenance, repair and servicing. They may also occur when the machinery (or the relevant part of it) is at rest.

It is not surprising that the highest rates of fatal injuries and serious accidents in this category occur in those industries where machinery is a dominant feature of the workplace, as in construction, agriculture and transport.

Electricity

Accidents in this category involve electric shock or burns, some of which are fatal. Most involve contact with overhead or underground power cables, but normal mains voltage can also kill.

Electricity is a common cause of accidents and may also be placed under other headings; for example, shocks from faulty equipment can cause falls from ladders or scaffolding, poor electrical installations and faulty or misused electrical equipment can lead to fires, and just one electrical spark may ignite flammable gases or cause an explosion.

Transport

Transport accidents are usually classed into rail transport and those involving other vehicles. Accidents may be where the vehicle is moving under power or not under power, or where the vehicle is stationary.

Statistics show most fatalities result from reversing vehicles striking a pedestrian, loading/unloading operations, and vehicles over-turning.

Contact with Chemicals

As industrial processes become more complex, it is not surprising to find that exposure to hazardous substances has resulted in a large number of diseases and fatalities each year. While the number of deaths relating directly to workplace exposure is low compared to other types of accidents, the problem of occupational ill-health shows the importance of health monitoring and specific chemical control legislation.

Suffocation/Drowning

This is a significant cause of fatalities.

Fire and Explosion

The main cause of accidental fires remains the misuse of equipment or appliances, many of which occur in the construction industry.

Animals

This is a relatively new category which mainly concerns agricultural activities where cattle are involved and incidents in zoos.

Violence

Most incidents involving violence at work are in the service industries and health care.

CATEGORISATION OF HEALTH RISKS

Unlike workplace injuries, risks to health are generally classified by the type of agent involved in creating the health risk. An agent is any substance, force, or organism which poses a health risk. It includes chemicals; physical agents such as noise, vibration and radiation; and biological agents. Note that such risks may have an immediate serious impact on health, perhaps after a single exposure to the agent, or instead cause a chronic and disabling disease after repeated exposure, possibly with no apparent effect on health until many years have passed.

Chemical Hazards

In using any chemical at work it is important to understand the nature of the hazard it represents. In particular, we want to know how any toxic (poisonous) substances may enter the body, what the symptoms of exposure are and what effects it may have in the short or long term.

Hazards are related to the different physical forms of a chemical agent:

- **Liquids**

  It has been estimated that two-thirds of all industrial injuries from chemicals are skin injuries caused by direct body contact with liquid acids and alkalis, due to the corrosive effect of those substances.

- **Dusts**

  Dusts consist of very small solid particles and are created by such operations as grinding or sieving of solid materials, controlled detonations and various drying processes. In undisturbed air, dusts tend to settle due to gravity.

  A dust can be a health hazard when breathed in, causing acute poisoning (for example with beryllium compounds) or more commonly, chronic diseases of the lung, such as pneumoconiosis.

- **Fumes**

  Fumes are very small solid particles created by condensation from a vapour, often after a metal has been converted to the molten state. The metallic fumes are usually the oxide of the metal and can produce highly toxic fumes.

  Lead, cadmium, zinc, copper and magnesium are particularly hazardous and inhaling their fumes can give rise to an illness known as **metal fume fever**. Complete removal from the exposure sees full recovery within a matter of days.

- **Mists**

  Mists consist of very small suspended droplets formed by condensation from a gas or the atomising of a liquid or from aerosols. Mists are created by many industrial processes, such as chromium plating or charging lead acid batteries, and serious hazards can arise.

Biological Hazards

Biological hazards relate mainly to illness resulting from exposure to bacteria, viruses and fungi. People who work in medical care are at risk from all types of infection found in society. It is a specialist area which we shall consider in more detail later.

Physical Hazards

Physical hazards relate to harm caused to the body from mechanical, radiation or thermal sources or because of ergonomic conditions.

- Mechanical stressors are mainly concerned with vibrations, which may also create noise, and with variations of external pressure above and below normal atmospheric.

- Hazards from radiation are classified under two headings:

  - **Ionising radiation**, which includes alpha-, beta-, gamma- and x-ray radiations.

  - **Non-ionising radiation**, which includes lasers, ultra-violet, infra-red, microwave and radio frequencies.

- Thermal (or heat) energy problems are related mainly to the effect of sweating and losing large quantities of body salts. Where the working environment is hot and humid, fatigue may be induced. This may be a less obvious condition, but it can contribute considerably to risk of accidents.

- Ergonomics is concerned with the scientific study of the efficiency of people in their working environment. This relates mainly to the way in which people sit, stand and move in order to carry out the operations which are required for their jobs, and the effects include such things as back pain or upper limb disorders arising from bad posture (as a result of workstation design).

Psychological Hazards

These relate to the mental or emotional well-being of individuals and can be affected by stress or fear.

DISTINCTION BETWEEN ACUTE AND CHRONIC HEALTH EFFECTS

When evaluating the degree of damage that could result from exposure to harmful substances or conditions, the key considerations are:

- The harmful characteristics of the substance or condition

- The concentration, intensity or level of exposure to the harmful agent

- The period over which the exposure occurs.

Two types of effect may be observed:

- An **acute** effect, which is the short-term response triggered by a single dose or limited exposure to the agent causing the ill-health

- A **chronic** effect, which is the long-term response, usually after repeated exposures to a sub-lethal concentration of the agent.

Acute effects are less common and generally arise from a failure of equipment or processes leading to an escape of the harmful agent; for example in gassing accidents.

REVISION QUESTION 2

(1)   What are the two ways in which accidents may be classified?

(2)   What are the main causes of accidents?

(3)   State the four forms in which chemical agents may be encountered.

(4)   What is the difference between an acute and a chronic effect?

(5)   State the four ways in which physical hazards may cause harm to a person's general health.

(6)   Into what categories are accidents which result in injuries caused by falling divided?

The suggested answers are given at the end of the unit.

THE RISK ASSESSMENT PROCESS

An assessment of risk is nothing more than a careful examination of what could cause harm to people, an evaluation of whether the hazard is significant and an analysis of whether enough precautions have been taken to prevent them. The aim is to make sure that no one gets hurt or becomes ill.

An individual risk assessment exercise may be carried out in relation to the totality of hazards in a particular workplace, or may be limited to particular work activities or specific equipment, depending on the circumstances. However, it is still a requirement that all of the risks in the workplace have been covered in this way.

Five Steps to Risk Assessment

Although there are often no fixed rules about how a risk assessment should be undertaken, it is important to take a structured approach which will allow all relevant risks or hazards to be addressed. The UK enforcing authority's guidance *Five Steps to Risk Assessment* (IND(G)163) is a good example of such a structured approach.

- **Step 1: Look for the hazards**

    This is the process of identifying all the hazards that exist in the workplace. You must be aware of all the possible hazards, but it is the significant ones which are important.

    One approach is to take each task and break it down into steps, assessing the hazards associated with each step. For example, the preparation of a meal could be broken down into preparation of the vegetables, etc.; cooking, to include boiling or roasting; serving, including the dishing-up and the moving to the table; and washing-up. Each step will have its own hazards. The staff actually performing the tasks are likely to be the best people to assess them, although their familiarity with the job may make them less objective about potential hazards.

- **Step 2: Decide who might be harmed, and how**

    This is the process of determining who may be at risk from the hazards, that is the groups of staff and others likely to be affected in the case of an incident involving the hazard.

    It is important to consider the wider implications of hazards, not just as they may affect those working in the immediate environment. We have to be aware of other staff groups, such as maintenance personnel and cleaners, as well as visitors and the public. Special attention should be given to inexperienced staff, lone workers or temporary staff, and to the particular needs of disabled staff, pregnant women and children.

- **Step 3: Evaluate the risks arising from the hazards and decide if existing precautions are adequate or more should be done**

    This is where we assess the significance of the risks and suggest what should be done to protect people.

    The key question is: have precautions been taken to protect the people we have identified against the risk from the named hazards? For example: are there proper working systems and procedures in place; are control measures such as guards on machines working properly; is there adequate information, instruction or training relating to the risk?

Action has to be taken where any existing measures do not appear to be adequate.

- **Step 4: Record your findings**

  The significant findings of the assessment should be recorded and kept. There should be a record of all hazards, the risks that they present and what precautions are in place to protect people from harm. This written record is an important reference for future use, not only as the basis for reviewing risks, but also as information for enforcement officers; or even as evidence in any court proceedings arising from an accident involving the risk.

  The record must cover all significant risks and state the current position; for example, "electrical wiring checks carried out in building A and everything found to be satisfactory". Reference can be made to other information where appropriate; for example, "loading bay markings checked and all in accordance with site plan 44A".

- **Step 5: Review your assessment from time to time and revise it if necessary**

  The way we work is constantly changing, perhaps as a result of new equipment or modifications of existing equipment, building alterations, new procedures, new or modified products, etc. Sometimes systems and procedures are changed by the staff themselves. They all bring their own hazards, but new hazards can also arise in existing methods of work; the effects of stress is a recent example.

  It is important that we continue to be vigilant about hazards and risks and review workplace conditions regularly. How often is "regularly" will depend on the extent of the risks and the degree of change.

Identifying Hazards

All risks in the workplace should be assessed in order to identify the most important ones. We must concentrate on these and not become distracted into devoting too much time to trivial risks.

Sources and Form of Harm

A hazard is something which has the potential to cause harm. In looking at the range of hazards which exist in the workplace, we have to look at all aspects of work, including the way in which the work is carried out and the way it is organised as well as the substances and/or equipment used, in order to assess what harm may arise.

Some hazards and their associated potential harm are obvious because they have an element of danger; for example, handling chemical substances may lead to exposure to chemical vapours or spills resulting in external and internal burns, or climbing up and down ladders may result in falls. There are many other instances where the hazards are less obvious, particularly where a normally safe operation may only become hazardous in particular situations. This may be as a result of defects in equipment (where handling simple electrical equipment may cause shocks or burns due to a wiring problem), or a change in circumstances, such as spillages or misplaced boxes and equipment making walking across a floor hazardous.

So, the circumstances also have to be looked into. Non-routine operations, such as maintenance operations, loading and unloading, changes in production cycles, are particularly important. Also, interruptions to the work activity are a frequent cause of accidents, and the management of such incidents and the procedures to be followed should be studied.

There are two main ways of identifying such hazards:

- By looking at incident data – this is reactive in that we are looking at hazards which have already been identified by the fact that the risk they present has been realised.

- By looking at the way work is performed – this is active in that we are trying to identify hazards before they are realised. The main ways of examining work are through inspections and by job/task analysis.

Roles of Inspection

Inspection relates to the examination of plant and equipment and the way in which they are used. It involves physically watching operations and testing equipment to see if there are any hazards or non-compliance with legislation, rules or safety procedures.

Inspections are usually carried out on a regular basis, including tests of plant and equipment, to ensure that everything is working as it should be. This is likely to be done as a part of routine maintenance. In most cases, some form of checklist of key points will be used as the basis of a thorough and methodical approach.

Less common are inspections of the work environment (such as the fabric of the building, the air quality, etc.) and the way in which machinery and equipment is used. It is particularly important to establish what actually happens in the workplace or during the work activity, especially where it differs from the approved methods as set out in manuals. Here, inspection is possibly the only way of checking reality, rather than what workers may want others to believe about the way the work is carried out.

All inspections should be properly documented, noting the hazards identified, the precautions in place and any action which has been or should be taken.

Job/Task Analysis

Method study and work measurement are used to analyse a particular job with the purpose of improving efficiency. A job can also be analysed in a similar way with the emphasis on safety or hazards. The results can be used to correct existing analyses and to improve, among other things:

- Methods, instructions, protection, rules, emergency procedures, serviceability of machinery and plant

- Reporting of hazards, provision of information

- Layout of work areas.

The process of job analysis should be carried out methodically through a series of steps, as explained below, and the whole analysis should be documented. (A sample job safety analysis form which relates directly to these steps is shown after they have been explained.)

Preliminary study of documents

We should have some information about most jobs. Usually there will be a job description and possibly procedural manuals which describe how the tasks should be carried out. Other relevant information may include equipment instructions and training and legal requirements, all of which help to identify the obvious hazards.

Also relevant is incident data which will reveal the (historical) existence of certain hazards.

The information obtained from this review of information about the job can be entered in the safety form as "predictable accidents". It also forms a background against which the job analyst can consider the way in which work is performed in practice.

Observation of work

The analyst should now observe the work being done, including work undertaken by operators working in groups:

- All operations should be recorded in the "job performance" section of the analysis form

- Actual and potential hazards should be sought, by observation and by questioning

- Risks which are not easily visible, such as health dangers from fumes, gases, noise, lighting and dangerous substances, etc., should be looked for

- Rules and precautions for controlling any hazard or risk should be supplied either by the operator, his/her supervisor or a specialist.

Special safety aspects

In most jobs there are special safety procedures which are not part of the production process. They should be recorded separately. Such procedures include:

- Activities concerned with permit-to-work systems

- Reporting of unsafe conditions

- Specialist inspections

- Tests of safety features and emergency procedures.

Both the operator's and the supervisor's duties should be noted.

Interaction

The next stage is to consider those situations where there are other people in the immediate work area, either because they are involved in the work activity, or for some other purpose. Thus, interactions with others during the course of the maintenance, repair, cleaning and inspection of equipment and the delivery of materials and the removal of finished articles will be part and parcel of the work. Other interactions may not be routine occurrences connected with the work, such as people passing through the work area or perhaps involve social interaction among workers.

This information can be obtained by questioning workers, but may also require direct observation.

Where potential hazards are identified, rules for controlling risks should be worked out.

Validation

Any new rules or procedures, together with the basis on which they have been devised, must be understood and accepted by the job holder and any others directly affected. The final stage of the analysis is therefore to check the findings with the operator and any others involved to make sure they represent a correct assessment of the hazards of the job and the precautions that should be taken. This applies particularly where conclusions have been drawn based on information obtained from other people or from observation.

The validated analysis can be used to prepare revised training programmes and procedure manuals, etc.

Sample Job Safety Analysis Form

Job title:	**Dept.:**
Job purpose/function:	

1. Predictable accidents *(those which have happened or obviously could happen):*

2. Equipment, etc

Machines, tools, etc	Materials	Protection supplied/required

3. Job performance

Tasks/operations	Hazards	Rules for controlling hazard

4. Safety performance *(Work done specifically for safety reasons)*

Standards	Operator's duties	Supervisor's duties

5. Interaction

Job titles	Related activities	Rules

Approved and validated:

Job holder: Date:

Legislation

Information about hazards and risks can be obtained by studying any legislative requirements which apply to the workplace in general and to specific jobs in particular.

Manufacturer's Information

Information about potential hazards and possible risks is usually available from the manufacturers and suppliers of equipment and materials, along with the instructions for use. Indeed, it is a legal requirement for them to provide such information and keep it up-to-date.

Incident Data

If the company has been in operation for some time there are likely to be records available of any incidents which have happened in the past. They are an obvious source of information about hazards, but as they are historic, they should be checked to find out whether the hazards still exist and whether appropriate safety precautions have now been put in place.

This emphasises the value of keeping detailed records of all incidents, including the losses (if any) which result from them.

The types of incident data which may be used are:

- **Maintenance and inspection records**, which give details of problems with machinery and equipment.

- **Accident records**, which should provide information about the causes of accidents (note the distinction here with the classification of accidents by cause of injury, which is not so relevant to identifying hazards). Ideally, accident data will indicate people, jobs, work areas, times of day and situations which require careful consideration.

- **Ill-health data**, which might not be so readily available. Claims for time off work due to recognised industrial conditions will be there, but it will also be worth checking on absence records to see if there are individuals or groups of workers who might be at risk.

Identifying Population at Risk

When considering people at risk, it is important to think not only of those carrying out particular activities, but also of all those who may be affected by those activities. This may include other workers who may be in the area, both during working hours (such as maintenance staff, contractors and other staff who just happen to be passing) as well as those who may be present at other times, such as cleaners and security guards. In addition, the position of visitors and other members of the public who may be affected must be assessed.

Any groups who may particularly be at risk must be identified; for example, young or inexperienced workers, those who work alone, and any disabled staff. These people may be subject to different levels of risk, depending on their personal qualities, competence, experience, age, state of health, etc.

Operators

Operators are those directly involved with the activity, or other workers working nearby or in the workplace. They may be skilled workers, trainees and young or new workers. They may be disabled in some way or may work under special conditions (such as shift workers, home or lone workers).

The way in which hazards may affect different groups has to be identified clearly.

Maintenance Staff

Particular considerations relate to maintenance staff, who will often be working under very different conditions to those applying during normal operations. They may face different hazards as a consequence.

Cleaners

The position of cleaners is often overlooked, but because they are unlikely to be aware of the operational detail of safety measures associated with particular hazards, they may be at more risk if the hazards are still "live" when cleaning operations are taking place (often outside normal working hours). Cleaning operations also present their own hazards.

Contractors

Contractors, by definition, will not be fully aware of all the hazards or control procedures at the workplace in which they are working. Their position in relation to identified hazards must be noted and the assessment must consider what must be done in addition to provide them with the same level of protection as workers.

Visitors

Visitors are in a similar position to contractors in that they are unlikely to be aware of the hazards or control measures at the workplace they are visiting. In many ways they may be more at risk since, unlike contractors who may be expected to have a general understanding of workplace risks, they may have no idea of them. Again, their position in relation to identified hazards must be noted and the assessment must consider what must be done in addition to provide them with the same level of protection as workers.

Members of the Public

This term covers all other people who may be affected by work activities, as well as trespassers (those who may be on the premises in an unauthorised capacity). Hazards affecting these groups may not be the same as for company workers and it is unlikely that they may be expected to take any safety precautions themselves. So there is an important requirement to ensure that any hazards which they may face as a result of workplace activities are contained within the workplace.

Particular issues must be addressed relating to the possibility of children coming onto the premises (for example, playing on building sites or near railway lines).

Evaluating Risk and Adequacy of Control Measures

After we have identified the hazards in the work situation, it is important to calculate the risk that they represent. There will usually be a limit to what it is possible to do in the way of controlling risks; the ideal of a perfectly safe working environment is probably impossible on financial grounds, let alone operational requirements. Therefore, we need some means of deciding where the priorities lie and what it is practicable to do.

Likelihood of Harm and Probable Severity

The basis of risk evaluation is to identify the likelihood that harm will occur as a result of the hazard and how severe that harm will be.

To show the ideas involved, we can take the approach suggested by Brian Kazer in a practical guide on risk assessment. He proposed five levels of probability that an accident will occur, as follows:

- Likely – occurs frequently, with the event to be expected

- Probable – not surprising that it occurs and likely to occur several times

- Possible – could occur sometimes

- Remote – unlikely, although it might be foreseen

- Improbable – so unlikely that the probability is close to zero.

These probabilities may be combined with possible outcomes in terms of the severity of injury caused, to give a matrix table:

Accident Probability/Outcome Matrix

	Likely	Probable	Possible	Remote	Improbable
Fatal	1	1	2	3	
Major injury/permanent disability	1	2	3		
Minor injury	2	3			
No injury					

This matrix may be used to develop simple priorities for action to control hazards. Items ranked 1 would be dealt with first since they represent the most likely occurrences with the most severe outcomes, followed by those ranked 2 or 3 where the likelihood is less and/or the outcome less severe. Those with no rank (such as a minor injury which might occur sometime) would mean that the risk is acceptable and no action would be taken.

Qualitative and Semi-Quantitative Risk Ranking

Our matrix shows a general approach to risk ranking, in which we identify those hazards which represent the greatest risk in terms of likelihood and outcome. The question is how do we put hazards into the categories?

We might make subjective judgements by looking at hazards and the possibility of harm. How effective this is depends on the quality of the judgements made by the assessor, and it is quite possible that a different assessor may come to different conclusions about the same issues.

The aim in ranking risk is to have some method which allows meaningful comparisons to be made between different risks, so that we can make an objective judgement as to the level of risk which the hazard represents. To do this, we need some agreed method of quantifying likelihood and outcome.

We have seen that accident data may allow us to do this using the following formula:

Risk measurement = Probability (or Frequency) × Severity

If we can put figures to probability and severity, we can arrive at a quantitative assessment of risk. The figures can come from data which relate to the particular workplace or the organisation as a whole, or from the industry or even wider statistics about accidents in society in general.

Note that figures from the workplace or organisation itself may not be large enough to allow meaningful assessments to be made.

There will always be an element of qualitative assessment, simply because accident data is historic and may not cover all possibilities. Subjective judgements will continue to be made about circumstances not covered by the available data.

Residual Risk

Residual risk is the risk that remains once controls have been put in place.

When a hazard is controlled in some way so as to prevent harm arising, there are always likely to be circumstances when those controls will not be effective and there will therefore be some element of risk remaining. In risk assessment, it is important to identify those circumstances and ensure that they are considered so unlikely as to warrant protective measures being taken.

Residual risk must be at an acceptable or tolerable level.

Acceptable/Tolerable Risk Levels

Where risk has been reduced to the lowest level that is reasonably practicable, it is deemed to be at an acceptable or tolerable level.

If we accept that it is not practicable, or even possible, to eliminate all risk from the workplace, our aim must be to reduce the level of risk to a level where all those concerned accept and tolerate it. This will be where the inherent risk associated with a hazard is so low as to not warrant control measures, or where the control measures will be effective except in very unlikely circumstances.

The level of acceptability and tolerance of risk may vary with different groups of people who may be affected by the hazard. It is all very well for workers who are aware of the hazard to accept circumstances where the controls may not offer protection, but visitors or members of the public may not share that knowledge and the level of risk they are under as a consequence may be intolerable, however unlikely the circumstances. It is important therefore to assess the conditions under which the risk actually is acceptable and ensure that controls clearly map them out.

General Control Hierarchy

In assessing the practicability of control measures it is usual to refer to a hierarchy of control measures. This is a list of approaches to reducing risk, starting with the most effective. The order, starting at the top with the complete elimination of risk, is based on three general principles:

- Elimination of the hazard

- Using physical or engineering controls which reduce the risk at its source and provide general protection, rather than to individuals (such as substitution by different processes or process enclosure of the risk, by guards, etc.)

- Control of the person by job design, management or (as a last resort) personal protective equipment (PPE). Such measures include safe systems of work, training and instruction, supervision, etc.

We shall look in more detail at these principles and the associated methods later.

Prioritisation Based on Risk

Our objective in ranking risks is to determine to what extent protective measures must be put in place for each hazard. We have already noted that the ideal of a perfectly safe working environment is a practical and financial impossibility. This is recognised by health and safety legislation, which usually requires that the measures used to protect people from harm are those that are "practicable" or "so far as is reasonably practicable".

Where there are limitations on resources available (human as well as financial), those resources must be applied where they will have the most beneficial effect in terms of controlling risk. The process of identifying where to apply those resources to the problems faced is known as **prioritisation**.

Priorities for action will be based on the risk ranking obtained from the assessment process and the availability and practicability of control measures to reduce those risks to acceptable levels. There are a number of ranking systems which may be used for this purpose. Note that establishing priorities should always involve identifying timescales for the implementation of the action required. Action may be required:

- Priority 1 (Immediate) – where work should not continue until the risk has been reduced

- Priority 2 (medium term) – where measures should be taken within the next 14 - 28 days

- Priority 3 (long term) – where non-urgent action is required within the next 12 months.

Priorities Versus Timescales

The method of putting solutions in order of their urgency is known as **prioritisation**. Because there is a limit to the finances of an organisation, not all recommendations arising from a risk assessment can be implemented at once. It is important to deal with those hazards which pose an immediate threat or with conditions of work that do not comply with legislation first, while lesser problems can wait until resources are available. The following are useful guidelines:

- High risk – where it is certain or near-certain that harm will occur

- Medium risk – where harm will often occur

- Low risk – where harm will seldom occur.

So our priorities will be:

- High – where remedial action must be implemented **immediately**

- Medium – where remedial action should be implemented **as soon as possible**

- Low – where remedial action should be implemented as soon as **practicable**, when resources allow .

Quite often remedies can be easily and cost-effectively put into place even if the priority is not high. While it is important to target hazardous conditions first, it is also possible to deal with other problems of lesser importance quickly, even immediately, in order to ensure that more serious problems do not arise later. It is important to distinguish here between the importance of solution and what can realistically be done in the time, between the unsafe **conditions** and **causes** of unsafe conditions or acts.

For example, an immediate solution to poor housekeeping will be to sweep up debris; but changing work methods and attitudes, while important, may involve training etc., and this would take longer to carry out. So it is important not only to propose remedial action but also to set a

realistic and cost-effective timeframe or **timescale** (i.e. one week, one month, etc.) when that remedial action will be in place.

Recording Significant Findings

We noted that the significant findings of risk assessments should be recorded to provide a written statement of the hazards in the workplace, the extent of the risks that they present and the action taken to control those risks.

There is no standard format or layout for such documents, but we give some examples below to show the types of forms used for recording the assessment itself, summarising the risks and presenting action plans. Taken together, whatever documents are used to record the process, they must deal with the following issues:

- A description of the processes/activities assessed and identification of the significant hazards involved

- Identification of any group of workers at particular risk

- Evaluation of the risks (quantified where possible)

- Identification of the adequacy of existing control measures and action plans for implementing any further precautions necessary

- Date of assessment and date for next review if appropriate, and name of the competent person carrying out the assessment.

Sample Risk Assessment Form 1

WORKPLACE RISK ASSESSMENT		
No: Date: Valid until:		
1. Department/Work Area:		
2. Work activities in the workplace:		
3. Key Risks		
4. Risk assessment (*based on identified hazards*):	Risk Rating	
4.1 Fire protection		
4.2 Emergency procedure		
4.3 Vehicle movements		
4.4 Electrical installations		
4.5 Pressure systems		
4.6 Welfare amenity provisions		
4.7 Environmental factors		
4.8 Articles and substances		
4.9 Falls and falling objects		
5. Information and authorisation:		
5.1 Emergency procedures		
5.2 Training standards		
5.3 Safe systems of work		
5.4 Safety notices		
5.5 Reference documents		
Record-keeping requirements:		
Risk assessment summary:		
Assessor:	Date:	

Sample Risk Assessment Form 2

RISK ASSESSMENT SUMMARY
Risk Assessment No: Work activity/Workplace: Date of assessment: Assessor:
Principal Risks
Specific Risks
Remedial Action 1. Immediate: 2. Short-term (28 days):   3. Medium-term (6 months):   4. Long-term (over 12 months):
Information, Instruction and Training Requirements
Supervision Requirements
Date of next review:

Sample Risk Assessment Form 3

RISK ASSESSMENT ACTION PLAN				
Action/situation hazard	Action required	Target date	Action by	Completed by

Action plan prepared by:

Date:	Next assessment before:

Reviewing

Risk assessments should be reviewed in the event of doubt or where there are changes to the information or circumstances which would invalidate the original assumptions used. In addition, an organisation's safety policy may include a number of circumstances when reassessment of relevant risks is necessary.

Factors that would require an automatic review might include:

- A change in legislation

- A change in control measures

- Any significant change in work practices and processes

- Installation of new machinery and equipment.

However, it is important to realise that work situations are always changing without necessarily involving these factors. Modifications to processes, procedures and use of plant and equipment are made continually, both directly and indirectly by both management and workers. It is important that risk assessment is not seen as a one-off event, but an on-going process whereby work methods and safety precautions are monitored and kept under regular review to make sure that:

- There is continued compliance with legislation

- Plant modifications are taken into account

- Substituted materials are taken into account

- New work methods are incorporated

- Systems still work safely in practice

- New advances in technology are exploited

- Safety precautions are adjusted to take into account accident experience.

THE EXTENT OF RISK ASSESSMENT

It is recognised that for reasons of both practicability and cost it is not possible to ensure that every eventuality is considered and planned for. That said, we must ensure that the risk assessment is both suitable and sufficient. So our aim is to ensure that the assessment is extensive and detailed enough to:

- Identify the significant risks arising out of work, namely those which are most likely to occur and result in harm being caused, with any remaining risks being at an acceptable low level

- Enable the employer to identify and prioritise the measures that must be taken to protect people from harm, including complying with any relevant legal provisions

- Be appropriate to the nature of work and remain valid for a reasonable period of time.

This last point is particularly significant. The extent of the assessment must be in proportion to the extent of the hazards and risks in the workplace. In complex high-risk industries, the level of detail and the regularity of review will have to be much greater than in low-risk workplaces, and is likely to require carefully quantified rating.

SPECIAL CATEGORIES OF WORKERS

Where workers fall into special categories, the duty of care extends to ensuring that those workers are neither exposed to workplace environments nor involved in activities which are made more hazardous because of their disability or physical attributes. Young people, expectant mothers and disabled people would be typical examples. Young people may require special supervision or even be prohibited from operating certain dangerous machines. Expectant and nursing mothers may require rest facilities and temporary re-assignment to more suitable work, etc. Disabled people may require alteration of the workplace (escape routes, access, lighting, accessibility of services) or machinery.

Lone Workers

Working alone can bring additional risks to a work activity. Apart from ensuring that workers are capable and competent when carrying out their duties, employers should lay down clear procedures and outline restrictions for working alone. The lone worker should be aware of the hazards and risks associated with his/her duties, be trained in what to do if things go wrong and ensure that someone is aware of their whereabouts and activities when carrying out their duties. Some high risk activities should never be carried out alone.

REVISION QUESTION 3

(1) State the five steps involved in risk assessment.

(2) Apart from operators, what particular staff groups require special consideration during a risk assessment?

(3) What techniques are used for identifying hazards?

(4) What is residual risk?

(5) What factors are used to evaluate risk?

(6) State the three principles which underlie the order of the general control hierarchy.

(7) What conditions might trigger a risk assessment review?

The suggested answers are given at the end of the unit.

UNIT SUMMARY

In order to promote safety and safe systems of work in an organisation, all employers are required to carry out a systematic and critical assessment of the hazards and risks in the workplace, and the precautions put in place to protect people from harm. This risk assessment should ensure that all significant risks are identified and addressed.

There is no one fixed approach to carrying out a risk assessment, but all assessments should cover the following five steps:

- Identifying hazards by examining work processes and the use of equipment. Account should be taken of the circumstances which may arise in the course of work and consider other possible situations which may give rise to risk. Approaches to hazard identification include inspections, job/task analysis and analysis of incident data, and should also include a review of existing precautions.

- Identifying those who may be harmed and how. The needs of all groups who may be affected by the hazards should be addressed. This includes those working temporarily at or visiting the workplace, both during and outside of normal working hours, and others who may be affected outside the workplace. The particular needs of vulnerable groups (such as disabled people, new and expectant mothers, lone workers and young people) should be specially assessed.

- Evaluating the risk arising from hazards in terms of the likelihood of harm being caused and the severity of that harm. Some form of rating should be applied to the risk in order that priorities may be set for action.

- Recording the significant findings of the assessment to provide a written statement of what has been identified and what has been and will be done.

- Monitoring and reviewing the assessment at regular intervals in order to take account of changes in the workplace.

SUGGESTED ANSWERS TO REVISION QUESTIONS

Revision Question 1

(1) Hazards will always exist to some extent in the workplace and usually it is not possible to eliminate them. Risk can be controlled and reduced. This is the central point of health and safety management.

(2) Risk assessment is an examination of what could cause harm to people as a result of work activities in order that appropriate precaution may be put in place to prevent harm. Its overall aim is to ensure that no one suffers harm as a result of workplace activities.

(3) Risk = Frequency × Severity.

(4) Accident triangles show the relationship between numbers of accidents with different outcomes. They give the numbers of less serious accidents which occur for each occurrence of the most serious.

(5) The basis on which the statistics were prepared may not be the same and the workplaces themselves may not be directly comparable. The larger numbers of accidents included in statistics for an industry as a whole are likely to provide a more accurate reflection of reality than the smaller numbers involved in one particular workplace.

Revision Question 2

(1) By the cause of the accident itself or by the cause of the injury arising from the accident.

(2) Human failings.

(3) Liquids, dusts, fumes and mists.

(4) An acute effect is the response induced by a single dose or limited exposure to an agent, and a chronic effect is the long-term response, usually after repeated exposures to a sub-lethal concentration of the agent.

(5) Physical hazards cause harm to the body through mechanical, radiation or thermal sources or because of ergonomic conditions.

(6) Slips, trips and falls on the same level, and falls from a height.

Revision Question 3

(1) Identifying hazards, identifying who might be harmed and how, evaluating the risks arising from the hazards and deciding if existing precautions are adequate or more should be done, recording the findings, and reviewing the assessment.

(2) Maintenance staff, cleaners, young workers, lone workers, new and expectant mothers and disabled staff.

(3) Inspection, job/task analysis, analysis of incident data, examination of legislative requirements and associated guidance, examination of manufacturer's information.

(4) Residual risk is the level of risk remaining after the application of safety precautions. It should be only low-level, tolerable risk.

(5) The likelihood of harm occurring and the severity of that harm.

(6) Elimination of the hazard, using physical or engineering controls to reduce the risk at source and provide protection generally, and control of the person by job design, management or (as a last resort) personal protective equipment.

(7) Factors which would require a risk assessment include changes in legislation or control measures, a significant change in work practices and processes, or installation of new machinery and equipment.

NEBOSH International General Certificate

Unit 6 | Principles of Control

INTRODUCTION

We have seen that risk assessment is the identification of hazards and evaluation of the risk which they pose. Here we will be concerned with the measures which may be taken to eliminate or minimise the risk.

There are a number of general principles upon which the prevention of accidents and other incidents threatening the health and safety of workers and others is based. There is also a hierarchy of methods of control, starting from elimination of the hazard, through controlling the risk either by technical means applied to the hazard itself, or by rules and procedures which dictate how people work with the hazard; and as a last resort, providing protection for the individual worker through specific job training and personal protective equipment.

All these forms of control are brought together in the definition of safe systems of work. These systems describe safe ways of working with hazards and must be followed at all times. A special feature of safe systems is the permit-to-work system, where the procedures require documented authorisations and confirmations which must be in place before work can proceed or restart after interruption.

Finally we will review the importance of emergency procedures.

In covering these topics, the unit is designed to meet the following aims and learning outcomes as specified by NEBOSH for this part of the syllabus for the International General Certificate.

Overall Aims

On completion of this unit, you will have knowledge and understanding of:

- Fundamental strategies for controlling hazards and reducing risk

- The various hazard control and risk reduction methods available.

Specific Intended Learning Outcomes

When you have worked through this unit, you will be able to:

- Describe the general principles of control and a basic hierarchy of risk reduction measures that encompass technical, behavioural and procedural controls

- Develop and apply safe systems of work for general work activities

- Explain the key elements of a safe system applied to the particular situations of working in confined spaces and lone working

- Explain the role and function of a permit-to-work within a safe system of work

- Assess the adequacy of emergency procedures and provision.

GENERAL PRINCIPLES OF PREVENTION

There are many different ways of reducing or even avoiding risk. The following approaches are typical:

- **Avoiding risks** (wherever possible)

- **Evaluating risks which cannot be avoided** by carrying out a risk assessment

- **Controlling the risks at source**, rather than taking measures to control the risk in the wider context of the workplace

- **Adapting work to the requirements of the individual**. This applies particularly to the design of workplaces, the choice of work equipment and the choice of working and production methods, with a view to reducing repetitive work and work at a fixed pace, in order to minimise effects on health

- **Adapting to technical progress**

- **Replacing the dangerous by the non-dangerous or less dangerous**

- **Developing a coherent overall prevention policy**. This should cover technology, organisation of work, working conditions, social relationships and the influence of factors relating to the working environment

- **Giving priority to collective protective measures over individual protective measures**.

- **Giving appropriate instructions to workers**. This covers specific and general instructions, including the use of safety signs, training and supervision.

This list does not constitute a hierarchy, nor are the principles specific legal requirements. Rather, they are guidelines on the way in which employers should approach the prevention and control of risks.

We will look at more specific approaches within these general principles as we work through this unit, but we will develop two of the most important aspects mentioned above first of all.

Collective and Individual Protective Measures

Collective protective measures are those which protect the whole workplace and everyone who works there, as opposed to individual ones which, naturally, just protect single individuals.

Collective measures are based on containing the hazard, usually through technical, engineering solutions; for example, through venting fumes out of a building; but also through general procedures and systems. Individual solutions are based on specific training, procedures and personal protective equipment.

These two approaches give rise to the ideas of a safe place and a safe person:

- **Safe place** – This refers to the environment of the workplace and is one where the emphasis is on collective protective measures in the premises (including access/egress), plant, processes, materials, systems of work, supervision/training and competent personnel.

- **Safe person** – This applies to an individual who, in relation to his or her work, has received adequate information, instruction and training and who follows safe systems of work, hygiene standards and wearing of PPE. Such people are aware of their immediate job/task,

and also the context within which it is performed, that is the wider workplace and their fellow workers.

Roles, Categories and Features of Safety Signs

Safety signs are defined as those combining shape, colour and pictorial symbols to convey specific health and safety information or instructions, according to widely understood standards.

The standards are usually international so that safety signs are instantly recognisable throughout the world, regardless of language. Safety signs are divided into five categories:

- **Prohibition**

    These are directed at stopping dangerous behaviours; for example, "No Smoking", "Not Drinking Water", "No Naked Lights" signs.

    The signs are round or circular with the main colour being red (at least 35% of the area of the sign). They have a black symbol or pictogram on a white background with a red border and diagonal cross bar.

- **Fire-fighting equipment**

    These signs identify particular types of equipment and locations; for example, fire extinguisher labels and hose reel instructions.

    The signs are rectangular or square with the main colour being red (at least 50% of the area of the sign). They have a white symbol or pictogram on a red background.

- **Warning**

    Warning signs tell people to be careful and take precautions in respect of a particular hazard; for example, high voltage electricity, slippery surface, fork lift trucks operating in the area, etc.

    The signs are triangular with the main colour as yellow (at least 50% of the area of the sign). They have a black symbol or pictogram on a yellow background with a black border.

- **Mandatory action**

    These instruct people to take a specific action or follow a behaviour, usually relating to wearing personal protective equipment; for example, helmets, eye protection, safety belts and harnesses, etc. They are circular with a solid blue background with a white pictogram.

- **Safe conditions**

    These identify safe behaviour or places of safety; for example, drinking water, emergency wash rooms, emergency exits, first aid stations, etc.

    The signs are rectangular or square with the dominant colour being green (at least 50% of the area of the sign). They have a white symbol or pictogram on a green background.

Some examples are shown in the figure below.

No Unauthorised Entry   Toxic Material   Safety Boots Must Be Worn   Emergency Escape Route

Examples of Safety Signs

GENERAL HIERARCHY OF CONTROL

The best way of controlling a risk is to get rid of the thing which is, or creates, the hazard, so that there is no more risk. However, this is impossible in many situations, so some other form of controlling the risk is required. This gives rise to a hierarchy of control measures, as follows:

- Eliminate the hazard, through elimination or substitution

- Use engineering controls which reduce the risk at source and provide protection generally rather than individually, through isolation/segregation of the hazard or physical controls applied directly to it

- Control the way in which people interact with the hazard by working patterns and methods, or as a last resort by the use of personal protective equipment.

These principles can be applied to any risk situation and are discussed here in more detail.

Elimination and engineering controls are the most effective in reducing risk, but they are usually more expensive and take much longer to put in place. They should be thought of as long-term objectives. Although in practice it might be technically possible to achieve total elimination of a hazard, the large cost involved and the small benefits obtained may mean that it is not reasonable to expect an employer to implement it.

Personal controls are usually the cheapest option and can be put into operation very quickly. They should provide an acceptable level of protection, but it is important to remember that they are not permanent. Their effect is of short duration, only so long as the people concerned remember to use them.

Elimination/Substitution

The first priority for control of any significant risk to health is to try to eliminate completely the agent responsible. This is particularly true in the chemical industry, where many highly toxic chemicals are used. For certain risks it is possible to eliminate the hazard at source by careful examination of the work activity or process, and to identify a different way to achieve the same ends without it. This often involves the substitution of different types of equipment, substance or material for the hazardous one. Note that this may not remove risk from the situation completely, but should always reduce the level if it is to be worthwhile.

For example, hazardous substances can sometimes be replaced with materials which do the same job but present no risk to health. Mechanical devices such as hoists and lifts can be used to avoid manual handling of difficult or heavy loads. Careful design of equipment using components which generate less noise and vibration can often eliminate the risk of hearing damage.

Improvements in technology often present the opportunity to replace older hazardous processes or activities with those involving no risk to health. For example, the use of new water-based materials such as paints or adhesives can eliminate completely the risk to health of exposure to organic solvents.

The main objection to hazard elimination is usually the cost, since it may involve a radical change in the way that the work activity is carried out. For that reason the elimination of hazards as the overriding goal of the health and safety programme must be built into the risk assessment

process. The opportunity for elimination should be re-examined every time an assessment is reviewed.

Changing Work Methods

In some circumstances, an analysis of the work process or operations may identify specific activities which contribute to risk; for example, by producing harmful substances or agents or by bringing people into close contact with a dangerous object. In such cases, changing the work method may reduce the risk.

Thus, a new method might minimise or suppress the generation of the agents of concern; for example, where harmful emissions of solvents are being generated, brush painting rather than spraying will considerably reduce the level of airborne contaminant. Similarly, the use of pressing techniques rather than panel beating will minimise noise generation.

A key area where changing the work method has significant impact is where ergonomic problems are identified. Health hazards arising from the way people work, such as keyboard use, repetitive activities and manual handling, can often be controlled satisfactorily by redesign of the work method. So, for example, better design of VDU workstations will often remove the imposition of awkward postures. Similarly, a thorough manual handling assessment should indicate critical activities where redesign of the work method will minimise the risk of injury to hands, wrists, joints or back.

Changing Work Patterns

The ill-health effects arising from activities and hazardous substances in the workplace are often related to the length of time of exposure as well as the severity of the hazard. The combination of these two factors is referred to as the "dose". This idea is important when dealing with such hazards as noise, airborne contaminants, vibration, radiation, heat and manual handling.

We can use a reduction of exposure as a means of minimising possible ill-health effects. For example, where workers are exposed to high noise levels or in conditions where heat stress is a risk, it is necessary to set strict time limits on exposure to prevent harm.

As a general principle, when a hazard exists from a substance or a physical agent, the cumulative dose should be reduced to as low a level as possible by organising the work pattern to provide periods of no exposure. Another method is job rotation, where the exposure of any particular individual is reduced by sharing the dose with other workers. This method was often used in the nuclear industry, where a number of workers performed a task in rotation, with strict control over length of time of exposure in order to distribute the radiation exposure and ensure that dose limits were not exceeded.

Thus, we can see how changing work patterns by a combination of working time limits, breaks and job rotation can be used as a method to reduce the length of time of exposure and consequently minimise the risks to health.

Isolation/Segregation

The aim here is to isolate the hazard physically so that nobody is exposed to risk. Total enclosure or containment is the best form of risk control since no one can then be exposed to the hazard. Examples include:

- Total enclosure of a process which generates dust or fumes to prevent the escape of airborne contaminants which could be inhaled by operators in the vicinity

- Acoustic enclosure of a noisy machine to reduce noise levels and consequently the noise exposure to people working nearby

- Guards around moving or other dangerous machines, or parts of them, to prevent operators coming into contact with them.

When a whole area has been totally isolated it may still be necessary to access equipment or material within that area. The use of robotically-controlled, remote handling systems may be incorporated, allowing access without disturbing the integrity of the enclosure.

If the hazard can be totally enclosed and sealed, it controls the risk at source, providing protection for all with no need for further measures. However, if cleaning or maintenance work has to be carried out, which will usually be the case, the seal of the enclosure will be broken with potential risk for workers or others during the operations. Under such conditions, sometimes with special risks (such as ionising radiation), additional precautions will be necessary while the enclosure is breached to protect maintenance workers or others nearby.

In some circumstances, total enclosure may not be possible; for example, access to a process may be necessary to introduce raw materials or remove the product. Here, removable enclosures must be provided which will isolate people from the hazard during the most dangerous operations, but permit access as necessary for effective operation. Movable machine guards are one example of this.

Measures must also be taken to reduce risk when the hazard is not enclosed. This may be by engineered controls, such as the use of exhaust (suction-based) ventilation to increase control over the release of airborne contaminants, or through working procedures and methods.

It is often possible to isolate potential hazards by locating operations which present a risk to health in an area separate from where the operators are. In this way, access is restricted physically by placing a barrier around the hazardous activity or locating it in a separate room. Perimeter fencing or other types of barriers are often built around machines or areas where work is being carried out. X-ray equipment is controlled by being physically separated from the operators, to prevent exposure; and the use of controlled and separated areas is often found with the use of ionising radiation.

Engineering Controls

These involve the elimination of hazards or hazardous work processes at the design stage, by designing safety into plant, equipment and machinery, vehicles, containers, etc., with proper consideration of guarding and enclosure features, as well as adding special purpose safety equipment to processes in order to remove or reduce risks.

Designing for Safety

Good design and construction should include the following types of features:

- Operating controls which are easy to see and use, do not allow machines to be turned on accidentally and incorporate emergency stops

- Automatic seals on lids and valves to prevent accidental spillages

- Fail-safe devices which do not allow a machine to operate if there is a fault

- Fire doors and other containment measures which come into operation automatically when a sensor sets off an alarm

- Hazard lights and sounds which operate in hazardous circumstances, such as when a large vehicle is reversing.

Ventilation Systems

These are examples of additional controls used to reduce risk from airborne contaminants. Two types are in common use:

Dilution Ventilation

Dilution ventilation works by reducing the concentration of the hazard to an acceptable level. This applies in two circumstances:

- Where the concentration of a harmful contaminant can be reduced to below the occupational exposure limit by the dilution method

- Where the concentration of a flammable substance can be reduced to below its lower explosive limit by using dilution.

For example, the level of gaseous contaminants (and sometimes fumes) in the air may be reduced by changing the whole workplace air over a given period of time. The workplace air is extracted by the use of fans set in the walls or roof.

Dilution ventilation has a fairly limited use as an effective control strategy, although it may be used with reasonable success for certain types of contaminants (those with a high OEL and low evaporation rate), where the escape is slow and operators are not in close contact with the contamination generation point, or where the hazardous substance is carried swiftly away from the operator.

When contaminants are to be removed from a workplace using dilution ventilation, two important criteria have to be considered:

- The rate at which the contaminant is being created or released and hence the number of air changes per hour required.

- The position of the extraction fans. The important factor which controls the positioning of the extraction fan unit is the density of the contaminant. The fans should be positioned in the walls at a low level for high density materials, while the fan must be positioned high on the workplace walls or in the roof for less dense materials.

Local Exhaust Ventilation

A local exhaust system operates by removing a contaminant at or near the point where it is being created or released and ducting it away in an air flow through piping or tubing to a safe place.

In general, these systems are made up of five main parts:

1. The hood or exhaust inlet
2. Ducting
3. Filter or purifying system
4. Fan or motor
5. Exhaust outlet
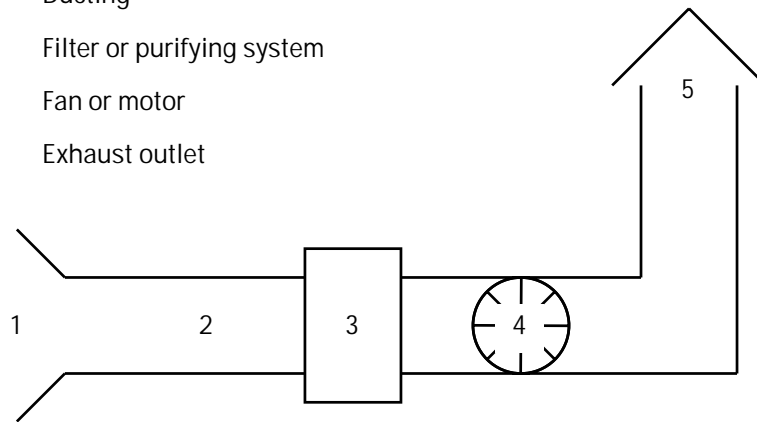
A Local Exhaust Ventilation System

There are a number of different types of local exhaust ventilation system, which vary with the type of hood used to receive the contaminant:

- Receptor hood systems – such as a cooker hood which draws in air from a general area surrounding the point at which the contaminant is generated

- Captor hood systems – bell or cone shaped hoods which are placed as near as possible to the contaminant generation point and draw away air directly from the process at that point

- Fume cupboards – enclosed systems which are widely used in laboratories.

Multi-hood extraction systems involve extractor hoods linked to a common extraction system.

Personal Protective Equipment

Despite considering the range of control measures outlined previously, it may still not be possible to reduce exposure to a risk down to an acceptable level. Under such circumstances it becomes necessary to consider protecting the individual rather than the working environment as a whole. Many different types of personal protective equipment are available, such as ear defenders for noise; gloves to prevent contact with substances hazardous to the skin; and respiratory protection against substances hazardous by inhalation (breathing in). However, in the hierarchy of control measures, personal protective equipment (PPE) comes last and is only used when all other control measures have been found inadequate in eliminating or controlling the risk.

In practice, personal protective equipment is often required as a temporary measure until more efficient measures are introduced, or as an added control during non-routine operations such as maintenance. Consequently, you must be familiar with the details of its selection and use, which are covered in detail later in the course.

REVISION QUESTION 1

(1) Which three general principles of prevention are not included in the following list?

 – Avoiding risks (wherever possible)

 – Evaluating risks that cannot be avoided by carrying out a risk assessment

 – Adapting work to the requirements of the individual

 – Adapting to technical progress

 – Replacing the dangerous by the non-dangerous or less dangerous

 – Developing a coherent overall prevention policy.

(2) What type of sign is represented by the following pictograms?

(i)

Blue

(ii)

Red

(iii)

Green

(iv)

Yellow
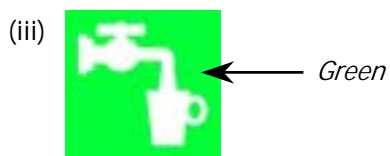
(3) State, in order, the three elements of the hierarchy of control.

(4) What do engineering controls do?

(5) When should personal protective equipment be used?

The suggested answers are given at the end of the unit.

PERMITS-TO-WORK

A permit-to-work system is designed to ensure that all necessary actions are taken before, during and after particularly hazardous operations. These operations are mostly related to maintenance work which can only be carried out if normal safeguards are dropped, but also include certain routine work which demands that special precautions be taken. Examples include working with, or undertaking maintenance of, high voltage electrical equipment and supply plant, overhead travelling cranes, hot or highly flammable materials and pipework containing hazardous substances, as well as working in confined spaces.

Permits-to-work are formal documents specifying the work to be done and the precautions to be taken. Work can only start when safe procedures have been defined and put into place. The permit provides a clear written record, signed by a responsible officer, that all foreseeable hazards have been considered and all the necessary actions have been taken. It **must** be in the possession of the person in charge of the operation before work can commence.

Note that a "permit-to-work system" should not be mistaken for a "safe system of work". Rather, a safe system of work may require a permit-to-work system to be adopted as part of its overall systematic control of risk.

Operation of the Permit System

The main principles to be observed for the operation of an effective permit-to-work system are described below.

Hazard Evaluation

This means recognising every type of hazard which may be encountered, and then working out the method of eliminating or overcoming them. The best way of achieving this in the long term is by the introduction of a **hazard appraisal programme**, by which it is possible to formulate a very long-lasting system of precautions. A major problem may be that work is frequently performed under emergency conditions and little time is then available for a detailed appraisal to be made.

Precaution Planning

All planning associated with the permit must be carried out by a competent person who should have sufficient detailed knowledge of the hazards of the process or plant that he can formulate the plan properly. The person must have the necessary position of authority for his or her instructions to be recognised and complied with. He/she should also have an adequate knowledge of the legal requirements, and of technical terms such as "isolate", "lock off" ("lock out/tag out"), and "blank off", as they apply to the permit-to-work system.

Instructing Supervisors and Operators

Ideally, the control of permit-to-work systems throughout the company should be the overall responsibility of one person. That person should possess the ability to understand what hazards exist and know how to eliminate them. He/she must have sufficient authority in the organisation to instruct and make recommendations to managers, supervisors and others on safety procedures.

The person responsible must also have authority to co-ordinate the efforts of everyone concerned with the provision of safe working conditions. In the event of a permit being issued,

he or she must ensure that everyone concerned understands the terms of the permit and follows its instructions down to the smallest detail.

These provisions should be extended to any outside contractors who are involved and it must be made clear that their workers must not in any circumstances begin work until the safety precautions and procedures have been fully explained to them. It is very important that those people responsible for the work should be carefully briefed by the person issuing the permit. The instructions in the permit must be fully understood, which is best achieved by direct questions and answers in addition to the written word.

Issuing the Permit

The permit-to-work form must help communication between all the people who are involved. It should be designed by the company issuing the permit, taking into account individual site conditions and requirements. Separate permit forms may be required for different tasks, such as hot work and entry into confined spaces, so that sufficient emphasis can be given to the special hazards present and the precautions required. However, the number of permits issued should be kept to the minimum necessary to the efficient running of the plant.

The permit, which should be completed and signed by the issuer, must be given to the person in charge of the work (who signs for it). Copies must also be given to any plant or site management and supervisory staff who may be involved, especially where it is necessary for them to be kept informed of work progress. An additional copy of the permit should be displayed nearby during the time it remains in force.

Before Work Starts

Before work is commenced, the following general safety precautions should be observed, where they apply:

- Electrical or mechanical isolation of the plant
- Isolation of the machine or equipment area
- Locking or blanking off of water, steam, acid, gas, solvent, and compressed air supplies
- Erection of scaffolding
- Provision of temporary guards (or other like equipment) to make the job safe.

Checking and Cancelling Permits

Managers or safety officers should make spot checks to ensure that rules and procedures are being followed. On completion of work, the permit should be returned to the responsible person, who should check that people and equipment have been removed from the site of work and all personnel are warned that entry to perform controlled work is no longer permitted. The plant can then be returned to service.

The Application of Permits

Permits must be specific about the type of work and the location to which they refer, and the hazards identified and the necessary precautions to be taken. Signatures must be obtained at each stage to confirm that the necessary work has been carried out.

The following list gives all the points which must be included on a permit-to-work form:

- Permit title

- Permit number

- Reference to other relevant permits or isolation certificates

- Job location

- Plant identification

- Description of work to be done and its limitations

- Hazard identification, including residual hazards and hazards introduced by the work

- Precautions necessary – details of all precautions to be taken, including isolation, necessary for the job to be done safely. Completion of these must be confirmed by each person who carries them out.

- Protective equipment necessary when undertaking the work

- Authorisation – signature of the manager releasing the plant for the job and confirming that isolations have been made/ precautions taken, except those which can only be taken during the work

- Date and time duration of the permit

- Acceptance – signature confirming understanding of the work to be done, the hazards involved and the precautions required. This should also confirm that the permit information has been fully explained to all workers involved.

- Extension/shift hand-over procedures – signatures confirming that checks have been made to ensure that the plant remains safe to be worked upon, and that the new acceptor/workers have been made fully aware of the hazards and precautions. Where an extension to the work is involved, a new expiry time for the permit must be given.

- Hand-back – signatures, with time and date, of both the permit receiver and issuer, confirming that all the procedures have been carried out correctly, the work has been completed and the plant is ready for testing and recommissioning.

- Cancellation – signatures, with time and date, certifying that the work has been tested and the plant satisfactorily recommissioned, and that it has been accepted back in a safe condition for production to recommence.

Typical Permits and Appropriate Circumstances

The types of hazardous situations in which permit-to-work systems should be used include work in the areas outlined below.

Hot Work

Hot work permits are concerned with preventing fires/explosions where maintenance activities and other non-routine work involve burning ,welding, use of a naked flame, etc. The permit will allow such work to be performed only after all the necessary precautions have been taken, including testing to check for flammable atmospheres. Similar tests may be required during operations as well.

Work on Electrical Systems

The hazards associated with electricity are frequently either not understood or are treated in too casual a manner. Because of the high level of risk involved and the serious consequence of

switching errors and other careless mistakes, it is essential that a comprehensive safety system is put into operation whenever work is to be started on high voltage equipment (in practical terms, 440 volts AC or higher).

Any work on substation equipment must be covered by a permit-to-work system if safe working conditions are to be ensured. (It is interesting to note that the electricity supply industry makes full use of such systems.)

Machinery Maintenance

The biggest risk to maintenance workers is that they may be injured if machinery is started up while work is still in progress. Often this is because the men carrying out the maintenance work may be hidden from the sight of people at the plant controls. The machines may be set in motion as a result of some misunderstanding, negligence or lack of knowledge and, unless the power is isolated and locked off and cannot be reconnected without specific authority, an accident might easily follow.

Sometimes it is not possible for every part of complex machinery to be isolated at the same time and here it will be necessary for the isolation to be completed section by section, taking extra special care. Typical methods of isolation include:

- Locking-off switch handles

- Removing drive belts

- Locking the clutch

- Using key interlock systems.

The use of key interlock systems enables several people to work on the same plant without fear of one of them finishing work and starting the machine, thereby endangering the others. Each person is supplied with a key, which he keeps in his possession, and the lock cannot be opened until all the keys have been turned.

Confined Spaces

The nature of confined spaces was discussed earlier. Entry to a confined space can be extremely hazardous. The following precautions should be included in the permit-to-work:

- Mechanical and/or electrical isolation of the confined space

- Adequate ventilation to ensure a sufficient supply of respirable air

- Cleaning and purging to remove all hazards, particularly in respect of dangerous fumes, and testing to ensure their absence

- A specified working period, which is not to be exceeded in any circumstances.

If the confined space cannot be completely cleared of dangerous gas, then special breathing apparatus and lifelines must be worn and a rescue standby team should be present to assist in the event of difficulties. Entry can be authorised only by a responsible person. Other measures which may be taken include the use of rescue harness, suitable protective clothing, spark-proof tools and lights.

SAFE SYSTEMS OF WORK

A safe system of work is a formal procedure which is based on a systematic examination of the tasks of a working process in order to identify all the hazards. It defines methods of working which eliminate those hazards or minimise the risks associated with them.

The essential idea is that it is a *system* for dealing with the hazards. Based on the precise identification of hazards and assessment of risks for a particular task, job or process, the system describes a comprehensive procedure for the way in which people may safely interact with each other, and with the materials, equipment and plant which form part of their work, so the risks are minimised. The procedure must be followed at all times in order to work safely in relation to the hazards.

Safe systems of work are necessary whenever hazards cannot be physically eliminated and some element of risk remains. This applies to any task involving any risk. Thus, there is a specified routine for changing the toner in a photocopier to avoid spillages and dust contamination, just as there are specific practices for the separation of cooked and uncooked meats in kitchens, and detailed procedures for the setting and detonation of explosives in a quarry. In all these situations, the safe system is essential to prevent accidents or other incidents.

Employers' Duties

Earlier we considered the general duties of employers to take all reasonable measures to ensure the safety of their workforce: safe workplace, safe equipment/substances etc.

Regulations and government agencies may specify some of the detail that an employer is expected to follow.

The "arrangements" section of an organisation's safety policy will normally address safe systems of work, establishing the general guidelines under which they are developed and the rules under which they must be used. Risk assessments must also consider them and look at their continuing effectiveness in practice, and anything that may be done to strengthen them.

Role of Competent Persons

One of the ways in which employers meet their health and safety duties is through the appointment of "competent persons". In practice, we all know what constitutes competence; you can spot this by what people know and how well they do their job. Competence is not universal, it is often job specific. In relation to health and safety, a competent person is one who "has sufficient training and experience or knowledge and other qualities" to assist the employer in compliance with his legal duties. This role of a competent person is central to the development of safe systems of work. Whether carried out by a specialist health and safety practitioner or as a designated responsibility additional to other duties, the competent person will be a leading figure in all aspects of the system, including hazard identification, strategies for reducing risk and specifications of working practices. He or she will share with management the responsibility for implementing systems and monitoring their compliance and effectiveness.

Worker Involvement

The competent person cannot do the job alone. He or she will have to work closely with the workers who do, or will be doing, the work. They should take an active part in all stages of both the development and review of safe systems of work. Their practical knowledge and skills in the tasks provide a valuable source of information about the nature of the risks, including any unusual ones, and methods of working around them. They can also contribute by assessing plans and written documentation, and provide feedback on the effectiveness of the system in practice.

Involvement in this way enables workers to gain a deeper understanding of the hazards and risks, and of the way in which the safe system of work will minimise those risks. This helps to build the safety culture and reinforces commitment to the system.

Written Procedures

The safe system of work must be understood by all workers and any others who may be involved from time-to-time (such as contractors), and applied correctly. For this to happen, it must be communicated effectively and the basis of it is written procedures.

All systems must be properly documented to provide a precise reference for all operators. It may be in the form of short notes and instructions about what to do if the toner needs changing in the photocopier displayed on the wall next to it, or it may take the form of manuals detailing exactly what steps to take in carrying out more complex and lengthy procedures, such as calibrating and setting up grinding wheels for use. These will form the basis of training programmes. They are likely to be accompanied by checklists for workers to use as aids to ensure that all the correct steps are taken, and to check off details before continuing with the next step or starting operations.

Written documentation also provides the employer with a record of actions taken in compliance with the legislation. This may be essential if there is an inspection by enforcement agencies or any proceedings arising out of an accident at the workplace.

Technical, Procedural and Behavioural Controls

A safe system of work will involve all the elements of control that we identified in the general hierarchy of control:

- **Technical**, or engineering, controls are those which are applied directly to the hazard itself in order to minimise the risk. This may involve fencing or barriers of different kinds to isolate workers from the hazard as far as possible, or failsafe devices designed into equipment to stop its operation if there is a fault. It is important for the system to recognise such controls since they often underpin the safety of the whole operation. Similarly, workers must recognise their importance and the need to ensure that they are in working order at all times.

- **Procedural** controls are those defined in the way in which work should be carried out in relation to the hazard. They will specify the exact tasks involved, their sequence and the safety actions and checks which have to be taken. Thus, there will be a set procedure for operating a grinding machine, opening machine guards, checking for problems before changing the workpiece, securing a new workpiece and closing the guards before switching back on, and finally waiting until it is safe before opening the guards again.

Often the procedure will relate to the correct operation of the technical controls. In other instances it will specify management checks which have to be made as part of the process.

- **Behavioural** controls relate to how the individual operator, or groups of workers, act in relation to the hazard. They will relate to general points of good safety practice in the workplace; for example, not consuming drugs or alcohol, not hurrying or cutting corners, always reporting defects or faults, cleaning up spills, etc.; and to specific measures relating to the particular job, such as personal protective equipment.

Development of a Safe System of Work

The process of developing a safe system of work starts with a risk assessment, in which the hazards and risks involved in the various tasks making up the work are identified. Appropriate controls are then formulated and introduced, so the work may be carried out in a safe and effective way. This demands that there is a compromise between the needs of the job and the safety controls which are applied, depending on the extent of the risk.

Analysing Tasks, Identifying Hazards and Assessing Risks

The basis of hazard identification is task analysis. This has to consider all aspects of the tasks necessary to carry out the work of a defined process. The process may be just one task (such as operating a slicing machine in a food store) or a whole series of interlocking tasks involving one or more people, such as feeding steel sheets into presses. Factors which must be addressed in order to identify hazards include:

- What is used and how it is used – plant, machinery, equipment, substances handled, etc. The risks associated with each element have to be assessed.

- Where the task is carried out – the immediate and wider environment of the job and the issues which they present, such as lighting, weather conditions, hazards from adjacent areas, etc.

- Who does it – the workers, supervisors and possibly other management levels involved in the work process, and the levels of training, expertise and other attributes necessary.

- How the work is done – the way in which the people or person actually goes about the job, using equipment, etc., and interacting with the environment generally and with other people.

- Unexpected events – ways in which the work may vary according to different circumstances.

The first step on completing this analysis is to consider whether any hazards can be eliminated from the process altogether by changing any feature of the work. Where this is not possible, controls will be required to reduce the risk presented.

Introducing Controls and Formulating Procedures

The safe system will be defined by the use of technical, procedural and behavioural controls applying to the tasks involved in the work. In most cases this will be a simple written procedure, but it might be a highly developed system of rules and prescribed actions. In certain cases where there are extreme risks involved, a formal "permit-to-work" system may be in use. This would be for work processes where permissions and confirmations are necessary at each stage in order to proceed safely, such as working with high voltage electricity. We will cover permits-to-work in detail later.

As we noted, both the competent person and the workers actually doing the work should be involved in the process of identifying hazards and formulating the control procedures.

All aspects of the controls – technical, procedural and behavioural – must be properly documented.

Instruction and Training in the Operation of the System

The safe system of work must be properly understood by workers and applied correctly. This involves communication, training, instruction and supervision. They form an essential part of the system in that only people who are competent by means of appropriate training and instruction may be allowed to undertake the work.

Instruction and training has to be specific to the work itself to ensure that all workers, and others, have the necessary knowledge and skills to operate safely in the defined situation. It may be delivered by means of training courses in using particular equipment, verbal instructions, demonstrations, written instructions and notices, etc. Supervisors will have to monitor behaviour to see that staff follow instructions and training.

Monitoring and Reviewing the System

The safe systems should be monitored regularly to ensure that they continue to work effectively. Even if the system is working well, it may be that more can be done to reduce further the level of risk. Just because a system is effective, it does not mean it is having the optimum effect. Where it is not, there may be two basic reasons; that the circumstances have changed, or it was not right in the first place. When workers find systems impractical, they usually find ways to work around it, either with no effect on the level of risk or at a higher level of risk (which they may find acceptable in the circumstances).

In either case, changes may have to be made to any of the technical, procedural or behavioural controls. Note that this may include strengthening instructions, training and supervision in order to ensure compliance with behavioural controls.

Specific Examples of Safe Systems of Work

We will provide two brief examples of safe systems of work here.

Working in Confined Spaces

The term "Confined Space" can be a little misleading. It is often used to describe the combined presence of both a large enclosed structure AND a range of specific hazards such as oxygen deficiency, flammable vapours, potential for flooding, etc. It is not the confined space itself that is the problem, but the presence of several different types of hazard within it. In addition, "confined" may not mean "small" even though this is usually so. An example will serve to make the point: working underground in mines, tunnels, sewers, etc., where flammable or toxic gases may build up. These areas are usually specifically regulated by governments because confined space incidents almost always involve multiple fatalities.

The controls in place will include:

- Technical – methods of sealing openings to ensure, so far as possible, that nothing hazardous can get into the confined space whilst there is work going on, that access routes are fixed open, ventilation systems provide for both removal of bad air and the input of good air, provision of adequate lighting, etc.

- Procedural – prior checks to be made on the atmosphere before entry, systems for monitoring workers' entry and exit, provision of emergency rescue staff as necessary, checking and availability of emergency equipment, time limits on duration of work, etc.

- Behavioural – use of safety helmets, breathing apparatus and lifelines as necessary, fire precautions, etc.

The level of competence necessary for undertaking the work will be specified and the system will require checks to be made to ensure that only those with the appropriate training are allowed to do the work. Other methods of supervising workers in confined spaces, either from outside or inside the same space, necessary in order to ensure safety will also be detailed.

Lone Working

Lone workers are those who are separated by distance from their work colleagues and are not in continuous direct face-to-face contact with them. Many people carry out their work in this way, either all the time or on a regular or occasional basis; for example sales representatives; installation, repair and maintenance staff; cleaners and night security workers, etc.

The hazards they encounter might be the same as for their colleagues working together, but the risks can be higher because of the lack of assistance, e.g. lifting a heavy object. Furthermore, if out of touch with base, they cannot notify colleagues of any problem, nor receive warnings. Neither do they have access to the facilities normally available in the workplace, not only those for performing a task but also ones to deal with emergencies, such as fires and injuries requiring first aid. Where travel is involved, this itself introduces risks.

Technical controls which can be applied to lone workers are mainly to do with ensuring that appropriate communications are available to allow the lone worker to contact colleagues (and they to contact him) and the emergency services at all times, and the provision of first aid and fire extinguishers, etc. Procedural controls may include logging movements so that someone is aware at all times where the lone worker is, and ensuring any necessary precautions are taken before entering other premises, including notification of his/her presence and checking for any particular requirements. Behavioural controls will include the issue of personal protective equipment appropriate to the hazards likely to be faced in the course of the work (such as hard hats and safety boots for visiting construction sites).

REVISION QUESTION 2

(1) Define a safe system of work.

(2) How does involving workers in the development of safe systems of work contribute to strengthening the safety culture?

(3) What is the difference between technical, procedural and behavioural controls?

(4) Which types of control listed in (3) are used in permits-to-work?

(5) Why do instruction, training and supervision form a part of safe systems?

(6) What is a permit-to-work?

(7) What three key points are missing from this list of requirements for a permit-to-work form?

- Permit title, number and reference to other relevant permits or isolation certificates

- Job location, plant identification, description of work to be done and its limitations

- Hazard identification and precautions necessary

- Signature of the manager releasing the plant for the job and confirming that isolations have been made/precautions taken, except those which can only be taken during the work

- Signature confirming understanding of the work to be done, the hazards involved and the precautions required

- Hand-back – signatures, with time and date, of both the permit acceptor and issuer confirming that all the procedures have been carried out correctly, the work has been completed and the plant is ready for testing and recommissioning

- Cancellation – signatures, with time and date, certifying that the work has been tested and the plant satisfactorily recommissioned, and that it has been accepted back in a safe condition for production to recommence.

The suggested answers are given at the end of the unit.

EMERGENCY PROCEDURES

Emergencies may happen in any workplace; they might include serious personal injury, fire, explosion, chemical spills, toxic gas release, vandalism, flooding, and perhaps riots or terrorist activities. Anticipating emergencies and planning your response can greatly reduce the extent of injuries and damage to equipment, material and property.

Developing Emergency Procedures

The main objective of emergency procedures is to provide a temporary safe environment for workers and to limit the loss of property. There should be a prepared plan spelling out a course of action which directs people in acting immediately and correctly in all types of emergencies.

The emergency procedure should outline the basic steps necessary to handle foreseeable emergencies in the workplace. Although it does not have to be all-inclusive, it should provide appropriate guidance on what to do in an emergency; for example:

- Clear, written policies which designate a chain of command, giving the names and job titles of the people (or departments) who are responsible for making decisions, monitoring response actions and returning operations back to normal.

- Names of those who are responsible for assessing the degree of risk to life and property and who should be notified for various types of emergencies.

- Specific instructions for shutting down equipment and production processes, and for stopping business activities.

- Evacuation procedures, including a designated assembly point outside the workplace and a method to account for all workers, and others, after an evacuation.

- Procedures for workers who are responsible for shutting down critical operations before an evacuation.

- Specific training, special equipment, and practice schedules for workers who are responsible for rescue operations, medical duties, hazardous situations, fire fighting and other responses specific to the workplace.

- The preferred means of reporting fires and other emergencies.

The first step in developing an emergency procedure is a risk assessment. The hazards to be identified include those at the workplace, and also those at nearby facilities which may affect it. Where hazardous substances are used, the manufacturer or supplier should be able to provide information about the emergency and first-aid procedures which may be necessary.

The procedure should cover different emergency situations and identify appropriate responses in all areas of the workplace. It should be developed in co-operation with workers, and reviewed with them when responsibilities or the plan itself change. Finally, it must be communicated clearly to workers and others who may be affected. This includes posting appropriate notices at key locations, describing procedures in induction programmes (both for new workers and those visiting the workplace) and carrying out training in the procedures themselves.

First-aid Requirements

First aid is the immediate and temporary care given to the victim of an accident or illness until the services of a qualified medical practitioner can be obtained. It can save lives and prevent serious personal harm, so every workplace should have sufficient trained people available and suitable facilities to deal with any cases which might occur.

Risk assessments must be carried out to determine the level of provision required. You will at least need a first aid box and someone to call the emergency services and look after the first aid equipment, but this may have to be extended depending on such factors as the nature of the work and the number of people involved.

Role and Training of First Aiders and Other Personnel

A first aider is someone who has been trained to administer first aid appropriate to hazards of the particular workplace; for example, controlling bleeding, giving artificial respiration, etc. It is likely that all workplaces will need at least one qualified first aider; and where the work is of a particularly dangerous nature (in relation to the equipment used and/or the materials handled) it may be necessary to have many more.

The main functions of first aid are:

- Preserving life

- Minimising the consequences of an injury until medical help is obtained

- Treatment of minor injuries which would not receive or do not need medical attention

First aiders and other staff should never administer treatment which they have not been trained to deliver. Their role is to provide initial assistance to the victim while waiting for an ambulance or other medical help. This is likely to include separating the patient from the hazard and such actions as:

- Preventing any serious loss of blood

- Maintaining breathing

- Attending to burns or scalds

- Preventing shock

- Dealing with localised injuries, such as those to the eye.

It is no good having a first aid organisation if the names of its members are not known to those at risk. Therefore, the following measures should be taken:

- A notice must be prominently displayed giving the name(s) of the person(s) in charge, together with the names of the qualified first aiders.

- In large premises, it may be necessary to have more than one notice displayed and it is useful to add a reminder relating to the importance of seeking first aid treatment for all injuries, however slight. In addition to the notices, each new worker should be told to whom he/she should go for first aid treatment.

First Aid Facilities

All workplaces must have a first aid kit, suitably stocked, as well as other facilities appropriate to numbers of staff and the risks which they face in the workplace. This includes not only workers, but also contractors, visitors and members of the public.

First Aid Boxes

First aid boxes should be strategically sited in relation to the work areas and should be easily seen and marked. If possible they should be sited in good lighting and near a wash basin; a chair should be provided.

The person in charge of the box or cabinet should make sure the box is kept properly stocked and in a clean, serviceable condition. To aid stock checks, a list of contents is valuable and additional items should be ordered before the stock is used up. A record should be kept of all cases treated. The contents of first aid boxes will reflect the types of risk associated with the workplace. Note that medicines and tablets should not be included, since they may only be given by qualified medical personnel.

First Aid Facilities

For larger premises a first aid room may be provided where injured or unwell people can be taken for immediate treatment. Depending on the nature of the work carried out and the numbers of people involved, the following points are important when considering the site for such a room:

- It should have adequate floor space, including sufficient room to manoeuvre stretchers

- It should be in a central position, easily accessible to all parts of the premises, and preferably on the ground floor so that ambulances may be driven up to the door. It should be accessible to people in wheelchairs.

- It should be in a quiet place with good natural lighting and ventilation

- There should be an adequate waiting area for patients and consideration should be given to patient flow, ease of control and use by the nursing staff.

Arrangements for Contacting Emergency and Rescue Services

The arrangements for contacting the appropriate emergency or rescue services, such as the fire brigade, ambulance service, police, environmental agency, utility (water, gas and electricity) authorities and local authorities, should be set out in the organisation's safety policy and emergency procedure.

Part of the response to an emergency is likely to include taking action to contain the hazard, such as fire-fighting, shutting down equipment or giving first aid. It is important that the procedures should clearly set out the limits of such actions to be taken by workers and stress the need to bring in specialised assistance at the earliest opportunity.

The procedure should identify individuals or groups with specific responsibilities in the event of an emergency. It will be part of their role to:

- Receive information about incidents likely to give rise to an emergency situation (so workers must know exactly who to alert in such situations).

- Decide on the initial reaction to a situation, including whether an evacuation is necessary and then lead that response with other individuals who have specific responsibilities under the procedure (such as first-aiders or emergency fire-fighters).

- Contact the emergency and rescue services as necessary, and give them an outline of the incident and any special problems/hazards they might have to face.

Emergency Cover in Relation to Shift Work and Geographical Location

The safety policy and emergency procedures should set out the necessary arrangements to ensure adequate cover is in existence whenever the main designated personnel are not available. It is normal practice to have back-up personnel identified to cover for absences, but special arrangements have to be made in certain circumstances, based on specific risk assessments.

This applies in particular to shift work, where separate cover of the responsibilities for emergencies and first aid must be ensured at all times. Where the designated person or persons carrying out these roles changes, it is important that notification is given to workers of who holds the responsibilities at any given time.

Organisations who have workers who work in remote areas or alone should consider making special arrangements, such as providing a two-way radio and personal first aid kits, and organising emergency transport facilities. Contact arrangements with the main workplace must be set out clearly.

REVISION QUESTION 3

(1) What is the main objective of an emergency procedure?

(2) What hazards should be included in a risk assessment relating to emergency procedures?

(3) What is the role of those with specially designated responsibilities in the event of an emergency?

(4) What items should not be included in a first aid kit?

The suggested answers are given at the end of the unit.

UNIT SUMMARY

Safety controls are based on nine general principles:

- Avoiding risks (wherever possible)

- Evaluating the risks which cannot be avoided by carrying out a risk assessment

- Combating the risks at their source, rather than taking measures to control the risk in the wider workplace

- Adapting work to the requirements of the individual

- Adapting to technical progress

- Replacing the dangerous by the non-dangerous or less dangerous

- Developing a consistent overall prevention policy

- Giving priority to collective protective measures over individual protective measures

- Giving appropriate instructions to workers, including the use of signs, training and supervision.

There is a hierarchy of control measures which involve firstly eliminating the hazard through its removal or substitution if possible. If this is not possible, engineering controls should be used to reduce the risk at source and provide protection generally rather than individually, through isolation/segregation of the hazard or physical controls applied directly to it. Any residual risk should be dealt with by control over the way people interact with the hazard, using given working patterns and methods or, as a last resort, personal protective equipment.

A safe system of work is a formal written procedure, which is based upon a systematic examination of the tasks of a working process in order to identify all the hazards and defines methods of working which eliminate those hazards or minimise the risks associated with them. The system should be developed by competent personnel in consultation with the workers who are involved with the actual work. Instruction, training and supervision form as important a part of the system as the general and specific technical, procedural and behavioural controls which are applied. Employers are under a general duty to provide safe systems of work for their workers.

Where particularly hazardous operations have to be carried out, special permit-to-work systems may be used as part of the safe system. These are formal arrangements which confirm that appropriate safety measures have been taken at each stage in the operation, and that the designated procedures have been followed.

Emergency procedures for the safe shutting down of operations and the evacuation of premises must be in place. Specially designated personnel will be given specific responsibilities in dealing with emergencies, including co-ordinating/leading the response to the event, arranging for safe evacuation and notifying the emergency and/or rescue services. Arrangements must be in place to provide cover for such personnel in the event of their absence.

SUGGESTED ANSWERS TO REVISION QUESTIONS

Revision Question 1

(1) The three missing principles are:

–   Combating the risks at their source, rather than taking measures to control the risk in the wider workplace

–   Giving priority to collective protective measures over individual protective measures

–   Giving appropriate instructions to workers.

(2) (i)   Mandatory action – must put litter in bins

(ii)   Prohibition – not drinking water

(iii)   Safe conditions – drinking water

(iv)   Warning – radiation hazard.

(3) First, eliminate the hazard through elimination or substitution.

Second, use engineering controls which reduce the risk at source and provide protection generally rather than individually.

Finally, control the way people interact with the hazard by working patterns and methods, or as a last resort by the use of personal protective equipment.

(4) Engineering controls provide plant and equipment with built-in safety features and add particular safety equipment to processes in order to remove or reduce risks.

(5) When it has not been possible to eliminate the hazard or reduce risk to acceptable levels by the use of engineering controls, working methods or working patterns.

Revision Question 2

(1) A safe system of work is a formal procedure which results from a systematic examination of the tasks of a work process in order to identify all the hazards and define methods of working which eliminate those hazards or minimise the risks associated with them.

(2) Involvement enables workers to gain a deeper understanding of hazards and risks, and of the way in which safe systems of work will minimise those risks.

(3) Technical or engineering controls are those which are applied directly to the hazard itself in order to minimise the risk. Procedural controls define the way in which work should be carried out in relation to the hazard. Behavioural controls define how the individual operator or groups of workers must act in relation to the hazard.

(4) All of them.

(5) Because only people who are competent by means of appropriate training and instruction may be allowed to undertake the work. Supervision is necessary to ensure that staff follow instructions and their training.

(6) Permits-to-work are formal written documents specifying the work to be done and the precautions to be taken. Work can only start when it is confirmed that it is safe to do so, and the work must be carried out strictly according to the requirements of the permit. On

completion, confirmation is required that all safety measures have been reinstated before any further work can commence.

(7) The three missing elements are:

- Protective equipment necessary when undertaking the work

- Date and time duration of the permit

- Extension/shift hand-over procedures – signatures confirming that checks have been made to ensure that the plant remains safe to be worked upon, and that the next workers have been made fully aware of the hazards and precautions. Where an extension to the work is involved, a new expiry time for the permit must be given.

Revision Question 3

(1) The main objective of emergency procedures is to provide a safe environment for workers during an emergency and to limit the loss of property.

(2) Hazards at the workplace, and also those at nearby facilities which may affect it.

(3) Their role will be to:

- Receive information about incidents likely to give rise to an emergency situation

- Determine the initial response to the situation, including whether an evacuation is necessary, and lead that response

- Contact the emergency and rescue services as necessary, and brief them on the nature of the incident and any special problems/hazards they might face.

(4) Medicines and tablets (since they may only be dispensed by qualified medical personnel).

NEBOSH International General Certificate

Unit 7 | Movement of People and Vehicles – Hazards and Control

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INTRODUCTION

This unit deals with the hazards created when people move around in the workplace and when vehicles are being operated. The movement of vehicles represents one of the biggest hazards in the workplace, creating both the risk of injury to people and of damage to buildings, plant and equipment. Many fatal accidents at work are caused by moving vehicles.

In considering the movement of people, we are concerned with general hazards rather than specific risks associated with their workplace activities. We must recognise that people tend not to take any more care when walking around the workplace than they would do in the street and they may be unaware of the risks they face. This is in contrast to working with specific equipment and undertaking particular tasks where there may be recognised dangers.

The unit is designed to meet the following aims and learning outcomes as specified by NEBOSH for this part of the syllabus for the International General Certificate.

Overall Aims

On completion of this unit, you will have knowledge and understanding of:

- The hazards presented by the movement of people and vehicles and the interaction between them

- The precautions necessary to control these hazards and to reduce the risks they present.

Specific Intended Learning Outcomes

When you have worked through this unit, you will be able to:

- Identify the hazards that may cause injuries to pedestrians in the workplace and the control measures to reduce the risk of such injuries

- Identify the essential elements of a safe workplace management strategy

- Suggest ways of ensuring segregation of pedestrians and vehicles in the workplace and the appropriate control measures when segregation is not practicable

- Suggest suitable measures to ensure the safe operation of vehicles on site

- Explain the importance of site driver training as part of an overall safety programme.

HAZARDS TO PEDESTRIANS

We could divide the hazards faced by people moving around the workplace, and around areas associated with workplace activities, into three groups:

- Slips, trips and falls – either on the same level, as a result of changing levels, or from a height (which also includes falling into a hole of some kind)

- Collisions – either being hit by something, such as a moving vehicle or falling object, or striking a fixed object

- Injury or damage caused by environmental conditions – either from the effects of noise, heat or harmful substances in the air.

Note that the harm from any of these hazards may be in the form of immediate injury or longer term ill-health.

Conditions in which Hazards Arise

To some extent, many of the risks to pedestrians may be avoided by people taking more care and being alert to the hazards around them. Accidents are often caused by individuals being distracted whilst moving around the workplace, perhaps by talking to other people, by watching something or someone else, or simply by thinking about something else, etc. and failing to notice the hazards. They may also be unprepared for the likely hazards (for example, by wearing inappropriate clothing) or may simply be acting in a manner which increases risk, such as running or playing games.

Although it is important to be aware of the actions of individuals and to address these through the control strategies introduced, it is the physical conditions in the workplace which constitute the hazards that they face.

Slips, Trips and Falls on the Same Level

These are caused by dangerous conditions of the surface on which people are walking. Particular hazards include:

- Wet or greasy floors – caused by spillages of fat or oils from working processes, from water and other liquids used for cleaning purposes, or even from fruit, etc., fallen from market displays. In addition, outdoor surfaces may be made hazardous by rain, snow or ice, or the presence of leaves, particularly when wet.

- Uneven or loose surfaces – caused by broken or poorly laid paving stones or other materials, ledges at doorways, edges of mats, holes in carpets, ends of duckboards, unsecured mats or boards, etc.

- Obstacles on the surface – particularly those which may be easily overlooked, such as trailing cables, small boxes, bags and cases, etc.

Falls on Change of Level

These may result from using steps and stairs, ladders, escalators or lifts. Hazards include not noticing the change of level on a step or on stairs, ladders slipping, escalators or lifts not working properly or clothing being caught in moving parts, etc.

In addition, it is common for people to use anything to hand to gain some extra height to reach objects and materials placed above themselves. Using chairs, particularly those with wheels, or boxes, etc. is particularly dangerous.

Falls From a Height

This is a major problem on construction sites which we will deal with later. Any circumstances in which people are close to an edge requires special attention.

Collisions with Moving Vehicles

Any situation which involves crossing a vehicle traffic route is a hazard, particularly where visibility is restricted and it is not possible to see approaching vehicles clearly. Emerging from doors can present a problem where the exit leads straight on to a vehicle path, as are the corners of warehouses obscured by stacks of boxes, etc.

Other hazardous situations include:

- Working close to moving vehicles, such as in loading bays or carrying out road repairs.
- Where vehicles cross or move around areas which are normally reserved for pedestrians, such as in parks.

Collisions with Moving, Flying or Falling Objects

These may be the result of accidents themselves or the consequences of unprotected moving parts being too close to pedestrian walkways.

- Accidents involving moving objects may be where normally secured objects break loose and hit people, such as a container sliding down a slope.
- Flying objects are usually the result of an accident, such as parts being ejected from a machine or a broken drill bit coming off. They may also be naturally occurring events in work activities, such as waste materials flying out from drilling or cutting operations.
- Being hit by falling objects is perhaps the most common hazard, particularly on construction sites. Any unsecured object near an edge or on a sloping surface may be liable to fall given a vibration or a push (even from the wind) and injure someone passing or working below. This can include materials on shelves or the tops of cabinets, flowerpots on windowsills, etc.

Striking Against Fixed or Stationary Objects

This may occur as a result of objects projecting out into areas where people walk or simply being placed in a position where people may walk or run into them. For example:

- Poor stacking in a store may leave pipes, rods or pieces of timber protruding
- The edges of scaffolding, or even the cross-poles themselves, may be at a level where people might walk into them
- Boxes and containers may be left on pedestrian pavements outside shops, etc. awaiting removal to storage.

Any of these situations may be made more dangerous where visibility for the pedestrian is restricted, such as coming out of a door or around a corner.

Environmental Conditions

The risks associated with any of the above hazards may be increased where lighting is poor. This may be as a result of inadequate lighting levels, broken light bulbs, etc., or where weather conditions reduce visibility (as in dust, sand, rain, snow, fog, etc.).

In addition, certain environmental conditions present risks in themselves:

- Heat – extremes of heat may be a hazard, such as in foundries or deep refrigeration stores, but the general level of heating in the workplace (either too hot or too cold) can present health risks.

- Noise – any operations creating high levels of noise can cause temporary or permanent damage to the hearing of those nearby (who may not necessarily be workers).

- Air quality – dust, fumes and other harmful substances can be generated by a wide range of processes involving the use of chemicals (glues, paint sprays, etc.), cutting (wood dust) and burning (welding).

CONTROL STRATEGIES TO PROTECT PEDESTRIANS

We have noted that people are quite often distracted when walking around in the workplace, they may well be unaware of possible hazards and may well not notice things as apparently obvious as quite large obstructions or stair steps. This is inevitable, as it would be impossible to guarantee that people would walk around concentrating all the time on potential hazards. As a result, it is important to adopt appropriate control measures to reduce the risks associated with the types of hazards we have identified. These measures will include engineering, procedural and behavioural controls, based on systematic risk assessment.

Risk Assessment

Identification of the hazards faced by pedestrians must take account of the following factors:

- The natural patterns of movement in and around the workplace and in the vicinity of the workplace – remember that measures must be taken to protect those outside (the general public) who may be affected by what happens inside.

- Patterns of movement outside of those which are normal, whether authorised or not, and which may be reasonably predicted – such as short cuts taken, unusual numbers of people at certain times, etc.

- The particular needs of certain groups of people, including visually or hearing impaired people, people in wheelchairs, pregnant women, elderly people and children.

- The needs of people not normally on the premises, including temporary workers, contractors and visitors.

- The impact of different weather conditions.

- The impact of maintenance strategies and processes – for example, in repairing floor surfaces, repairing light fittings, etc.

- Accident and incident reports.

- The practical effectiveness of existing measures and systems of work in providing adequate protection for pedestrians.

Floor Conditions – Slip Resistant Surfaces, Spillage Control and Drainage

Floors, including suspended walkways, should be of solid construction and be of appropriate strength and stability to cope with the load placed on them and the traffic passing over them. They should not be overloaded.

The surfaces of pedestrian traffic route floors should be free from any holes, excessive slopes, unevenness or unsecured coverings which may be likely to cause a person to slip, trip or fall, or to drop or lose control of anything being lifted or carried. Holes, bumps or broken or uneven areas resulting from damage or wear, should be made good at the earliest opportunity; and there should be procedures in place for reporting such conditions and for action to be taken in response.

Floors which are likely to become wet or are subject to spillages should be of a type which does not become unduly slippery. A slip-resistant coating should be applied when necessary.

Effective drainage should be provided where a floor is liable to get wet. Floors near to machinery which could cause injury if anyone were to fall against it should be slip resistant and kept free from slippery substances or loose materials. Any spillages should be cleaned up immediately.

In regions where snow is a problem, arrangements should be made to minimise risk from snow and ice on outside walkways. This may involve gritting, snow clearing and closure of some routes, particularly in relation to outside stairs, ladders and walkways on roofs. The same would apply where blown sand presents a similar problem.

Designated Walkways/Traffic Routes

Traffic routes include those for pedestrian traffic as well as for vehicles (and for both) and include stairs, staircases, fixed ladders, doorways, gateways, loading bays and ramps.

There should be sufficient traffic routes in the workplace, of sufficient width and headroom, to allow people to circulate safely and without difficulty. Any slopes should be no steeper than are necessary. All routes should be kept clear of any obstructions which may present a hazard or block access.

Secure handrails must be provided for moderate or steep slopes, and on ramps used by people with disabilities. There should be handrails on at least one side of every staircase, and where the width of the staircase exceeds one metre, a handrail is required on both sides.

In areas where pedestrians have to pass possible hazards, such as machinery, stacks of materials, overhead workings, etc., their movement should be confined to "**designated walkways**". These are areas which are specially protected from hazards and within which pedestrians should be reasonably safe from harm. They should be clearly shown by markings on the floor (usually with white lines or yellow diagonal lines defining the limits of the safe area) and by notices and signs. Physical barriers in the form of fencing and other types of guards should provide protection from hazards to the sides, and from above and below. Handrails should be provided as necessary. Special rules ensuring that designated walkways are kept clear of any obstacles should be in place and they should be checked to ensure compliance.

Fencing and Guarding

Physical barriers should be erected to ensure that where there is a risk of collision with vehicles, moving/flying/falling objects and fixed objects, there is adequate protection for pedestrians. Barriers should be fixed and permanent, and of sufficient strength and type to resist both objects and people.

Temporary barriers may also have to be erected to prevent access to certain areas at certain times; for example, broken floor surfaces prior to repair, wet or slippery floors during cleaning and around temporary obstacles, etc.

Fencing should be provided on any open walkways where there is a risk of falling. This includes the open sides of staircases, suspended walkways and bridges.

Use of Signs

Clearly visible and easily understood signs, markings and notices should be provided to ensure that pedestrians, however unfamiliar they may be with the workplace, are aware of any hazards and what they must do to avoid them. Signs should conform with the international standards specified earlier:

- Prohibition – for example, no pedestrian access, no entry through a particular doorway, no smoking or no naked lights in particular areas, etc.
- Warning – for example, relating to dangers from falling objects or hazardous substances.
- Mandatory actions – for example, compulsory wearing/use of personal protective equipment in an area.
- Safe conditions – for example, emergency exits, fire escape routes, etc.

Hazard warning markings (for example, yellow diagonal stripes on a black background) should be fixed by tape or painted onto any object likely to present a foreseeable hazard. Examples include the edges of steps, overhead obstructions and cables or pipes temporarily laid across a floor. In addition, hazard markings on floors should indicate which areas to avoid, such as around doors used by vehicles, and show the edges of safe walkways.

Use of Personal Protective Equipment

It may be necessary for pedestrians in a particular area to have the same or similar personal protective equipment as people who are working in that area. Examples include:

- Wearing ear defenders in noisy areas
- Wearing dust masks or hoods in dusty or otherwise contaminated areas
- Wearing non-slip footwear in a kitchen or chemical plant
- Wearing a safety helmet on a construction site.

Safety signs will indicate where such requirements are mandatory and they will apply to all people entering such areas, even if they are just visiting or passing quickly through.

Information, Instruction, Training and Supervision

We should never assume that people will automatically be aware of the hazards around them and understand the necessary preventative and protective measures in place. It is important that everyone is given appropriate information to enable them to move around the workplace in safety. Instruction should be given as to general conduct, such as not running or playing games, as well as regarding particular hazards.

Part of this will be in the form of signs, markings and notices, but additional information may also be necessary, for example, about keeping to designated walkways, being aware of special hazards (such as temporary work going on overhead), etc. Visitors to premises may need special instruction prior to entry.

In certain circumstances, people must be specifically trained (even if just by being shown) in how they should move around; for example, correct procedures for securing and climbing ladders, walking through certain types of door (where a one-way system is in use), moving around while carrying loads, wearing appropriate clothing, etc.

It is part of management's job to ensure that the correct procedures are followed and that people do not act in an irresponsible manner.

Maintenance of a Safe Workplace

There are several particular topics relating to the general conditions applying in the workplace which we must look at; they are outlined below.

Cleaning and Housekeeping Requirements

There should be procedures in place to ensure the regular cleaning of all workplace areas and the removal of waste. It is particularly important that pedestrian and traffic routes are kept clear.

Workshop areas tend to produce scrap, offcuts, swarf, etc. which must not be allowed to accumulate. Sweeping and removal should take place at the end of every day or shift, although if the process produces much waste or the material is hazardous, removal during the shift could be a wise precaution.

General areas should be cleared on a regular basis. Areas which are not used regularly may be where waste materials, plastic cups and general rubbish will tend to accumulate and arrangements should be made to include such areas in inspections. Outside areas should also be cleared regularly, particularly when falling leaves or other seasonal debris is likely to accumulate.

Access and Egress (Entrances and Exits)

All passageways and corridors between working areas, and those leading on to the outside of buildings, must be kept clean and free of obstructions. Just because they do not form part of a working area does not mean that they are excluded from the same or similar hazards to those faced elsewhere, and so require the same attention to control measures.

Doors are often a problem. People rarely think about whether there might be any hazards on the other side and many accidents are caused by people colliding with other people, plant and equipment, or vehicles, when coming out of a door. There are a number of measures to ensure safety around doors, including:

- One-way systems through double doors, as used in busy areas such as restaurant kitchens, schools and hospitals.

- Automatic doors which can be easily pushed open when carrying or pushing loads.

- Hazard signals and warning lights on the doors themselves and in surrounding areas, where there are particular hazards such as the presence of vehicles.

- Insertion of window panels. The panels should be made of specially strengthened or shatter-proof glass so that they do not in themselves become a hazard. Positioning of the panels is also important, as small children may not be seen if the viewing panel is set too high.

Stacking and Racking

All materials, boxes, containers, etc., should be carefully stacked to avoid any projections or risk of falls. Any maximum height or restrictions on numbers of items to be stacked, as identified by manufacturers or suppliers, should be strictly adhered to.

Safe means of reaching materials, etc., on higher levels should be provided and inappropriate methods, such as standing on chairs or boxes, must not be allowed.

Heating

The general air temperature should be maintained at a comfortable level for the type of work. Where variations are likely, appropriate warning should be given and personal protective equipment provided as necessary (for example, on entering refrigerated stores).

Lighting

All areas used by pedestrians should be adequately lit so that people are able to see any hazards. When natural light is normally satisfactory, there should be additional artificial light after dark and at other times when weather conditions demand it. Stairs should be lit in such a way that shadows are not cast over the main parts of the treads.

Noise

Where noise is an unavoidable part of work, those in the vicinity should be provided with ear protection, even if just passing through.

Ventilation

Ventilation systems to remove dust and fumes, etc., must be in working order at all times to ensure that pedestrians are not harmed, in just the same way as workers are protected.

REVISION QUESTION 1

(1)   What are the three main types of hazard faced by pedestrians?

(2)   What are the main hazards causing slips, trips and falls on the same level?

(3)   What are the four main environmental hazards?

(4)   State four items that a risk assessment should consider in relation to potential hazards to pedestrians.

(5)   What is a designated walkway?

(6)   Where and how should hazard warning markings be placed?

(7)   What safety measures may be taken relating to doors?

The suggested answers are given at the end of the unit.

VEHICLE OPERATIONS

Many accidents involving vehicles, some of which are fatal, are caused by operator error. A particular problem is the use of lift trucks by untrained or unauthorised personnel. Other major causes of accidents are poor vehicle maintenance and unsuitable operating surroundings.

The hazards involved in vehicle operations in the workplace may be divided into three groups:

- Loss of control, where the vehicle is not under the full control of the driver.

- Overturning, tipping over onto the vehicle's side or onto its front or back.

- Collisions with other vehicles, pedestrians or fixed objects.

Note that the harm from any of these hazards may be to the vehicle itself and/or the driver, and/or to people and/or buildings, plant and equipment in the vicinity.

Conditions in which Hazards Arise

Driver error is often a key factor in vehicle accidents and it may vary from simple mistakes to acts of gross irresponsibility, such as driving too fast or under the influence of alcohol or other drugs. Many such errors occur during reversing procedures and manoeuvring. Driver error may compound or cause the following hazards.

Loss of Control

Assuming driver competence, loss of control is likely to have one of two main causes:

- Mechanical failure – for example, of the braking or steering mechanisms, preventing the driver from using the main controls.

- Environmental conditions – particularly as they affect the road, such as water and ice, but also as they may affect visibility, such as sunlight suddenly blinding a driver.

A possible outcome of a vehicle being out of control is that it will hit something. It may also cause the vehicle to overturn.

Overturning

There are two main ways in which a vehicle may turn over:

- Onto its side, that is lateral instability – as when a high-sided vehicle is blown over in high wind or when a loaded fork-lift truck tips over whilst driving across a slope.

- Onto its front or back, that is longitudinal instability – as when a tractor's front wheels lift due to the weight applied by an attached trailer, or when a fork-lift truck is moving up or down a slope.

Overturning is caused by the centre of gravity of the vehicle moving outside of its wheelbase, as shown in the following diagrams of loaded fork-lifts.
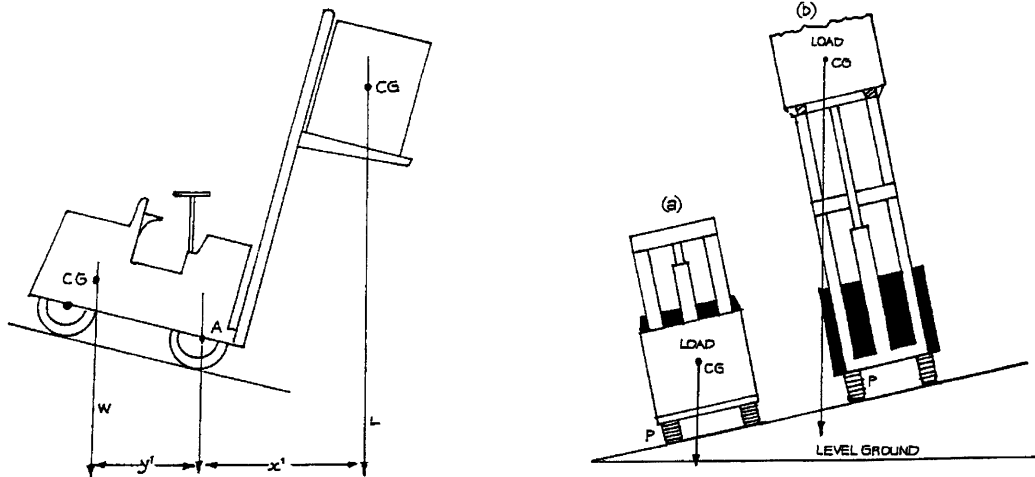
Loaded Forklifts

Such instability is a major problem in the safe use of high vehicles, particularly those with lifting mechanisms. The risk is increased by:

- The speed of travel

- Steepness of the slope

- Height the load is raised to and the stability of the load

- Increased tyre pressure

- Any external longitudinal pressure, such as wind or colliding objects

- Presence of any bumps or holes in the surface, and their size.

Note that a similar effect to that of a slope may be caused by uneven ground. Where a vehicle goes over a pothole, for example, the front wheels will dip giving the effect of a slope. Fork-lifts are difficult vehicles as they have small wheels which enlarge the effect and no suspension to keep the body steady.

Loading and Unloading

Many accidents are caused by the loads carried by the vehicle becoming unstable and either falling off, causing the vehicle to overturn or the driver to lose control. Loads do not do this by themselves, it happens because of inadequate loading (or unloading) procedures, such as:

- Overloading

- Uneven weight distribution

- Unsecured loads

- Slippery surfaces on the vehicle or load itself.

Environmental Conditions

Again assuming a competent driver, we note that collisions with other vehicles, pedestrians or fixed objects are generally caused by adverse local conditions:

- Poor weather – ice or rain causing skidding or longer braking distances, sunlight blinding vision, rain or fog restricting visibility

- Poor lighting – decreasing visibility or obscuring parts of the traffic route, including obstructions

- Poor sight lines – causing blind spots and concealed junctions

- Poor ground surface – uneven or slippery surfaces or excessive slopes

- Congestion – there simply being too many vehicles in one area.

CONTROL STRATEGIES FOR SAFE VEHICLE OPERATIONS

Vehicle movements are highly regulated on the public roads by a mixture of engineered controls, trafficking procedures and behavioural controls on individual drivers.

The same types of controls will be used in the workplace, based on a risk assessment to decide on the extent and types of control necessary.

Risk Assessment

Identification of the hazards presented by vehicle operations has to take into account the following factors:

- The tolerable patterns and volume of vehicle movements in and around the workplace, including access to and exit from it onto the public roads

- The types of vehicles on the premises

- The types of operations undertaken by vehicles in the workplace and the types of loads being moved

- The need to segregate vehicles and pedestrians

- The impact of different weather conditions

- The local environment, such as conditions of the roads, lighting and sight lines.

Traffic Routes – Suitable and Sufficient

All routes used by vehicles should be clearly marked and should separate pedestrians from moving vehicles where possible.

Routeways should be laid out logically and be wide enough to allow all forms of movement by all the types of vehicles using them, including passing, turning, reversing and loading and unloading. They must be wide enough and high enough for the safe movement of the largest vehicle likely to use them, with allowance made for visiting vehicles which may be larger than those used exclusively on site.

The individual requirements of vehicles using the premises must also be allowed for; for example, although articulated lorries are more manoeuvrable than rigid lorries of smaller size, they have different requirements for turning and reversing.

The volume of traffic is also a factor in deciding size and layout of traffic routes. Two-lane routes which allow for passing in opposite directions may or may not be necessary, although passing places must always be allowed for. The need for barriers to separate lanes should be considered. Adequate space must also be provided for entering or exiting the site, given the number of vehicles involved in the site and the public roads outside.

Management of Vehicle Movements

The way in which vehicles move around a site should be carefully controlled and be appropriate for the types of vehicle operating on the site. This has to be carefully thought out and can have wide implications; for example, the circulation of vehicles collecting rubbish from skips and

bins, and their need to park during operations, may affect the siting of the rubbish containers or require special access routes to them.

Movement Systems

So far as possible, the need for vehicles to reverse should be eliminated, since this is one of the biggest causes of accidents. One-way systems are one means of achieving this and many sites operate such systems. Specially designated turning areas may also be used.

Traffic lights may be employed to control movements at heavily used junctions or at blind exits, for example around doors.

Speed Limits

Speed limits should be set and enforced on all parts of the site. They should take into account the environmental hazards, presence of pedestrians, the conditions of the road surface, the types of vehicle and the operations they are involved in. Special restrictions may apply in certain parts of the site, especially where pedestrians are close, such as in loading/unloading bays.

As enforcement is often difficult, speed retarders (road humps) accompanied by prominent warning notices may be used to prevent vehicles being driven at excessive speeds.

Vehicle Parking

Sufficient and suitable parking areas should be provided for all vehicles using the site, including workers' and visitors' private vehicles. If vehicles are left in unplanned areas the safe operation of the site may be jeopardised; for example, by obscuring sight lines.

Signs and Markings

Surface markings and road signs play an important part in regulating vehicle movements:

- White lines on the road surface may be used to divide two-way roads into lanes, indicate priorities at junctions and mark the boundaries of parking spaces and loading bays

- Hazards should be clearly marked by diagonal yellow lines on a black background; for example, to identify temporary or permanent obstructions, low bridges, speed bumps, etc.

- Warning and prohibition signs should be clearly visible to the drivers of all types of vehicles operating on a route and should give adequate warning of an approach to a hazard.

- Direction signs should clearly indicate any required movements, such as one-way systems, as well as help drivers to find their destination.

Signalling

Where vehicles are required to reverse or to operate in restricted spaces such as loading bays, the use of people to direct vehicle movements may be required. There are standard hand and directional signals used for this, including those shown in the figure below.

Danger (emergency stop)   *Indicating horizontal distance*

Move forwards   *Move backwards*
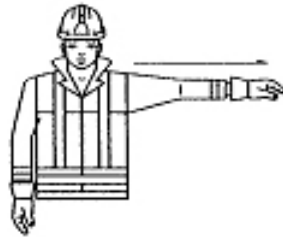
Move to the (signalman's) left   *Move to the (signalman's) right*
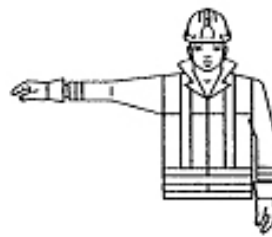
Hand Signals

Loading and Unloading Procedures

Many accidents occur during loading and unloading, but they may be reduced by having well designed areas and safe systems of work for the procedure itself.

Adequate space should be provided to allow access to all parts of the vehicle necessary for loading or unloading, and for the stacking and temporary storage of goods. The time that goods are left before loading or removal should be minimised. Empty pallets and other material should not be allowed to accumulate in an unplanned way. There should always be sufficient clearance overhead, and particular care should be taken when vehicle bodies are raised.

Loading procedures should ensure that:

- Vehicles are not loaded beyond rated capacities or the legal limits of gross weight

- The floor of the vehicle is checked for soundness before loading

- Loads are evenly distributed, and secured or arranged so that they do not move in transit

- Tail and side boards are closed

- Overhangs are kept to a minimum and suitably marked

The following precautions should be taken when unloading:

- The load should be checked for stability before ropes or tarpaulins are removed

- The load should remain stable and evenly distributed so far as practicable during unloading.

Falls from elevated areas of vehicles during loading, unloading, sheeting and checking operations often occur when people have to gain access to the tops of vehicles. The risk of injury may be reduced by the provision of safe means of access to and from the vehicle, instructions to staff and the use of mechanical aids where appropriate. For example, to prevent people who are sheeting a vehicle having to climb onto the vehicle itself, sheeting sheds can be used, where sheets are rolled on to a roller which is raised horizontally on a gantry above the vehicle, one end of the sheet is then secured to the leading end of the vehicle which is then driven forward, pulling the sheet from the roller and spreading it over the load. The tail end of the sheet is then secured by hand at ground level.

Environmental Considerations

The conditions applying to traffic routes must ensure that they are safe to use at all times.

Visibility

Adequate lighting is essential for safe and efficient operations, as well as for security reasons. Outside areas which may have natural daylight will require artificial lighting when it is dark and during weather conditions which restrict visibility. Increased levels of lighting may be necessary in certain circumstances, for example:

- At junctions of traffic routes

- Where traffic routes are close to buildings or plant

- In pedestrian areas

- Places where there is regular movement of vehicles and other mobile plant.

Lighting columns close to the edges of routes can cause difficulties and if they cannot be set back then overhead or wall mounted lights should be used.

The sight lines of traffic routes must be carefully considered to ensure that drivers can see ahead and around them, and so that others can see them. Hazards such as sharp bends or blind corners should be eliminated where possible by, for example, lowering or removing walls, stacks, etc, at corners and junctions. Where this is not possible, warning signs, hazard markings and mirrors can reduce the risk.

Parked vehicles should not be allowed to cause obstruction to lines of sight. This can be a problem where vehicles have stopped for checking on leaving premises. Lay-bys should be provided wherever appropriate.

Gradients and Changes of Level

Excessive gradients, namely those in excess of 1 in 10, should be avoided where possible. This may be difficult in certain areas and any steep ramps should always be clearly marked. Strict rules about driving on steep slopes are required.

The transverse slope (camber) of traffic routes should allow for adequate drainage, but not be any steeper due to the risk of overturning. Wherever possible, traffic should not be allowed to travel across slopes.

Surface Conditions

All routes should be even, constructed of suitable materials for the vehicles using them and well drained. Maintenance of roads is particularly important; for example, potholes should not be allowed to develop, loose materials should be cleared regularly, snow clearing and gritting may be necessary, and any temporary obstructions (including goods, etc., fallen from vehicles) should be cleared as soon as possible.

Raised kerbs should be kept to a minimum where collision with them may cause overturning; for example, where lift trucks operate.

Maintenance of Vehicles

Key areas of concern in ensuring the safe operation of vehicles include:

- Braking systems
- Steering mechanisms
- Tyres – to ensure that grip is maintained at all times and the risk of blow-outs is minimised
- Exhaust systems – to reduce fumes and other emissions.

Driver Protection and Restraint Systems

Drivers must be adequately protected in their driving position by such means as the use of seat belts, secured doors and protective cages and cabins with shatter-proof glass. Vehicles at particular risk of overturning, such as cranes, lift trucks and tractors, require extra protection. Drivers must ensure that they use all the safety features at all times.

Safe access to and from vehicles is also important. Every year, many accidents happen when drivers and operators fall getting into or out of their cabs. Well designed, positioned and maintained handrails and footholds are one way of preventing such falls.

Drivers may also need personal protective equipment for any environments they enter; for example, dust masks and ear protection.

Special measures to prevent vehicles overturning or rolling away may also be provided. These include safety stops to prevent vehicle movements on slopes and extendable legs to provide stability when operating.

A particular hazard with vehicles which have raised or tipping bodies or extending parts is that the body or extended part may descend and trap any person working underneath. No work should be carried out beneath a raised body unless it is suitably propped, and warning notices to this effect should be displayed. It is preferable that body props are incorporated into the vehicle itself. A tipping vehicle should never be driven unless the body is locked in the lowered position.

Protective Measures for People and Structures

Appropriate means of warning people of hazards relating to vehicle operations, and of protecting them, the buildings, plant and equipment in the workplace, should be provided.

Barriers

Physical protection of vulnerable plant and equipment such as storage tanks, pipe work and storage racking may be necessary. Such plant should be located away from roads, but where this is not possible then suitably constructed barriers should be provided for protection.

Columns, pillars and walls may have to be padded to limit damage in case vehicles collide with them.

Barriers may also be used to prevent pedestrians entering vehicle traffic routes and to separate vehicles within routeways.

Signs, Markings and Signals

Pedestrians should be given information about vehicle movements and other aspects of vehicle operations, as well as informing drivers about the hazards, rules and directions applying to traffic routes.

- Information and warning signs should conform to the international standards mentioned earlier.

- Dangerous locations – where there is a risk of collision with vehicles, such as the edges of loading platforms, the edges of inspection pits, projecting surfaces or objects, etc. – should be identified and, where it is impractical to safeguard them by other means, must be clearly marked using yellow and black angled stripes.

- Warnings of vehicle approach – lights and sirens may be used to warn people and other drivers of the approach of vehicles at blind corners and junctions (for example, at doors) and on reversing.

Site Rules

It is important that all drivers using a site are aware of all the rules that apply, such as one-way systems, speed limits, parking, etc. Visiting drivers may need to be given both general and specific instruction about the management systems operating on site.

There are a number of general rules applying to all situations in order to prevent unauthorised use or misuse of vehicles, and to ensure that when unattended or parked they do not create hazards:

- When a vehicle is not in use the keys should be kept in a secure place. At the end of the work period the engine should be switched off and the brakes applied. On battery operated vehicles the battery should be disconnected.

- All vehicles should always be parked in a safe place and not obstruct emergency exits, other vehicle routes, fire-fighting equipment or electricity control panels.

- Vehicles should not be left unattended on a gradient. If a vehicle has to be left or parked in an emergency, even for a short period of time, it should be left in neutral with the parking brake applied and wheels chocked to prevent unexpected movement.

- Horns should be sounded at every potential danger point, such as before entering doorways and at blind corners, although the use of a horn does not give the driver right of way.

Fork-lift Trucks

Special rules for fork-lift trucks include:

- The forks should be lowered whenever the vehicle is parked.

- Violent breaking of a loaded truck should be avoided as sudden movement could cause the load to fall or the truck to tip.

- Whenever possible when driving, the forks should be lowered to within 150 mm of the ground and the mast tilted back. (Driving with the load elevated increases the risk of overturning.)

- When a high load restricts vision, the truck should be driven in reverse, except when driving up a gradient.

- To minimise the risk of overturning, when a loaded truck is travelling up or down a gradient, the forks should face uphill. When unloaded and travelling down gradients, the forks should face downhill.

Vehicle Parking

In order to prevent a large number of transport related accidents, it is important to control not only the movement of vehicles but also the parking of private and company vehicles:

- Due attention should be paid to the design of parking areas, with adequate access and exit.

- Space should be available for loading and unloading skips and collection vehicles.

Ensuring Driver Competence

Many of the control strategies we have considered rely for their effectiveness on the driver operating according to the rules and applying the necessary measures at all times. It is very important that there are systems and procedures in place to ensure driver competence. They should cover the initial appointment and training of drivers, and developing and maintaining their skills.

Driver Selection

It is important to select new drivers carefully. The first point is usually age as minimum age may be stated in local legislation.

Other factors to be taken into consideration are that operators should be reliable, able to do the job in a responsible manner, and have a reasonable level of physical and mental fitness and intelligence. These guidelines do not exclude disabled or handicapped people, but in such cases, it is advisable to seek medical advice to assess their suitability. The use of selection tests can reduce wasteful attempts to take on unsuitable trainees.

Training

Operator training should include both general and specific requirements:

- General basic training – the basic skills and knowledge required for safe operation of the type of vehicle and any attachments which the driver will be required to use.

- Specific job training – covering knowledge of the workplace, any special requirements of the work to be undertaken and the use of any special equipment. This will include detailed controls of the vehicle to be used, routine inspections which should be carried out by the operator, use of the vehicle in different locations and in different weather conditions, site rules, loading and unloading procedures and transporting loads.

Refresher training is also useful for all drivers, but may be specifically required when, for example, drivers have to operate different types of vehicles or if there is a change of work.

Management Systems for Assuring Driver Competence

Employers should keep records of all training undertaken by drivers. In many regions, driver training is conducted to national codes of practice and certified by approved bodies. The record should indicate the types of vehicle which a driver may operate and any special conditions which might apply, such as area limitations and expiry dates.

Where an operator possesses previous experience and/or training, the evidence should be examined before he/she undertakes any driving tasks. It is necessary to assess whether the previous experience and training are suitable and sufficient to enable the driver to operate safely the particular types of vehicles and their attachments used in the given work environment. Previous training certificates should be examined and if they are not available the operator should undergo an assessment whilst actually driving the vehicle concerned.

It may be necessary to put in place management systems which make sure that drivers have the required skills and knowledge for operating under any special conditions on a site; for example, permit to work systems.

MEANS OF SEGREGATING PEDESTRIANS AND VEHICLES

Pedestrians should be physically separated from vehicle traffic routes wherever possible by using such methods as:

- Barriers to separate pedestrians from vehicle traffic routes or, where this is impractical, the use of clear surface markings to show the separate routes. These are particularly important outside exits from buildings where there is a risk of pedestrians walking directly onto a road.

- Designated crossing points for pedestrians to use when passing over vehicle routes. They should be clearly marked and controlled by traffic lights if necessary. Where traffic is particularly heavy, bridges or subways may be necessary.

- Where vehicles pass through doorways or under narrow bridges or tunnels which have insufficient width to allow vehicles and pedestrians to be separated by a raised or railed-off footpath, separate access for pedestrians should be considered.

There are many situations where pedestrians and vehicles cannot be separated for operational reasons. In such situations the following measures should be taken:

- Pedestrians may be required to wear high-visibility jackets

- Vehicles should be fitted with warning lights and alarms to indicate movement, particularly on reversing

- Structural and environmental conditions should be altered to improve safety, with particular attention to visibility (through lighting and mirrors).

REVISION QUESTION 2

(1)   What are the three main types of hazard caused by vehicle operations?

(2)   What may cause loss of control of a vehicle?

(3)   What factors may contribute to the risk of overturning?

(4)   Identify the environmental conditions which might contribute to accidents.

(5)   How can visibility be improved?

(6)   Identify the main safety measures used to manage vehicle operations and movement.

(7)   On what key areas should vehicle safety maintenance concentrate?

(8)   In what conditions should warning lights and alarm systems be used?

(9)   What special equipment should be fitted to vehicles to protect drivers?

(10) What are the main means of separating vehicles and pedestrians?

The suggested answers are given at the end of the unit.

UNIT SUMMARY

Hazards to pedestrians in the workplace include the risk of slips, trips and falls, of collisions with vehicles, moving or fixed objects, and of injury or damage caused by environmental conditions. Whilst many accidents are caused by not paying attention, the physical conditions of the workplace create the underlying hazard: condition of the flooring, inappropriate equipment being used, lack of barriers, guards and other restraints to prevent falls, separate pedestrians from vehicles and protect them from moving or flying objects, inadequate lighting levels, extremes of temperature, noise levels and poor air quality.

Control strategies to protect pedestrians include engineering, procedural and behavioural controls, based on a systematic risk assessment which takes into account patterns of movement in and around the workplace and the needs of different groups of workers, including visitors, and of the general public. Such strategies include:

- Pedestrian traffic routes, including marked walkways, which separate people from vehicles and provide protection from collision with moving objects and from falling. Special measures may be applied around doors and to ensuring stacks and racks are level and stable.

- Safe floor surfaces – free from any holes, excessive slopes, unevenness or unsecured coverings, and from conditions likely to cause slips.

- Permanent and temporary barriers, fences and guards to protect people from falls and from moving or flying objects, and to prevent access to dangerous areas.

- Use of signs, etc. to warn of hazards and require or forbid certain actions, such as marking out restricted areas.

- Provision of personal protective equipment when entering hazardous areas.

- Adequate instruction, training and supervision to ensure safe movement around the workplace, both in terms of general conduct and any special procedures.

- Appropriate cleaning arrangements which ensure the regular disposal of waste and keep floors and pedestrian traffic routes free from obstruction.

- Ensuring adequate levels of lighting, comfortable general air temperatures and noise levels, and clean air.

The hazards involved in vehicle operations in the workplace might be due to loss of control of a vehicle, overturning and collisions with other vehicles, pedestrians or fixed objects. Driver error is often a key factor, but accidents may also be caused by mechanical failure, poor environmental conditions (particularly by the conditions of the ground surface and visibility), speed of vehicles, gradient, stability of loads and congestion.

Control strategies for safe vehicle operations involve a mixture of engineered controls, traffic procedures and behavioural controls on individual drivers, based on a risk assessment which takes into account patterns of vehicle movement in and around the workplace, types of vehicles and operational requirements. Such strategies include:

- Logically arranged traffic routes for vehicles which separate them from pedestrians and allow adequate space for all forms of movement by all the types and numbers of vehicles using them.

- Adequate levels of lighting and clear sight lines to ensure maximum visibility at all times.

- Road surfaces which are sound, even, well drained and kept free of any obstructions, loose materials or conditions likely to cause skidding. Excessive gradients should be avoided wherever possible.

- Appropriate management arrangements to ensure easy movement of vehicles around the site and safe operations involving vehicles – including such measures as one-way systems, speed limits, designated parking areas, adequate signs and road markings, designated areas for loading and unloading, safe systems of work for such procedures, and general and specific rules about driving and vehicle security on a site.

- Appropriate arrangements for the regular servicing and maintenance of vehicles, and for reporting problems and making repairs.

- Protective measures to secure the safety of drivers, and of pedestrians and buildings, plant and equipment.

- Appropriate selection and training of drivers, and systems to ensure their competence to recognised levels.

Wherever possible, pedestrians should be physically separated from vehicle traffic routes by the use of barriers and clear surface markings, the provision of designated crossing points and separate means of access and egress. Where this is not possible for operational reasons, special protective measures should be taken to ensure the safety of people.

SUGGESTED ANSWERS TO REVISION QUESTIONS

Revision Question 1

(1) Slips, trips and falls; collisions; injury or damage caused by environmental conditions.

(2) Wet or greasy floors, uneven or loose surfaces, and obstacles on the surface.

(3) Lighting levels, heat, noise and air quality.

(4) There are many such factors. The following were given in the unit:

- The normal patterns of movement in and around the workplace

- Patterns of movement outside of those which are normal, whether authorised or not, and which may be reasonably predicted

- The particular needs of certain groups

- The needs of people not normally on the premises

- The influence of different weather conditions

- The influence of maintenance procedures

- Accident and incident reports

- How good are the existing measures and systems of work in providing adequate protection for pedestrians.

(5) Designated walkways are areas which are specially protected from hazards by segregating people from vehicles, and within which pedestrians should be reasonably safe from harm.

(6) Hazard warning markings (yellow diagonal stripes on a black background) should be fixed as tape or painted onto any object likely to present an unforeseen hazard. In addition, they may be used to indicate areas to avoid, such as around doors used by vehicles, and to mark the edges of safe walkways.

(7) Four strategies are suggested:

- One-way systems through double doors

- Automatic doors or soft doors

- Hazard signals and warning lights on the doors themselves, and in surrounding areas

- Putting in viewing panel windows.

Revision Question 2

(1) Loss of control, overturning and collisions with other vehicles, pedestrians or fixed objects.

(2) Driver error, mechanical failure and environmental conditions.

(3) Several factors may be involved, including:

- Speed of travel

- Steepness of the slope

- Height of the vehicle (including its load)

- Stability of the load

- High tyre pressure

- Any external longitudinal pressure, such as wind or colliding objects

- Presence and size of any bumps or holes in the surface.

(4) Adverse environmental conditions include:

- Poor weather

- Poor lighting.

- Poor sight lines.

- Poor ground surface.

- Congestion.

(5) By ensuring adequate lighting is provided for the traffic route (and its surroundings), and by making sure that sight lines are good.

(6) Management of vehicle operations and movements includes the following measures:

- Movement systems

- Speed limits

- Vehicle parking

- Signs and markings

- Signalling

- Loading and unloading procedures

- Special rules for particular sites

- General rules to make sure vehicles do not become hazards.

(7) Vehicle safety maintenance should concentrate on:

- Braking systems

- Steering mechanisms

- Tyres

- Exhaust systems.

(8) Warning lights and alarms should be used to alert pedestrians and other drivers of the approach of a vehicle. They are particularly important at blind corners, junctions and doorways, and on reversing.

(9) The main methods of protecting drivers are the use of seat belts, secured doors and protective cages and cabins with shatter-proof glass.

(10) There are three main means of separation:

- Barriers and/or clear surface markings to mark separate routes for pedestrians and vehicles.

- Designated crossing points for pedestrians to use when crossing vehicle routes.

- Separate doorways, etc., for pedestrians.

NEBOSH International General Certificate

Unit 8 | Manual and Mechanical Handling Hazards and Control

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INTRODUCTION

Here we will look at the way in which materials are handled during the course of work activities. This is not just confined to the lifting and moving of heavy loads, but covers all types of handling operations from small items, as might be purchased from a market stall, to prefabricated building sections being manoeuvred by a tower crane.

Manual handling is the cause of many workplace accidents. The most frequent injuries are to the lower back and are caused by incorrect lifting or movement, and by lifting or moving too heavy a load. Such injuries can disable a worker, preventing that person from either working or carrying out any non-work activities.

Manual handling work has to be designed so that workers do not strain themselves by lifting and moving materials, and especially to prevent back injury. A long period of hard physical work will result in an operator becoming tired and more prone to having an accident if he is not in good physical health.

The common solution to controlling such risks is to use mechanical methods to lift and move heavy objects; but whilst this does reduce manual handling risks and allows more work opportunities for people who are less able to use physical strength, it also introduces new risks and creates new hazards. Mechanical methods might include simple trolleys, two-wheeled sack trucks and roller conveyor systems, up to larger equipment such as motorised fork lift trucks (which cause many accidents when not properly used), travelling power hoists and cranes.

Where manual handling is unavoidable, there are three key points to bear in mind:

- No worker should be required to lift or move materials which are too heavy for that operator to cope with as an individual

- The time spent on heavy manual handling work should be controlled, varied throughout a work shift, and alternated with periods of less demanding work

- Workers must be allowed regular rest periods in which to recover.

In this unit we will examine the hazards and injuries associated with manual handling and the methods used to overcome them without using mechanical devices. We will also look at mechanical handling methods and the way in which safe systems of work can reduce the associated risks.

The unit is designed to meet the following aims and learning outcomes as specified by NEBOSH for this part of the syllabus for the International General Certificate.

Overall Aims

On completion of this unit, you will have knowledge and understanding of:

- The hazards involved in the movement of loads by physical and mechanical effort

- The risk reduction and preventive measures available

- The risks involved in the use of lifting and moving equipment.

Specific Intended Learning Outcomes

When you have worked through this unit, you will be able to:

- Describe the main types of injury associated with manual handling

- Carry out a manual handling assessment

- Suggest ways of minimising manual handling risks

- Explain the training requirements for those who are required to manually lift loads

- Explain the precautions and procedures necessary to ensure safety in the use and maintenance of fork-lift trucks, manually operated load moving equipment, lifts, hoists, conveyors and cranes.

MANUAL HANDLING HAZARDS AND INJURIES

People pick up and move objects all the time at work and any such activity may present a hazard. The risk is that the action will cause an injury of some kind to the person undertaking the operation or by causing the object to fall or move, create a risk that someone else may be injured.

The extent to which there is risk associated with any form of manual handling will be the subject of a risk assessment, which we consider in detail later. However, we note that risk does not just arise in relation to the lifting and movement of heavy loads. They do present a significant risk, but the way in which apparently light and easy objects are handled can also cause harm.

There are four main causes of harm in manual handling operations:

- Failing to use a proper technique for lifting and/or moving the object(s) or load

- Moving loads which are too heavy

- Failing to grip the object(s) or load in a safe manner

- Not wearing appropriate personal protective equipment.

Note that the harm from any of these actions may be in the form of immediate injury or longer term, chronic mobility problems.

Common Types of Injury

The type of injury caused by handling objects and loads will depend on the part of the body which is put under stress.

Back Injuries

These are caused by twisting, lifting or pushing loads where the stress is carried on the spine, usually towards the base.

Excessive torsional (twisting) or crushing movement on the spine can lead to displacement of the intervertebral discs, the fluid-filled cushions of gristle between the vertebrae (the bone structural units of your back). The most serious injuries are slipped or crushed discs, but this can also cause sciatica (pain in the sciatic nerve which runs down the back of the legs). More generalised back problems such as lumbago can also be disabling.

Whilst many back injuries are an immediate result of lifting a particularly heavy load, they can also become chronic problems, which have built up over time. Early investigation of complaints of backache is therefore recommended as it may develop into a more serious problem.

Muscular Problems

When a muscle is stretched beyond its normal limit it is strained. When it is subjected to sudden or excessive force it may be sprained. Either of these two causes may tear or rupture the casing of the muscle, which is a serious injury. The effect is to weaken joints and restrict movement, making movement painful.

Such muscular problems may be caused by stretching, lifting heavy loads or slips, trips and falls. In most cases they are acute injuries, but strains can build up over time. Some general lower back problems are the result of pelvic or sacro-iliac strains.

Hernias

A hernia is a tear in the muscles of the gut cavity wall, usually in the lower abdomen, which allows part of the intestine to stick out through the tear. It is caused by excessive strain on those muscles during lifting.

Cuts, Abrasions and Bruising

These will be caused by contact with the surfaces of the objects or loads being handled. The size and weight of an object makes no difference in causing cuts and abrasions; a single sheet of paper is well known for producing painful cuts on the fingers.

Bone Injuries

Fractures and breaks are usually impact injuries caused by crushing part of the body, usually fingers, under a load or dropping objects on feet. They may also be caused by slips, trips and falls.

Work Related Upper Limb Disorders (WRULDs)

The term "work related upper limb disorders" has replaced the term "repetitive strain injury" (RSI) to refer to ill-health conditions which affect the upper limbs. They may also be referred to as "cumulative trauma disorders" (CTDs). Upper limb disorders affect the soft connecting tissues, muscles and nerves of the hand, wrist, arm and shoulder. Severity may vary from occasional aches, pains and discomfort of the affected part through to well-defined and specific disease or injury. Loss of function may result in reduced work capacity.

WRULDs arise from ordinary movements, such as repetitive gripping, twisting, reaching or moving. The stress involved in the individual movements themselves may be very small, but the hazard is created by prolonged repetition, often in a forceful and awkward manner, without sufficient rest or recovery time. The load need not be heavy as it is the awkward or repetitive movement (such as twisting to turn a control lever) which causes the damage. A range of occupations may be affected, including production line workers, packers, painters and machine operators.

The effects are:

- General fatigue and loss of concentration or co-ordination

- Inflammation of the wrist tendon, muscle tendon junction or tendon sheath (tenosynovitis)

- Inflammation of the tissue of the hand (or elbow, or even knee), caused by constant bruising or friction

- Compression of the peripheral nerves serving the upper limb (Carpal Tunnel Syndrome)

- Temporary fatigue, stiffness or soreness of the muscles.

The key factors associated with the increased risk of WRULD include excess force used to overcome resistance in a work operation due to poor design, highly repetitive motions with short cycle times giving little time for recovery, and awkward postures causing high stress to joints of the upper limbs and surrounding soft tissues.

ERGONOMIC ASSESSMENT OF MANUAL HANDLING RISKS

Earlier on we introduced the general risk assessment methodology. You may recall that there is often no specific format for carrying out an assessment. However, where certain hazards are identified in an overall assessment of workplace risks, it is usually necessary to conduct more detailed risk assessments; these will have a practical focus to assess the specific risks and prompt the specific control options. Manual handling is a case where the risks and control options are well known. A typical procedure for carrying out a manual handling risk assessment may be as shown below in the form of a flow diagram. It fits into the general risk assessment methodology discussed in earlier units, but here it is adapted for manual handling. What is considered to be "reasonable" will vary from case to case and include all sorts of factors, including cost.

```
┌─────────────────────────────────┐
│ Does the work involve manual    │──── No ──────────────────┐
│ handling operations?            │                          │
└─────────────────────────────────┘                          │
                 │                                            │
                Yes                                           │
                 ▼                                            │
┌─────────────────────────────────┐                          │
│ Is there a risk of injury?      │──── No ──────────────────┤
└─────────────────────────────────┘                          │
                 │                                            │
           Yes/possibly                                       │
                 ▼                                            │
      ┌─────────────────────────────────┐                    │
  ┌──▶│ Is it reasonabe to avoid moving │──── Yes ───────────┤
  ┊   │ the loads?                      │                    │
  ┊   └─────────────────────────────────┘                    │
  ┊                │                                          │
  ┊               No                                          │
  ┊                ▼                                          │
  ┊   ┌─────────────────────────────────┐                    │
  ┊   │ Is it reasonable to automate or │──── Yes ──┐         │
  ┊   │ mechanise the operations?       │           │         │
  ┊   └─────────────────────────────────┘           ▼         │
  ┊                │                   ┌────────────────────┐ │
  ┊               No                   │ Does some risk of  │ │
  ┊                │                   │ manual handling    │ │
  ┊                ▼                   │ injury remain?     │ │
  ┊   ┌─────────────────────────────┐  └────────────────────┘ │
  ┊   │ Carry out manual handling   │◀─ Yes/possibly          │
  ┊   │ assessment                  │                         │
  ┊   └─────────────────────────────┘                         │
  ┊                │                                           │
  ┊                ▼                                           │
  ┊   ┌─────────────────────────────────┐                     │
  └─  │ Determine measures to reduce    │                     │
      │ risk of injury to the lowest    │                     │
      │ reasonable level                │                     │
      └─────────────────────────────────┘                     │
                 │                                             │
                 ▼                                             │
      ┌─────────────────────────────────┐                     │
      │ Implement the measures          │                     │
      └─────────────────────────────────┘                     │
                 │                                             │
                 ▼                                             │
  No ─┌─────────────────────────────────┐                     │
      │ Is risk of injury sufficiently  │                     │
      │ reduced?                        │                     │
      └─────────────────────────────────┘                     │
                 │                                             │
                Yes                                            │
                 ▼                                             │
      ┌─────────────────────────────────┐                     │
      │ End of initial exercise – review│◀────────────────────┘
      │ if conditions change            │
      │ significantly                   │
      └─────────────────────────────────┘
```

Manual Handling Risk Assessment

One approach to the identification of hazards in manual handling operations involves four key factors:

- **The task** – analysis of the type of the handling operation involved and identifying high risk activities

- **The load** – analysis, including measurements, of the object(s) being handled

- **Individual capability** – consideration of the (mainly) physical characteristics of the people who are doing the handling operation and their ability in terms of knowledge, skills, health and strength

- **The working environment** – analysis of the immediate physical surroundings within which the handling operation takes place.

Assessing Manual Handling Risks

In general, all tasks involving manual handling, however trivial, should be subject to a risk assessment and the result should be recorded unless it is simple and obvious, and the operation itself is low risk and of very short duration.

The Task

Manual handling may involve lifting or lowering loads from the floor or at any height, reaching up to get a load, pulling or pushing a load, twisting it around, etc. Such operations may be carried out only occasionally or they may be repetitive, such as lifting articles from the end of a moving conveyor belt.

All tasks involving any form of manual handling operation should be analysed. Whilst there are a number of jobs which, wholly or in part, involve carrying out such tasks, it is important that no jobs are overlooked. So, for example, it is obvious that the work of production line operators should be assessed, but less so where the Managing Director (or, more likely, his/her secretary) rearranges the tables and chairs every day for different meetings.

The types, frequencies and duration of movements should be analysed with the purpose of identifying those movements most likely to cause injury. Deciding on the level of risk will inevitably call for judgement. Where there is a clear risk, or where the risk is uncertain, the task may be broken down into more detail, considering such factors as whether it involves:

- Holding loads away from trunk

- Twisting

- Stooping

- Reaching upwards

- Large vertical movement

- Long carrying distances

- Strenuous pushing or pulling

- Unpredictable movement of loads

- Repetitive handling

- Insufficient rest or recovery

- A work rate imposed by a process.

The Load

A load may be any individual moveable object, including another person. A load constitutes a hazard because of its weight, size, shape, resistance to movement, rigidity or lack of it, position of its centre of gravity, presence or absence of handles, or surface texture. The stability of any contents may also be a factor, as may be the contents themselves if there is any possibility of the container breaking during handling.

Note again that a load may be anything, regardless of whether or not it is heavy. For example, lifting a packet of biscuits from a conveyor belt and placing it in a box on the floor involves a light load, but because of the repetitive nature of the task it may cause pain if repeated for several hours. Therefore assessments which concentrate only on weight limits are insufficient, although weight is an important consideration. Although there is no "safe" weight, it has been proved that the incidence of back injury increases with the weight of the load.

Other characteristics of the load may be just as important. Consider the example of a low density, lightly bulked material (say, 25 kg of feathers) and the same weight of a high density, tightly bulked material (25 kg of, say, lead shot) – the feathers may actually be more hazardous because the load has to be held further away from the body (because they take up a larger space), so the forces on the spine are greater.

Certain loads require particular attention as they require special handling techniques, as in the case of barrels, drums, kegs, sacks, sheet material, long loads, cylinders, coils or reels. For example, a sack can be potentially hazardous not only due to its weight, but also because of its shape (lack of rigidity, lack of corners to hold), or it may be slippery when wet or liable to split open with rough handling. Unfamiliar loads require individual assessment as experience of the nature of the load will be limited.

Again, deciding the level of risk associated with loads will call for judgement. Where there is a clear risk, or where the risk is uncertain, the characteristics of the load may be broken down into more detail, considering such aspects as whether it is:

- Heavy

- Bulky/unwieldy

- Difficult to hold

- Unstable/unpredictable

- Harmful of itself (for example, sharp or hot).

Working Environment

The term environment refers to the general and specific conditions in the immediate surroundings where the manual handling operations take place. This should include any routes taken by loads.

The key considerations are:

- Constraints on movement and posture – for example, confined spaces or fixed chairs, or interference caused by certain types of clothing or personal protective equipment

- Conditions of floors and other surfaces – for example, slippery, broken or uneven floors, or unstable shelving may increase the risks

- Variations in levels – for example, the presence of steps or ladders, or shelving heights

- Temperature and humidity – for example, high heat and humidity can cause dehydration and significantly increase the hazards, and extreme cold can make objects hazardous to touch

- Strong air movements – for example, gusts of wind may make loads unstable

- Lighting conditions – for example, poor general lighting and high contrast between light and shade can increase risks.

Individual Capability

There are three main points to assess in an individual's ability to carry out manual handling tasks job safely:

- **Whether the task requires unusual abilities**

  This considers the demands made by the task and the loads involved; for example, whether it requires unusual strength or people of a particular height. The range of capabilities of people is very large and it is difficult to make generalisations about different groups; for example, younger people tend to be stronger than older people, but that is not always the case and the maturity and experience of older workers may compensate. However, if there are particular requirements they should be made clear and only people who meet them should be allowed to carry out the task.

  Usually the level of risk of a task should be considered high if it cannot be carried out by most reasonably fit workers.

- **Whether the task presents a risk to those with a health problem or to pregnant women**

  An individual's general health and fitness is an important factor in that person's ability to undertake manual handling operations. Those who are overweight, underweight, suffering from arthritis or other conditions causing painful backs or joints, have chest or heart complaints, or suffering from a rupture or prolapse may be unsuited to some types of manual handling. They should not be expected to undertake any tasks which would make their condition worse or which, because of the condition, may make them more prone to injury.

  It may be appropriate to carry out medical checks to establish a person's general fitness, or the implications of any relevant previous injury or complaint.

The implications of the task for pregnant women and new mothers should be specially addressed. Certain tasks involving lifting moderately heavy weights, bending and twisting, or standing for long periods may present particular risks during pregnancy and during the 12 weeks following a normal childbirth confinement.

- **Whether the task calls for special information and/or training**

All workers should be provided with sufficient information about the nature of the tasks they are expected to do if they are to operate safely. Thus, the assessment should consider whether any special information should be provided; for example, about the characteristics of the load or appropriate methods of carrying out the operation. Special training in working practices should be given where necessary.

MINIMISING THE RISKS FROM MANUAL HANDLING

The risk assessment process will demonstrate that the need to lift and move loads by hand should be eliminated wherever possible. This will remove the risk completely. However, it may be impractical in many situations and therefore ways have to be found to reduce the risk of injury involved in the handling operations.

We can reduce injury risk by using mechanical equipment such as hoists, lift trucks, trolleys, etc. to undertake the lifting and/or carrying of loads. There are cost implications to this and they bring their own risks with them, as we shall see. Thus, a balance has to be struck between their use and other means of reducing risks.

The basis of safe systems of work for manual handling operations lies in adopting appropriate strategies to minimise risk in terms of the same four factors which we discussed for the risk assessment process.

The Task

Where it is not possible to use mechanical aids, consideration should be given to the re-design of the task itself. The following aspects of the task may be considered:

- **Sequencing** – adjusting the order of tasks performed to minimise the number of operations involving lifting and carrying loads

- **Work routine** – reducing repetitive operations to allow more variation in movement and posture by such means as introducing breaks, job rotation and providing ways in which workers can operate more at their own pace, rather than the work being controlled by a continuous feed supply of materials to be handled.

- **Using teams** – sharing the load by using teams of workers to carry out the task (for example, specifying that two people are required to lift certain types of load or passing the load on rather than carrying it, particularly at changes in level) may be effective. However, the co-ordination required brings its own risks and they be balanced against that of using just one person.

The Load

Attention should be given to reducing the weight of loads and making them easier to handle safely. The following aspects may be considered:

- **Weight and size** – is it possible to break up loads so that individual items are lighter and/or smaller? It may mean that more handling operations are necessary, with higher risks arising from more task repetition.

- **Making the load easier to grasp** – where it is not possible to make the load smaller, hand grips or handles may have to be provided.

- **Making the load more stable and rigid** – attention should be given to the way in which items are packed within containers to ensure that so far as possible they do not move inside rigid containers and that the weight is well distributed through the load (i.e. load is balanced and the centre of gravity is fixed). The type of container used can contribute to this. Flexible containers, such as sacks, should be avoided where possible.

- **Making the load less damaging to hold** – ensuring so far as possible that the surfaces of the load are clean, smooth, not slippery (or wet or greasy, or even dusty) and, in the case of hot or cold items, that they are held in insulated containers.

- **Markings** – it is helpful to those handling loads (particularly unfamiliar ones) if they are aware of the approximate weight and centre of gravity. In addition, special requirements such as which way up to hold and stack the load, or warnings about instability should be clearly indicated.

Working Environment

We can improve the conditions for people who are carrying out handling operations by changing different features:

- **Workstation design** – the object should be to make access to the load being handled and any equipment used during the operation as comfortable as possible. There should be adequate space for all movements involved, including allowance for variations in movement and individual flexibility in the way in which the operation is carried out. In particular, the positioning of the body in relation to the load has to be considered with a view to reducing the height over which it is to be lifted and/or carried, and allowing for comfortable posture when working. Thus, conveyor belt heights may have to be adjusted to suit the characteristics of workers (as a whole or individually) handling the items being carried, or swivel chairs provided for checkout operators, etc.

- **Floor conditions** – all floors should be free of obstructions, bumps, holes and any materials which may cause workers to slip, fall or otherwise lose their footing whilst undertaking the handling operations. So there must be appropriate cleaning procedures to ensure that fallen materials are picked up and cleared away, and that any spillages are quickly removed. Repair and maintenance of floor surfaces must be dealt with as a priority.

- **Changes of level** – the use of steps and ladders should be avoided wherever possible when carrying loads, particularly where they may obstruct visibility. Ramps may have to be provided.

- **Atmospheric conditions** – heating and ventilation should be set up so that conditions are comfortable to work in and do not cause fatigue. There should be adequate lighting levels in all parts of the workplace so that workers are able to see all parts of the loads they are handling and the floor and other working surfaces used.

- **Personal protective equipment** – operators should be provided with such equipment as is necessary to protect themselves and their own clothing from harm or damage as a result of the types of load handled. This will include gloves, aprons, protective footwear, etc., with the type of equipment depending on the risks involved.

Individual Capability

Part of the function of a safe system of work for manual handling should be to make sure that individuals are capable at all times of carrying out the necessary operations in a competent manner.

Allowance should be made for workers with temporary or permanent health problems, and pregnant women or new mothers, which may make them more liable to injury or less capable of undertaking the tasks without risk to others and to the load itself. This implies that there are

adequate arrangements for the reporting and checking such conditions, using medical certification if necessary, and that the need for consequent changes to individual duties is accepted by both management and staff.

To ensure competence in manual handling techniques, appropriate instruction and training should be provided. This should be closely related to a person's job and include theoretical and practical supervised sessions using typical loads in working conditions to ensure a thorough understanding of, for example:

- The design of the tasks involved

- Recognition of different types of load – for example, assessing the likely weights of loads and deciding which may or may not be handled without assistance

- The need for good housekeeping in and around the work location

- Safe lifting and handling techniques, including the risks from careless and unskilled handling

- Correct use of personal protective equipment

- Correct use of mechanical aids.

RECOGNISED TECHNIQUES FOR MANUAL LIFTING

There are recognised safe techniques for lifting loads and they should be practised by all workers at all times:

- **Before lifting**

    Before actually commencing the lift, there are a number of key checks to be made:

    – Check actual or approximate weight of load

    – Check for awkward shape, moving parts, etc.

    – Plan route and examine for tripping and other hazards

    – Remove obstructions, clear work surfaces

    – Wear suitable clothing

    – Establish a firm grip.

- **The lift or movement**

    Good technique is essential here and includes the following factors:

    – Bend knees

    – Keep your back as straight as possible

    – Avoid twisting, over-reaching, jerking

    – Establish good balance

    – Keep load close to body and maintain a firm grip

    – Use body weight to lift load or carry out a movement

    – If load is too heavy, seek assistance or use mechanical handling aids such as trolleys, wheel pallets, etc.

- **Completing the task**

    The same principles should be applied for setting loads down:

    – Keep your back as straight as possible

    – Avoid twisting, over-reaching, jerking

    – Maintain good balance

    – Keep load close to body and maintain a firm grip

    – Use body weight to lift load or carry out a movement.

    After completion you should check that the load is safely located and that the area is clear. The technique is sometimes referred to as "kinetic handling" or "kinetic lifting".

REVISION QUESTION 1

(1) What are the main causes of injury to workers as a result of manual handling operations?

(2) What is a WRULD and how might it be brought about?

(3) What is the primary means of minimising the hazards of manual handling?

(4) What are the characteristics of the load which may present a hazard?

(5) Identify the main hazards presented by the working environment in relation to manual handling operations.

(6) How can manual handling tasks be re-designed to make them less hazardous?

The suggested answers are given at the end of the unit.

HAZARDS, SAFE USE AND MAINTENANCE OF MECHANICAL HANDLING EQUIPMENT

We have noted that wherever possible mechanical aids should be used to lift and carry loads, so as to eliminate the risk of personal injury from manual handling. Such mechanical equipment may be divided into two types:

- **Manually propelled or powered devices** – where the weight of the load is taken by devices such as trolleys, sack trucks and pallet trucks, which are then pushed or pulled manually; or where the power source for the device used to raise a load comes only from the person operating it (such as with pulley hoists).

- **Mechanically powered devices** – where the power to lift and/or move the load is provided by a motor or other mechanical means, possibly together with manual power. Examples include various types of lift truck, conveyor belts, mechanical hoists and cranes.

Introducing these aids does not eliminate risk from the operation. Instead, it changes the types of risk faced. The use of motorised devices presents many hazards and is a cause of a great many accidents in the workplace.

Safe Systems of Work

Safe systems of work are required for all forms of mechanical handling equipment. The systems should cover the four general concerns about handling operations: the task itself, the load, the working environment and individual capability of the operator.

- The handling equipment should be appropriate for the task and be in good condition, made from sound materials, of adequate strength and free from faults. A comprehensive system of testing, examination and planned maintenance is essential, and records should be available and retained. There should be a safe procedure for the operation of the equipment in carrying out each designated task.

- The load itself should be packed for storage and transport in a manner that will minimise the risk of handling accidents. The considerations here are similar to those for manual handling in that the load should be of a suitable size and weight for the equipment available to handle it, items should be stable within a rigid container where possible and appropriate information should be given about the load. In addition, the load must be securely located on the equipment. Most items are packed in boxes nowadays and these are fastened to pallets, often by plastic wrapping, for bulk movement.

- The working environment must be designed in such a way as to ensure the safe operation of the equipment at all times. This will include minimising contact between people and the load as it is being lifted, moved or transferred, including the use of designated traffic routes for moving loads, and barriers and fencing to separate pedestrians. The ground surfaces of traffic routes should be flat, well made and free from obstructions, bumps and holes which may present a hazard to the equipment (for example, by causing it to tip over). Adequate lighting must be provided. Traffic management schemes should minimise congestion; for example, using one-way systems and queuing arrangements to allow for smooth and safe operations in, say, warehouse loading bays where over a hundred lorries may be loaded and unloaded a day by fork-lift trucks and other mechanical means.

- Finally, all operators should be trained and competent to use the equipment. This may seem obvious, but operator error is still the most frequent cause of accidents. They should also be provided with appropriate personal protective equipment.

We shall now consider the hazards, safe use and maintenance issues surrounding the use of specific types of equipment.

Fork-lift Trucks

Lift trucks are a very flexible class of mobile handling equipment designed for use inside and around buildings. They can cope with a range of materials and come in different designs. They are used to lift, move and restack palletised loads and may be fitted with a variety of attachments including drum-handling equipment, bale clamps, working platforms, skips, fork extensions and lifting appliances, all of which increase the versatility of the vehicle. Examples are shown in the figure below.

Pedestrian Pallet Stacker
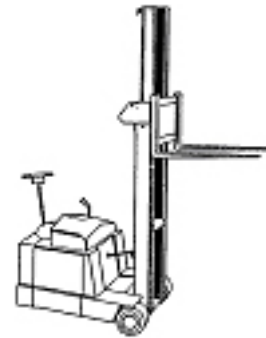
Pedestrian Counterbalanced Truck
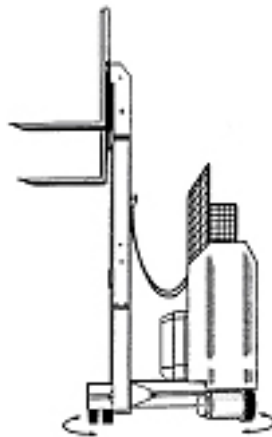
Four-directional Truck

Reach Truck
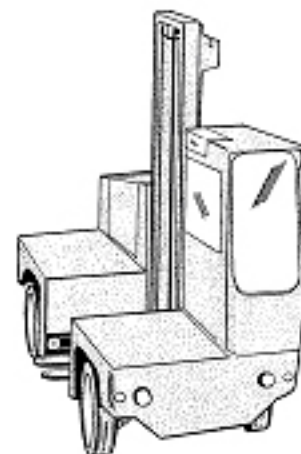
Side Loading Truck

Lift Trucks

Hazards

The biggest problem with small wheel lift trucks is that they may become unbalanced when loaded and with the forks raised. This may result in the load being shed or the whole truck tipping over.

Other hazards arise from:

- Poor visibility when reversing

- A raised load blocking the view of the operator

- Unsuitability of the truck for the working environment; for example, diesel-powered trucks with heavy exhaust fumes being used in poorly ventilated areas (such as basements); or counterbalanced or reach trucks being used on rough ground (such as construction sites).

Safe Operation

Apart from the general features of the task, load, working environment and individual capability outlined above, the following specific considerations apply to fork-lift trucks.

- Operator training is essential and strict rules about driving should be observed, particularly regarding speed and direction of travel under load, whether the forks are raised and whether travelling up or down an incline.

- Particular care must be taken near pedestrians, both in motion and when lifting. The load should not be picked up if someone is standing close to it and people should not work or stand beneath a raised load. People should never stand on the forks or use them as a working platform, except where specially designed for such work.

- The weight of the load must be assessed before lifting to ensure that the truck is capable of the lift. The forks must be suitably adjusted for the load and placed in the correct position, and any attachments to cope with the special characteristics of the load should be fitted and checked. Loads which are unsuitable for the particular truck and its attachments should not be picked up, nor should loads or pallets which are damaged.

- The handbrake should be on when lifting or lowering loads and the mast should not be tilted forwards.

- When two trucks are operating in tandem to lift or manoeuvre heavy or awkward loads, operations should be supervised by a competent person using recognised signals to guide both drivers.

As with all vehicles, fork-lift trucks must be used and maintained properly in accordance with the manufacturer's specifications regarding maximum lift height and capacity, routine inspection, maintenance and servicing. In addition, the operator should carry out a daily safety check. In most countries there is a legal requirement to regularly examine/test lifting equipment like lift trucks (and such parts as chains).

Pedestrian Operated Load Moving Equipment

There is a great variety of this type of equipment designed to assist in the movement of all types of load and thus eliminate the need for people to carry them. They include:

- **Platform trucks** – these are flat-bed trolleys with either two or four wheels which are pushed or pulled manually. The sides may be caged to avoid items falling off.

- **Sack trucks** – two-wheeled trolleys used for small stackable loads which are pushed or pulled manually.
- **Pallet trucks** – which are similar to fork-lift trucks, but are pushed or pulled manually (although they may have power-assisted steering and braking capabilities). The handle is used to manoeuvre the truck and also to activate the hydraulic system for raising the platform or lifting the forks up underneath a pallet. The extent of the lift is minimal, just sufficient to clear the ground.

Caged Platform Truck   *Two-wheeled Platform Truck*   *Sack Truck*

Pallet Truck

Manual Trucks

Hazards

For platform trucks and sack trucks, hazards include:

- Overloading, making the truck hazardous for the worker to move or causing danger to others from runaways (there being no brakes), collapse or falls.
- Instability of the load, particularly on sack trucks, which may cause the load to shift and fall. This may be caused by poor stacking or the characteristics of the load itself.
- Their small wheels make them difficult to move over steps and uneven ground, where they may get stuck or cause the truck to tip.
- Moving up, down or across slopes there is a risk of losing control and the truck running away or falling. Because such trucks have no brake, they must be under control at all times on slopes.
- Two-wheeled platform trucks may tip and spill the load or fall on to an operator's foot.
- Careless parking of the truck may cause collisions and trips, particularly if a sack truck is left lying down.

For pallet trucks, the risks are similar and include, in addition:

- The front wheels are pivoted for steering, so there is a risk that the truck may not start off in the correct direction

- The truck's forks may not be central to the pallet being lifted and the pallet could fall off

- There may be a trip hazard if the handle is not stored upright and the truck parked out of the way

- The hydraulic system may fail and lower the pallet

- The user's feet can be trapped beneath the platform or forks when they are lowered.

Safe Operations

The general considerations we noted earlier on about the task, load, working environment and individual capability apply. In addition, safe use of the equipment will require the following:

- Consideration of the route to be used – particularly avoiding any uneven surfaces and, wherever possible, slopes.

- The provision of ramps over any steps.

- Before loading/lifting, the operator must ensure that the truck will take the load without collapsing. When loading platform or sack trucks, the operator should not try to lift any load that is beyond his/her capabilities. For pallet trucks, the load must be square on and central to the truck before lifting.

- The load should be placed centrally on the truck and appropriately secured, if necessary, using straps.

- For pallet trucks, the brake should be applied every time the truck is stationary. If there is no brake, the wheels should be fixed by the use of chocks, especially on a slope.

- When lowering the pallet, keep feet well away from underneath it.

- When not in use the truck should be stowed so that no one can collide with the truck or trip over either it or its handles. In particular, sack trucks and the handles of pallet trucks should be stored upright.

- The truck must be inspected and serviced at regular intervals, with records kept of maintenance and tests.

- Appropriate personal protective equipment should be provided for operators. The most likely requirement is for safety boots to reduce the risk of impact or crush injuries.

Lifts and Hoists

These cover any equipment used in a static location for raising or lowering a load (goods or people) where the direction of the movement is limited by guides, tracks or other form of control. There are many examples, such as passenger lifts in buildings, hoists used for assisting hospital patients into a bath, window cleaning cages on high buildings, hoists and lifts for moving materials up structures on building sites, etc. The difference between the two is that lifts have some form of cage or walls around a platform, whereas a hoist will have an open platform.

The styles and types vary according to the work and the work environment. The simplest form of hoists are the cantilever type used on construction sites, where a rope passes over a pulley at

the top of the structure, with the lifting power being supplied by a machine or manually powered winch.
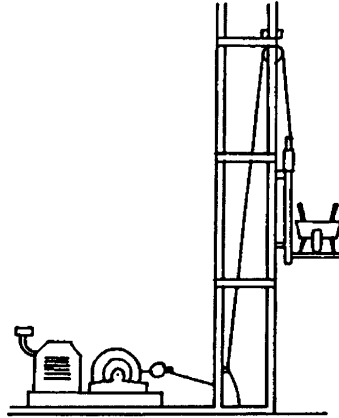
Cantilever Hoist

More complicated systems use geared drives to control lifting and reinforced cables rather than ropes. There are also rack and pinion drives, where the drive turns a small cog whose teeth engage with similar teeth on the pinion. These are widely used for passenger-carrying hoists and for inclined hoists and lifts, and for carrying large loads over longer distances. The interlocking of the cogs act as an effective brake and control over the movement.

Hazards

The main risks associated with lifts and hoists are:

- Falls from a height – from a landing level such as a scaffold platform, from the platform of the hoist or lift, or with the platform because of a failure in the operation (either as a result of operator error or mechanical failure)

- Being struck by the platform or other moving parts of the hoist

- Being hit by materials falling from the platform

- Being struck by landing levels, parts of any enclosure or other projections while riding on the platform.

Safe Operation

These hazards are significant and strict rules may be laid down by legislation about siting, use of enclosures and operation of lifts and hoists.

Siting

All hoists and lifts should be set up on solid ground and a concrete base is essential where they are intended for long-term use.

Free-standing equipment on the outside of buildings must be secured to the structure. In practice this often means tying (by means of rigid connections) the hoist or lift to a scaffold or to the building itself. Suitable and sufficient ties are often situated at every alternate floor, so a hoist serving six floors could have three sets of ties. We note that lifts operating inside a lift shaft are already tied in.

Enclosures

People must be prevented from getting underneath the lift or hoist and so being at risk from falling materials or being trapped should the platform itself come down on top of them.

Hoists, having no enclosure on the platform itself, create the most risk of materials falling from them. A substantial enclosure at ground level is therefore required around the hoist way. The shaft of the hoist way or lift should also, where practicable, be fully enclosed, although meshing may be sufficient.

Substantial enclosure gates must also be fitted at each landing level where access to the platform is required for loading or unloading. They must be kept closed except during loading or unloading and should normally interlock with the platform so they cannot be opened when the platform is not there, thus preventing falls of people and material down the lift shaft. The interlocking must also prevent the platform from moving until the enclosure gates are correctly closed. For passenger carrying lifts, the enclosure gates should interlock with the doors to the lift platform.

The construction of the enclosure must be such as to prevent any trapping of people or goods on the hoist; it must be capable of being opened, although normally only after the equipment has been immobilised. People inside the cage must be able to control the vertical movements of the cage.

Additional enclosures may also be necessary at other points where there is a risk that a person may be struck by the moving platform; for example, at a window opening.

Capacity

Hoists and lifts are designed for a maximum capacity, which should be marked and displayed in a prominent position on the unit.

In people-carrying equipment, this is normally stated as a maximum number of passengers. In goods lifts and hoists, the maximum load is given in kg or tonnes, which requires an assessment being made of the weight of materials being carried (particularly on construction sites where materials have considerable weight for little volume).

Safety devices

To prevent free fall and over-running, such measures as multiple ropes, holdback gears and overrun trip systems should be fitted.

For hoists and lifts used for carrying people, additional safety arrangements are required; for example, additional friction brakes which lock onto the guide cable, extra cables in case of emergency, landing gates which only open when the lift is static (although they should be capable of being opened in an emergency), alarm systems in the case of failure and non-slip materials on the platform floor.

When a winch is used to provide the operation, the winch should be fitted with a brake which is applied when the lever is not in the operating position.

Operation

Lift or hoist operators must be specifically trained in the safe use of the type of lift or hoist being operated.

It is important that the operator can see all the landing levels clearly from the operating position. If this is not possible then some form of signalling arrangement is required to enable stopping the platform in the correct position and to restart following loading or unloading operations.

Good practice is not to carry goods and people in the lift at the same time. Where the platform is not designed for carrying people, passengers should never be allowed to ride on it and a notice prohibiting them from doing so should be clearly displayed, either on the platform or at landing levels.

Care should be exercised in the use of hoists in exposed windy conditions.

All loads should be properly secured; for example:

- The wheels of wheelbarrows should be chocked so they cannot move about on the hoist platform

- Loose materials such as bricks should never be carried on an open hoist platform; they should be placed in proper containers (or transported by a hoist with a cage instead)

- Containers should never be overfilled, in order to prevent the risk of materials falling out and down the hoistway

- Long loads should be secured to the cage in a vertical position to prevent them from striking the hoistway enclosure.

Inspection, examination and maintenance

Whilst details vary between countries, it is a common legal requirement that all hoists and lifts are subject to regular examination by a competent person. Where faults are found on the equipment, the competent person should have the equipment taken out of use immediately, have the repairs carried out and re-examined before allowing it back into use.

Conveyors

The most common types of conveyor in use are belt, roller and screw conveyors. The main hazards associated with conveyors are trapping points at in-running nips, entanglement points at rollers and drive mechanisms, contact points with moving parts such as in screw conveyors, and the falling of materials from conveyors.

- **Belt conveyors**

  A belt conveyor transports materials by means of a moving belt. Guards are required at the trapping points where in-running nips are created between the belt and revolving drums. In some cases, guards or trip devices will be required along the complete length of the conveyor and at areas where belts change direction. Belt conveyors should be fitted with emergency trip wires or stop buttons which must be fully operational at all times.

- **Roller conveyors**

  The rollers of these conveyors may be power driven or free-running. Dangerous parts such as power drives and in-running nips should be guarded.

- **Screw conveyors**

  Materials are moved by means of a rotating screw which pushes the material forward. Access to screw conveyors should be prevented at all times by the provision of guards or covers, which should not be removed unless the conveyor is locked off.

Nobody must be allowed to ride on any conveyor and steps must be taken to prevent it. If people have to pass beneath elevated conveyors, barriers should be provided to protect them from falling materials. As with all mechanical handling devices, operators must be trained and instructed in their safe use.

Cranes

Cranes come in a variety of types, sizes and capacities. They include permanent derricks, fixed position towers, gantry and overhead cranes which move along defined tracks and different types of mobile cranes.

Hazards

The main hazards associated with cranes are:

- The risk of the crane becoming unbalanced and toppling over

- The arm (jib) of the crane swinging out of control and striking another structure, either itself or the load being carried

- The load striking something whilst being moved horizontally

- The load, or part of it, falling.

Safe Operations

A safe system of work for cranes includes:

- Planning the lift

- Selection of correct crane

- Selection of correct lifting tackle

- Selection and provision of trained and certificated staff

- Ensuring test certificates, etc., available and in order

- Controls to prevent unplanned lifts or movements.

A permit-to-work may be necessary on larger lifts or those with special restrictions.

Capacity

The capacity of a crane is its maximum lift in perfect conditions. Built into the capacity is a factor of safety which a competent person may increase (thus reducing the maximum load capacity) if circumstances are less than perfect. As the stability of any crane is based on the movements created by the load being matched by the crane weight and geometry, then the further the load from the crane, the less the maximum load it can lift.

All cranes come with load-radius charts which give the maximum load at specified radii from the crane. There are also a number of safety devices available to assist the crane driver in ensuring that capacity is sufficient for the lift, including:

- **Safe working load/radius indicators** – these devices indicate the safe working load applicable to the crane when the angle of the jib is varied and may operate automatically or provide read-outs for the crane operator

- **Automatic safe load indicators** – these devices give a visual warning to the crane driver when the safe working load of the crane is being approached and an audible warning to the driver and to the surrounding work area when the safe working load is exceeded.

Site conditions

The site conditions must be such as to ensure the stability of the crane at all times. The key factors are as follows:

- Entrance/Exit routes must be of sound construction and avoid, so far as possible, any slopes (which increase the risk of overturning)

- The ground conditions on which the crane will sit when undertaking the lift is level and is capable of taking the loading imposed by the crane

- There are no overhead or side obstructions – adjacent buildings, other structures and overhead power lines etc. – which could be hit by the load or the crane rear as it swings around

- No voids or cavities exist under the crane position – for example, manholes, culverts, gas/water routes, etc. – or that they are adequately protected.

Road mobiles normally have outriggers fitted which extend from the chassis of the crane and are used to support the weight of both the crane and the load, lifting the running wheels clear of the ground. Outriggers not only increase the capacity of the crane, but also increase its size, so adequate provision must be made for this. The outriggers must be on firm foundations, such as solid timber packing, steel plates or even specially cast concrete pads.

In addition, checks should be made about the oversailing of adjacent properties; for example, the railway authorities may not allow cranes to oversail their land until specific conditions are met.

The lift

Before commencing the lift, and when undertaking it, the key factors for safe operations are as follows:

- The area around the lift is marked out and only essential people are within it during the lift. It may be necessary to plan a "viewing area" if visitors are expected to watch the lift.

- The load(s) to be lifted are worked out reasonably accurately (to include the weight of the lifting tackle).

- The load is located within the load radius capacity of the crane.

- The load is free to be lifted – it is not uncommon when lifting out an existing component to find "unknown" fastenings still holding it, which increases the load the crane is trying to lift.

- The location of lifting points securing the load to the crane ensures that the load remains level at all times and does not allow it to tilt. The lifting points must be sufficiently strong to take the load.

- There are no people under the load at any time.

- The crane driver is given clear instruction by the banksman (the person responsible for directing the lift and movement of the load), either by hand signal or by radio.

- Safety helmets are worn by all staff in the vicinity of the lifting operation. (This is not to protect them if the load falls on them, but from small items which may be attached to or placed on the load.)

THE NEED FOR PERIODIC EXAMINATION AND TESTING OF LIFTING EQUIPMENT

Lifting equipment is often placed under a great deal of strain. If you do not examine and test the equipment regularly it can fail catastrophically. It will almost certainly fail under load, when the maximum damage will be done. A failing load may kill anyone underneath it. The care of lifting equipment is recognised throughout the world. There are therefore strict and detailed legal requirements which state what must be done and how often. The detail may vary with the country and the particular equipment concerned. The following are occasions when lifting equipment should be examined:

- When any lifting equipment is used for the first time, or the first time it is used at a new location, it should be thoroughly examined for defects and to ensure that it has been correctly installed.

- Afterwards a similar thorough examination must be conducted regularly and also whenever there is a change in the conditions affecting the lifting equipment, such as may affect the safety of its use. The frequency typically depends on the equipment. Things like ropes and slings should be checked visually every day. Other items may need checking only every 6 or 12 months.

The employer should have a written scheme for making sure that these requirements are carried out. Any defects discovered should be reported and corrected before the equipment is put to any further use.

REVISION QUESTION 2

(1) What are the most common hazards associated with:

(i) Fork-lift trucks

(ii) Lifts and hoists

(iii) Cranes

(iv) Sack trucks?

(2) What personal protective equipment might be appropriate for working with:

(i) Pallet trucks

(ii) Cranes?

(3) How can entry to and exit from lifts be made safe for people?

The suggested answers are given at the end of the unit.

UNIT SUMMARY

Manual handling operations present significant risks of personal injury and damage to goods. They arise from the characteristics of the task, the load, the working environment and the individual capabilities of the people involved. Note that the hazards presented by the load are not simply those related to its weight.

The main means of minimising these risks is the use of mechanical aids. Other approaches focus on the redesign of tasks to eliminate manual handling, reduce the weight of loads and make them easier to handle safely, improving conditions in the working environment and providing appropriate instruction, information, training and supervision for workers. Task and workstation design, and individual behaviour, should be supported using safe methods of lifting and handling loads.

Mechanical lifting and moving equipment, whilst reducing or eliminating the risks associated with manual handling, present their own risks and safe systems of work are required for their use. The following constitute safe systems of work:

- Ensuring the right equipment is used for each task, that it is adequate for the load, in good condition and properly maintained

- The load is securely packed, is stable and located securely on the equipment

- The working environment provides for safe operations, particularly in respect of the segregation of people from the equipment and the surface conditions on which the equipment operates

- The training of operators to ensure competence in the use of the equipment.

Special hazards are presented by each type of lifting or moving equipment, and they require specific safety measures to be incorporated into their use and the working environment. Lifting equipment must be examined regularly and tested in order to identify and correct defects and reduce the risk of sudden failure.

SUGGESTED ANSWERS TO REVISION QUESTIONS

Revision Question 1

(1)   The main causes of injury are:

–   Failing to use a proper technique for lifting and/or moving the object(s) or load

–   Moving loads which are too heavy

–   Failing to grip the object(s) or load in a safe manner

–   Not wearing appropriate personal protective equipment.

(2)   WRULD stands for "work related upper limb disorder" and refers to ill-health conditions affecting the upper limbs, particularly the soft connecting tissues, muscles and nerves of the hand, wrist, arm and shoulder.

WRULDs arise from the repetition of ordinary movements (such as gripping, twisting, reaching or moving), often in a forceful and awkward manner, without sufficient rest or recovery time.

(3)   The elimination of risk by the use of mechanical aids.

(4)   The characteristics of a load which constitute a hazard are its weight, size, shape, resistance to movement, rigidity or lack of it, position of its centre of gravity, presence or absence of handles, surface texture, stability of any contents and the contents themselves.

(5)   The main hazards in the working environment are:

–   Restrictions on movement and posture

–   Conditions of floors and other surfaces

–   Variations in levels

–   Temperature and humidity

–   Strong air movements

–   Lighting conditions.

(6)   Re-design of the task may include:

–   Sequencing – adjusting the sequence of tasks in a process to minimise the number of operations involving lifting and carrying loads.

–   Work routine – reducing repetitive operations to allow variation in movement and posture, by such means as introducing breaks, job rotation and providing ways in which workers can operate more at their own pace, rather than the work being controlled by a continuous supply of materials to be handled.

–   Using teams – sharing the load by using teams of workers to carry out the task.

Revision Question 2

(1)   (i)   The most common hazard of lift trucks is that, with their small wheels and particularly when loaded and with the forks raised, they may become unbalanced, resulting in them shedding their load or tipping over. Other hazards arise from the constant need

to reverse the truck, obscured vision when the load is raised and using unsuitable trucks for the working environment.

(ii) The main risks associated with lifts and hoists are falls from a height (from a landing level, from the platform or with the platform) and being hit by materials falling from the platform. Other hazards include being struck by the platform or other moving parts, and being struck by external objects or structures while riding on the platform.

(iii) The main hazards associated with cranes are the risk of them becoming unbalanced and toppling over, the arm of the crane swinging out of control or the load striking something whilst being moved horizontally or falling.

(iv) The main hazards of sack trucks are overloading, instability of the load, tipping when moving over uneven ground or on slopes, and careless stowage.

(2) (i) Safety footwear, as well as gloves and aprons to protect whilst handling loads.

(ii) Safety helmets.

(3) The main means of protection is the use of interlocking gates which ensure that access to and egress from the lift platform is only possible when the lift is at rest. Other relevant safety measures include the positioning of the operator so that each access point can be seen or the use of signallers to inform the operator that it is clear.

NEBOSH International General Certificate

Unit 9 | Work Equipment Hazards and Control

Contents   Page

INTRODUCTION

In this unit we will examine the hazards and control measures associated with the use of work equipment, which includes the wide range of tools and machinery used in the workplace. We look first at the general requirements to ensure the safety of equipment used at work before going on to consider the use of hand-held tools and then machinery. In doing so, the unit is designed to meet the following aims and learning outcomes as specified by NEBOSH for this part of the syllabus for the International General Certificate.

Overall Aims

On completion of this unit, you will have knowledge and understanding of:

- The hazards and risks from the use of work equipment

- The basic measures to be taken to minimise the risks.

Specific Intended Learning Outcomes

When you have worked through this unit, you will be able to:

- Outline the general principles for the selection, use and maintenance of work equipment

- Outline the hazards and controls for hand-held tools

- Describe the main mechanical and non-mechanical hazards of machinery

- Describe the main methods of protection from machinery hazards.

GENERAL PRINCIPLES

Work equipment can present high risks to the individual. As a result it is heavily regulated throughout the world. The main aim of such regulation is to ensure that equipment provided for use at work is safe and is used safely. The intention is that work equipment should not give rise to risks to health and safety, regardless of its age, function or place of origin.

Types of Work Equipment

In this unit we use the term "work equipment" in its widest sense and take it to include machinery, appliances, tools, etc. A few examples might be:

- Single machines – such as power presses, woodworking machines, abrasive wheels and photocopiers

- Tools – such as hammers and chisels, and portable electric drills

- Machines assembled from a number of items which work together – such as a bottling plant

- Vehicles – where they are used within workplaces (i.e. off public roads) and therefore including lift trucks, etc.

Suitability of Work Equipment

The key requirement for any work equipment is that first and foremost it must be suitable for the purpose for which it is to be used and appropriate for the work environment in which it will be used.

There are two aspects to this:

- When equipment is provided, the employer must ensure that it is appropriate for the work to be undertaken and is used in accordance with the manufacturer's specifications and instructions. If equipment is adapted it must still be suitable for its intended purpose.

- The location in which the work equipment is used must be assessed to take into account any risks from particular circumstances; for example, electrically powered equipment used in damp or flammable atmospheres.

Compliance Marking

In some countries it is common for manufacturers to fix some mark to the machine proving that it complies with some minimum health and safety standards. These standards are often country specific (e.g. the British Standards Institute (BSI), American National Standards Institute (ANSI)), but some are regional. As an example of the latter, let us take the European Union. In the European Union, the fixing of a "CE" mark to a piece of machinery signifies that it conforms to all the relevant essential health and safety requirements for that machinery as laid down by EU Directives. It provides an assurance of the initial integrity of the equipment; i.e. it is safe when properly installed, maintained and used for its intended purpose.

C E

CE Mark

The manufacturer must produce a *Declaration of Conformity* stating that the product meets the requirements of the directives which apply to it, and the standards or other references which were used to judge that it complies.

The act of fixing the CE mark to the product and signing the Declaration of Conformity constitutes a declaration by the manufacturer that the product meets the requirements of all the Directives which apply to it. The duty is on the manufacturer to take responsibility for this actually being true. Marking a product which is not fully in accordance with the requirements of the applicable directives is an offence.

Work Equipment Having Specific Hazards

Employers must take effective measures to prevent people coming into contact with dangerous parts of machinery. A "dangerous part" is any part of a machine which may cause personal injury, including moving parts, sharp edges, etc. We will look at the hazards of such parts of machinery and the protective measures available, in detail later.

Restriction of Use

If the use of work equipment is likely to involve a specific risk to health and safety, the use of that equipment should be restricted to those persons given the task of using it. In addition, any repairs, modifications, maintenance or servicing carried out on that equipment must only be undertaken by competent and trained people who have been specifically designated to perform the work.

Information, Instruction and Training

All users of work equipment must be provided with adequate health and safety information, either in writing or verbally. Written information, which relates primarily to manufacturers' manuals, warning labels, information sheets, etc., will normally only be required for more complex machinery, but must be easily accessible and in a form which workers will be able to understand.

In addition, everyone who uses work equipment should receive training on the equipment they are expected to use and be aware of the health and safety implications, potential risks and precautions. Young people should be given special consideration due to their inexperience and immaturity, and should be closely supervised by a competent person.

Appropriate information, instruction and training also needs to be provided for maintenance staff and managers.

The more complex the equipment is and the bigger the risks, the greater the need for comprehensive information, instruction and training.

Maintenance and Inspection/Examination of Pressure Systems

Some work equipment may have to be thoroughly examined as a legal requirement. Typically items such as boilers and air receivers are singled out for special attention. This is because they are repeatedly subjected to high stresses and aggressive conditions during normal operation. If they are not regularly maintained and inspected, the structure and safety systems can deteriorate to a dangerous state – failing catastrophically. For such items much inspection work is insurance company-driven.

Every employer should effectively maintain his work equipment and this is particularly important for any safety devices fitted.

Routine checks and maintenance should be carried out to ensure that all equipment remains safe to use at all times. This applies not only to easily visible parts of the equipment, but also to other parts which may be critical to safety. Any faults, or items found to be faulty or likely to fail, must be repaired or replaced.

Maintenance work should be undertaken by competent people. Maintenance on live equipment should be avoided and if this is not possible a permit-to-work system should be used.

Employers should keep records of inspections and remedial measures taken.

Importance of Machinery Controls

It is very important that machine controls are well designed. At a basic level all work equipment requires one or more controls for the purposes of starting up (including re-starting after a stoppage for any reason) and for controlling any change in the speed, pressure or other operating conditions. The employer must make all reasonable efforts to ensure that all work equipment control systems are safe; and are chosen making due allowance for the failures, faults and constraints to be expected during use.

Stop Controls

Where appropriate, work equipment should have one or more easy to reach stop controls, the operation of which will bring the work equipment to a safe condition in a safe manner. Activating the stop control should override all other controls.

Emergency Stop Controls

Where appropriate, work equipment must be provided with one or more readily accessible emergency stop controls, unless it is unnecessary (for example by reason of the nature of the hazards and the time taken for the work equipment to come to a complete stop). Emergency stop controls are emergency devices and should not be used routinely to stop machines, nor should they be treated as alternatives to guarding the machinery.

Standard emergency stops have a red mushroom-head push-in button against a yellow background. Normally they should be of the lock-in type and resetting the stop should not restart the machine.
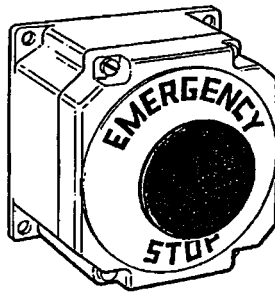
Emergency Stop Switch

Emergency stops should be located at each workstation and be both prominently displayed and easy to reach.

Environmental Considerations

The technical aspects of machine safety are not the full story. It is necessary to incorporate other controls and measures to ensure that machinery is used safely and maintained in a safe condition.

Apart from issues relating to the machine itself, there are other important considerations relating to the immediate environment of the machine and the way in which it is used. These include the following:

Stability

Any item of work equipment, or any part of work equipment, which has to be used in a fixed position, should be secured to prevent movement. This may be by bolts, clamps, ties, etc., or in the case of mobile equipment such as cranes, by the use of stabilisers, counterbalances and outriggers.

Account must be taken of the operating conditions when deciding on the need for and/or the type of fastening used; for example, equipment used outside and which may be affected by different weather conditions.

Lighting

Suitable and sufficient lighting which takes account of the operations to be carried out must be provided at any place where a person uses work equipment. Additional lighting over and above general lighting levels may be necessary for some parts of the machinery (such as where access to dangerous parts is required) and for particular operations, such as maintenance.

Markings and Warnings

All controls for work equipment should be clearly visible and identifiable by appropriate marking. The markings and warnings required will depend on the hazard and risk created by the equipment. This in turn will depend on the task being performed and the type of equipment being used; for example:

- Operating instructions

- Safe working load (SWL) marked on cranes, fork-lift trucks, lifting chains and tackle and ropes

- Maximum and minimum speeds for abrasive wheels, circular saws, bandsaws

- Maximum and minimum size of components or work pieces

- Hot, cold and abrasive surfaces

- Ejection hazards – for example, fumes, swarf, sparks and dust, etc.

Some markings may be specific, such as "RADIOACTIVE", whilst others may be more general, such as "MIND YOUR HEAD". Markings can comprise of words, letters, shapes or pictograms.

Specific visual or audible warning devices may be required to alert people to danger; for example, flashing lights on equipment, lights on control panels to signal that something is faulty or is still hazardous, reversing alarms on vehicles, etc. Visual warnings are limited in that they rely on people looking in that particular direction. Audible warnings will not be suitable in a noisy working environment, especially if workers are wearing ear defenders.

Clear and Unobstructed Workspace

The space within which workers are required to operate a machine should be such as to allow complete freedom of movement as necessary to perform all the necessary operations in a safe manner.

Congestion can arise for many reasons, including the size of rooms/workstation, number of people sharing the space, storage of materials, waste, passing traffic, furniture, amount of machinery and equipment, etc., so employers should take into consideration all the factors likely to cause restrictions on space.

The points to cover include:

- Space should be provided around each machine to allow clear separation from passing traffic and for the storage of tools and work in progress.

- The operator at the controls is able to see whether anybody else has approached a place where he would be exposed to any risk to his health or safety.

- Systems of work are effective to ensure that when work equipment is about to start, no person is in a place where he would be exposed to a risk to his health or safety as a result of the work equipment starting. Where this is not reasonably practicable, physical barriers or floor markings may be necessary to ensure an unobstructed workplace.

Responsibilities of Users

The other aspect of ensuring the safe use of machinery is the actions and behaviour of the users themselves. There are two points to this:

- Following proper procedures of general conduct in the workplace, including:

  – Using equipment only for the purpose for which it was intended and in the manner in which it is intended to be used

  – Not using equipment when under the influence of alcohol or other drugs, including certain types of medication

  – Always conducting oneself in a manner which is not likely to lead to any compromising of safety procedures and measures

- Following proper procedures in the operation of the work equipment concerned, including:

- Specific operating instructions for the use of the equipment

- Restrictions on who can use the equipment

- Cleaning, checking and servicing the equipment

- Action to take in an emergency or in case of a breakdown

- The reporting faults

- The keeping records.

Hand-held Tools

Hand-held tools cover all types of moveable equipment used in the workplace. This includes both:

- **Hand tools** – tools which are entirely powered manually, including anything from axes to wrenches

- **Portable power tools** – hand-held tools which have an external power source such as electricity, compressed air, liquid fuel, hydraulic and powder-actuated, including anything from an electric screwdriver to a pneumatic drill.

Hazards

The biggest hazard in the use of all types of hand-held tools comes from operator error, such as hitting one's thumb when using a hammer.

Most injuries caused by hand held tools will be contact injuries, where a part of the body strikes, or is hit by, the tool itself. Such injuries are usually of a localised nature, like burns from a blowtorch or cuts from a saw or chisel.

If we assume perfect technical competence, then the other hazards of hand tools arise from misuse and improper maintenance/defective equipment; for example:

- Using a chisel as a screwdriver – the tip of the chisel may break and fly off, hitting the user or other workers.

- Using a hammer or an axe when its wooden handle is loose, splintered or split – the head of the tool may fly off and strike the user or other workers nearby.

Safe Use

The employer is responsible for the safe condition and use of all equipment used by workers, including hand tools. There are four main aspects to this:

- Appropriate training and instruction to ensure the correct use of tools by competent workers – for example, when using saw blades, knives, or other tools, the user should direct the tools away from aisle areas and away from other persons working nearby.

- Correct maintenance – for example, ensuring that blades are sharp (dull tools may slip and cause contact injuries).

- Regular checks and the withdrawal of defective tools – for example, if the jaws of a wrench or spanner are sprung, the tool may slip and bruise the user, or if impact tools such as chisels have mushroomed heads, the heads might shatter on impact, sending sharp fragments flying toward the user or others nearby.

- Appropriate personal protective clothing such as goggles and gloves must be worn to protect eyes, hands and arms while using hand tools.

In addition, it is a management responsibility to ensure that the correct tools are used at all times and that appropriate maintenance and routine checks are carried out.

Portable Power Tools

Hazards

Portable power tools have the same types of hazard as manually powered hand tools (operator error, misuse and improper maintenance), but they are increased by the presence of the power source and the speed and force of the tool itself. Contact injuries may be much more severe and so there is a much higher risk associated with their use. Specific hazards include:

- Electrical problems. Power tools account for a large proportion of the electrical accidents which occur every year, most being electric shock incidents, but many result in burns from arcing or fire. Many relate to poor maintenance and/or the positioning of cables.

- Fuel spillages and risk of fire from flammable vapours given off by liquid fuel powered tools, such as some saws and cutters which use petrol.

- Noise and vibration can be severe and prolonged use may lead to hearing problems and upper limb disorders.

- The emission of dust and other fragments from sanders, saws and drills represents a possible source of breathing and lung problems or of collision injuries.

- The positioning of cables or pipes leading to the equipment may be a trip hazard.

Safe Use

Safe use is based on training to ensure competent operatives, correct maintenance, inspection and the use of PPE. Because of the greater risk of injury the measures taken are more extensive than with hand tools and must be more stringent:

- Correct operation should include safety procedures for the power leads and pipes – for example, never carrying a tool by the cable, ensuring the cables do not present a trip hazard, never yanking the cable to disconnect it, keeping cables away from heat, oil and sharp objects, disconnecting tools when not using them and before servicing, cleaning or changing bits and accessories, etc.

- Engineered controls should be used – for example, fitting guards and safety switches, and securing workpieces in clamps, if practicable, to allow hands to be free to operate the tool.

- Providing breaks to ensure that exposure to vibration is limited.

- Personal protective equipment will include gloves, safety footwear, ear protectors and goggles, as well as ensuring that other clothing is suitable – for example, not wearing loose fitting accessories or clothing, which could become entangled in the moving parts.

- The risk of electric shock should be specifically addressed by ensuring that all exposed metal parts are earthed and all-insulated casings are fitted, and that double insulation and reduced voltages (for example, 240v transformed down to 110v) are used.

- There is a proper system of routine inspection and maintenance of portable equipment. All pieces of equipment should be identified by a serial number and recorded in a register

which specifies when each item should be recalled for inspection. A nominated person should be appointed to ensure that recall and inspection do take place. The equipment should be marked to indicate to the user when the inspection is due. The frequency of inspection should be decided by the type of equipment and its use, the manufacturers' recommendations, and the experience of the user. Inspection and any subsequent tests and repairs should be carried out by a competent person experienced in that type of work. A record of inspection should be made and kept for the life of the equipment.

- In addition to regular inspections, operators should be instructed never to use damaged or defective equipment. They should visually check equipment before use and withdraw any defective items from service until repaired. Checks on portable electrical equipment should include:

  – Visual inspection of mains cable for damage

  – Confirm correct cable for tool

  – External inspection of plug

  – Internal inspection of plug wiring and fuse – check for correct rating

  – Cable correctly clamped in plug and in tool

  – On/off switch correctly operating and no damage

  – Outer case undamaged

  – Earth bond test if metal case.

Suitability for Purpose and Location

Employers should ensure that tools are used for the purpose and in the environment they are designed for. For example, floors should be kept clean and dry to prevent accidental slips while using hand-held tools and appropriate ventilation should be provided where dust is generated. This also means selecting equipment in accordance with the particular conditions in which it is to be used. This includes:

- Not using electric tools in damp or wet environments unless they are approved for that purpose

- Not using power-actuated tools in an explosive or flammable atmosphere

- Not using iron or steel tools, which may produce sparks that can be a source of ignition, around flammable substances. Where flammable gases and highly volatile liquids and other explosive substances are a hazard, spark resistant tools made of non-ferrous materials should be used.

MACHINERY – HAZARDS

The hazards arising from the operation of large, powered machinery may be divided into two groups:

- Mechanical hazards – arising from the direct interaction of people with the machine itself

- Non-mechanical hazards –associated with the use of machines, often the environment within which the machines are located, the materials used and other aspects of the machine's operation.

These types of hazards are well known and covered in legislation and standards. In this unit we use the descriptions and classifications laid down in European Standard EN 292, since it provides a convenient logical framework.

Mechanical Hazards

These comprise injuries caused by people coming into contact with machinery or a workpiece held in the machinery, particularly when they are in motion.

The general factors which create hazards are as follows:

- *Shape* – for example, whether an object has sharp edges, angular parts, etc., which may be a hazard even if not moving.

- *Relative motion* – this is concerned with the movement of one object in relation to another, in terms of their speed and direction. It will dictate the type of injury suffered where a body, or part of a body, comes into contact with a machine, or part of a machine. The speed and direction of movement of either the person or the machine, or both, is the relevant factor.

- *Mass and stability* – this involves the weight of an object and the likelihood of it moving from its normal position, particularly by falling (for example, the ability of a workpiece to break free from the machine if it is not secured).

- *Acceleration* – this is the rate of increase in speed of motion and is relevant to the way in which parts of a machine (or the workpiece) move, either under normal conditions or if something breaks. For example, the speed of travel of a piece of wood passing through a bandsaw has to be judged correctly to ensure safe operation, or the rate at which a broken drill bit is ejected from a machine will determine the damage that it may cause.

- *Inadequate mechanical strength* – this is concerned with the possible break-up or bursting of a machine or part of it. For example, the composition of abrasive grinding wheels means that they have poor internal strength and are prone to parts breaking off under certain conditions (and thus require thick outer casing guards).

- *Potential energy of elastic components* – this is concerned with the hazards from the stored-up energy present in such items as springs or a bandsaw blade, and their potential ability to translate that stored energy into movement (for example, if a saw blade breaks free).

We can identify eight types of hazard arising from these general factors, each of which has the potential to cause serious personal injury or death.

Crushing

This is where the body or part of the body is trapped between two moving parts of a machine or between moving and static objects such that they meet together. The effect is like a vice, crushing the part of the body which is trapped.
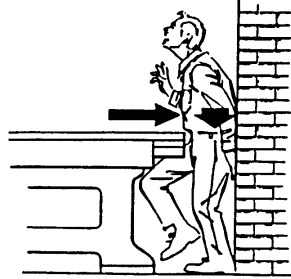
Crushing

Shearing

This is where a part of the body, commonly fingers, becomes trapped between two parts of the machine, one of which is moving over the other with some speed. The effect is like a guillotine, shearing off the part of the body which is trapped.

Shearing

Cutting or Severing

This is where a sharp-edged part of the machinery comes in contact with the person; for example, the blade of a bandsaw. It is a similar effect to what happens when someone cuts himself with a knife.
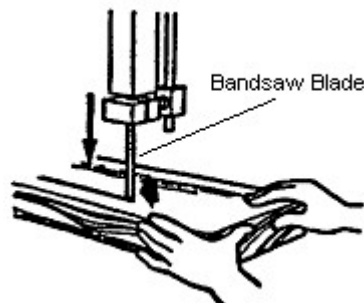
Cutting or Severing

Entanglement

This is associated with a single rotating part of a machine. Usually an item of clothing gets caught on the rotating part and the person is drawn rapidly to the machine.
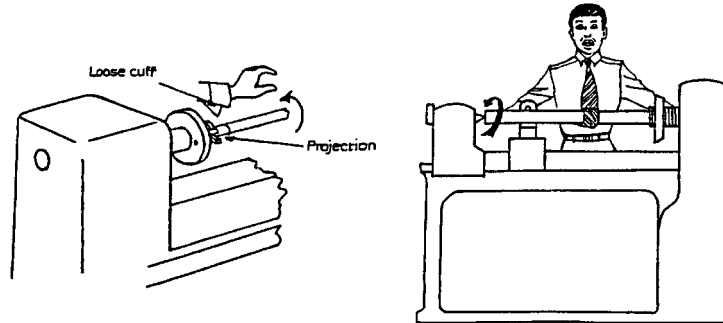
Entanglement

Drawing in or Trapping

This is where a part of the body is caught between two moving parts and drawn into the machine; for example, at "in-running nips" which occur at the point where a tangent meets a rotating member, such as the contact point between a chain and the drive sprocket, etc.
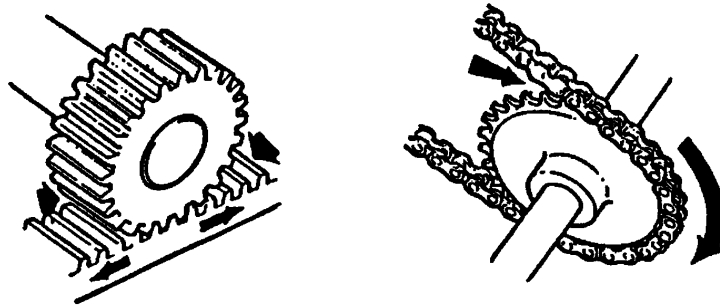
Drawing in

Impact

This is where a powered part of a machine hits the person. Injuries can range from serious fractures and internal injuries to surface bruising.
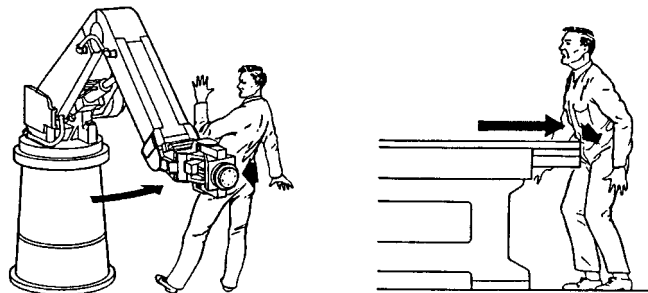
Impact

Stabbing or Puncture

This is caused by some sharp part of the machine or part of the process (for example, ejected material such as flying swarf or broken tooling) penetrating the person. The wound is normally small on the surface, but may be deep into the body.
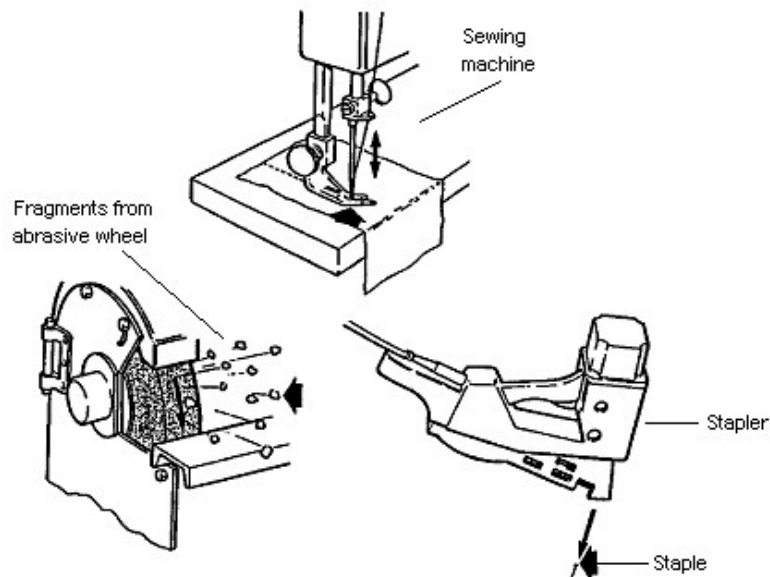
Punctures

A particular type of puncture hazard is that from high pressure fluid injection, often associated with the use of hydraulic systems. The pressure to which the fluid is subjected in the system can be quite high and following a sudden release (such as when a pipe or joint bursts), the fluid jet may have sufficient pressure to penetrate the skin and tissues of any person in the line of the spray. The fluid may be injected quite deep into the body where the blood circulatory system may then distribute it widely.

Friction or Abrasion

These injuries are caused by coming into contact with a fast moving surface. Where the surface of the moving part is relatively smooth, the effect is a burn due to the generation of heat through the friction generated between the machine and the part of the body in contact. If the rotating or moving part has a rough texture, the effect will be to create an abrasion, tearing the skin and perhaps deeper parts of the body in a similar way to rubbing the hand hard against abrasive emery paper.
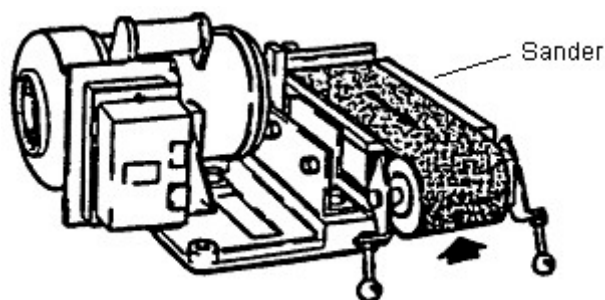
Friction or Abrasion

Non-Mechanical Hazards

These are hazards arising from the use of machinery and its effect on the immediate environment. The harm they cause is not necessarily through contact with the machinery and may affect people other than the operator him/herself. The injuries caused may be immediate and acute, but may also include longer-term damage caused by lengthy exposure to the hazard.

Note that these are hazards in themselves, but may also combine together to increase the severity of the hazard. They may also contribute to further hazards.

Noise

The noise made by a machine may be a hazard to both the operator and anyone else close by. Over a certain level it may cause temporary or permanent hearing loss, or tinnitus.

Noise can also be a contributory cause of other hazards by interfering with clear communication; for example, by blocking out speech or audio warning signals.

Vibration

The vibrations from a machine may be passed on to anyone in contact with it or, in extreme cases, parts of the immediate environment which are also affected by it (for example, the surface on which the machine is standing).

Vibration can affect the functioning of various parts of the body. At its worst it can interfere with blood flow and produce vascular disorders. The effect may be localised, as from holding hand tools, or it may pass through the whole body, such as from sitting in a poorly designed driving position on vibrating machinery.

Vibration is often associated with noise. It may also be a cause of other hazards in that it may cause objects to become loose and fall, or even make the machine itself unstable.

Electricity

Electrical hazards from machinery are covered in detail elsewhere in the course. We can note here that almost all machines will be powered by electricity and electric shock or burns are an ever-present danger.

The presence of electricity can make many other hazards worse and disconnecting a machine from its source of electrical supply may be a key factor in minimising injury. Note, too, that loss of electrical power may also contribute to accidents, such as where protective measures depend on it.

Temperature

Thermal hazards arise from extremes of either hot or cold. Where machinery is concerned, extreme heat is usually the main problem.

There are two ways in which the heat generated by machinery or as a part of the process can affect people – as a localised effect, such as burns from a cutting torch or touching a hot surface, or the fatigue causing effects of working in a hot environment which may cause drowsiness and hence lead to operator error.

Radiation

This refers to the rays emitted by certain types of machinery. There are two main types of radiation:

- **Ionising radiation**

  Because this penetrates the body and is the more damaging form of radiation. We might think of it as "radioactivity" and it includes gamma-rays and x-rays. Among the people at risk are workers in nuclear power plants, radiographers in hospitals and dentists who use x-ray equipment. The consequences of exposure will depend on the intensity of the dose and the length of exposure, and can include the breakdown of body cell mechanisms, multiple cancers, reproductive problems and death.

- **Non-ionising radiation**

  Sunlight and lasers are examples of non-ionising radiation. Workers in the leisure industry may be unintentionally exposed to ultra-violet light from operating sunbeds, while workers in the entertainment industry may be affected by lasers and office workers may be exposed by leaving the cover off a photocopier during use. Electric arc welding can cause "arc-eye", a form of conjunctivitis of the eye.

Hazardous Materials and Substances

The materials from which machinery is constructed which are used as part of the working processes of the machine, and those which make up the material being worked on, may all in themselves present a hazard. This may be from direct contact with the materials or substances, from inhalation or from the effect of their contact with something else; for example, recently felled trees being fed into a bandsaw may have very rough or sharp surfaces, the dust given off by the sawing may be dangerous to both the eyes and the lungs, there may be dangerous microbes or insects present, there is a risk of fire if wood chips come into contact with hot surfaces, etc.

Note too that some substances which are in themselves relatively harmless may combine with other substances to create hazards or may cause hazards; for example, the coolants and lubricating oils used by drills and lathes can make conditions very slippery.

Ergonomics

This refers to the way in which the operator works the machinery under normal conditions and includes such factors as reach distances required, working position, extent to which the operator can control the pace of work, etc.

There is a range of problems which can arise from the design of the machinery and the working process; for example, physiological problems such as postural backache caused by having to lean over continually to remove the workpiece, and psychological problems such as stress from the demands of keeping pace with a continuous work stream.

Good ergonomic design fits the working environment to the operator, not the other way around. It also takes account of human perception; for example, by designing machine controls which are accessible and understandable.

Hazards of Particular Equipment

In this section we will apply the points from above to various types of machinery found in different working environments. This is by no means exhaustive of either the working environments or the types of machine, but it does serve to illustrate the range of hazards presented by machinery in the workplace. You should consider the machines used in your own

workplace and some others with which you are familiar to extend your appreciation of the risks faced.

Office Machinery

Photocopiers

Because these machines are so familiar, perhaps we are not aware of the hazards. These may involve trapping or pinching of fingers when unjamming paper in the inner rollers, or exposure to intense light when the top is not properly lowered.

Guillotines

These machines are used for cutting different materials such as paper and metal. The operation of a guillotine means that the main mechanical hazard is shearing. Modern guillotines are often electrically operated with the associated mechanical hazards of noise (on large machines) and electricity.

Document shredders

Most people are familiar with the office shredder, used for reducing paper to very thin strips. They work by counter-rotating rollers which have tiny blades incorporated into them, so the main hazards are drawing in and cutting or crushing; for example, while attempting to clear a blockage. The main non-mechanical hazards are cuts from handling the paper and from the electricity used to power the machine.

Manufacturing and Maintenance Machinery

Abrasive wheels and grinding machines

These are used for removing surface material from metals or plastics in order to smooth the surface or reduce an object to a particular size. They work by bringing the workpiece into contact with a high-speed rotating wheel made of an abrasive substance, often with a coolant being sprayed on the piece during the process. Some grinders have two wheels working together in opposite directions.

Mechanical hazards include friction and abrasion, entanglement, drawing in, and possible ejection of the workpiece or parts of the wheel should it break. Non-mechanical hazards include electricity, heat, noise and hazardous substances given off as part of the process.

Drills

These are used for boring holes in different materials, such as metals, plastics, wood etc.

The main mechanical hazards are puncture or stabbing from either the drill or the waste materials produced (known as "swarf"), as well as the possibility of entanglement due to the rotation of the drill. Non-mechanical hazards include electricity, noise, high temperature (due to the heat generated during the drilling process) and coolants or lubricating fluids.

Lathes

These are most commonly used for reducing, cutting and shaping metals and woods. They work by rotating the material and introducing cutting tools and drills to the material.

The most common mechanical hazards are entanglement and cutting, again by contact with the lathe's cutting edge or from the ejection of sharp swarf. Non-mechanical hazards include electricity, noise, high temperature of the workpiece and tools and hazardous substances in the form of cooling and lubricating fluids.

Robots

These are increasingly used to take the place of humans in automated, repetitive production line tasks. The hazards depend upon which tasks the robot performs; for example, drilling, cutting, paint spraying, etc.

The main mechanical hazard is that of impact due to its making movements that a person in the vicinity may not be ready for. Hydraulically operated robots may also give rise to high-pressure fluid hazards. Non-mechanical hazards include electricity and others depending on the materials being used in the operation.

Presses

These are used for forming shapes in metals, plastics, etc. and for pressing components together. The mechanical hazards associated with presses include crushing and impact from contact with the machine, and the possibility of cutting from sharp-edged swarf. Again, if the press is hydraulically operated there is a high-pressure liquid hazard. Non-mechanical hazards can include electricity, noise and vibration.

Agricultural and Horticultural Machinery

Cylinder mowers

The main mechanical hazards are cutting or shearing on the blades, and drawing-in and entanglement with the rotating parts. Non-mechanical hazards include vibration and noise.

Strimmers/brush-cutters

Again, the main mechanical hazards are cutting or shearing on the cutter and entanglement in the rotating parts. Non-mechanical hazards also include vibration and noise.

Chainsaws

The main mechanical hazards are cutting on the teeth of the saw, and drawing-in and entanglement on the moving chain. Non-mechanical hazards again include vibration and noise.

Retail Machinery

Compactors

These have electric motors which drive a ram to crush waste. Mechanical hazards include crushing and impact injuries, while non-mechanical hazards may arise from noxious substances and fumes.

Checkout conveyor systems

There are many types of conveyors in everyday use from airport baggage carousels to supermarket checkout conveyor systems. All conveyors present mechanical hazards of drawing-in and trapping at in-running nips between the belt and rollers, and crushing between the load and the conveyor. Non-mechanical hazards include spillages and breakages of the materials being carried, and the ergonomics of the operator's working position.

Construction Machinery

Cement mixers

These are used for mixing sand and cement. The main mechanical hazard is entanglement due to the rotation of the drum and the inner blade. Non-mechanical hazards would arise from the cement dust and also noise.

Circular saws

These have a very sharp circular blade, set within a table, rotating at high speed and are mainly used for cutting wood. The main mechanical hazard is cutting, although it is also possible for drawing-in to occur between the blade and table. Non-mechanical hazards would include electricity, noise and the production of hazardous substances (sawdust).

REVISION QUESTION 1

(1)   (i)   From what do the risks in the use of hand tools arise?

      (ii)   From what do the additional risks of portable power tools arise?

(2)   Why might each power tool be marked?

(3)   What are the general factors about machines and the way in which people may come into contact with them which cause the specific mechanical hazards in any situation?

(4)   What are drawing-in injuries?

(5)   List the non-mechanical hazards arising from the use of machinery.

(6)   What hazards might arise from the use of the following machines?

      (i)   Bench top grinder

      (ii)   Simple robot

      (iii) Pneumatic drill

      (iv) Bench-mounted saw

The suggested answers are given at the end of the unit.

MACHINERY – METHODS OF PROTECTION

The hazards from each piece of machinery should be identified through a risk assessment. Most present several hazards and all have to be considered. The risk assessment should evaluate the extent of the risks from the hazards and identify appropriate measures to control them.

It is useful to adopt a hierarchical strategy in choosing protective measures. It is generally agreed that some form of robust physical barrier is the most effective measure and that relying only on training is the least effective at protecting people from dangerous parts. Thus, a typical hierarchy to follow is:

- Fixed enclosing guards

- Other guards (e.g. adjustable, self-adjusting) or protection devices (e.g. interlocks, trips)

- Protection appliances (e.g. push sticks used with woodworking machines)

- The provision of information, instruction, training and supervision.

The consideration of measures should start with fixed enclosing guards and then work through the other levels, applying protection from each level where it is appropriate. Thus, even if good protection is given by the use of movable guards, further measures in terms of protection appliances and information, etc., should still be considered. So in practice, a combination of measures is used, e.g. fixed guards with interlocks backed up with training and supervision of operators.

Fixed Guards

All guards are physical barriers which prevent access to the hazard. There are two types available depending upon the nature of the hazard, the extent of the risk and the demands of the working process: fixed and adjustable. We consider fixed ones here first because they offer the highest level of protection. Adjustable guards are considered later.

Fixed guards have no moving parts and are fastened in a constant position in relation to the hazard; for example, by locking, welding or riveting to the machine or the ground. They normally require the use of special tools or keys to open them.

There are two main types:

- **Enclosing guards**

  Enclosing guards encase all parts of the hazard, such as the moving parts of a machine, to prevent any access during normal operations. There may be access points where materials can be inserted and withdrawn and hatches for maintenance or inspection.
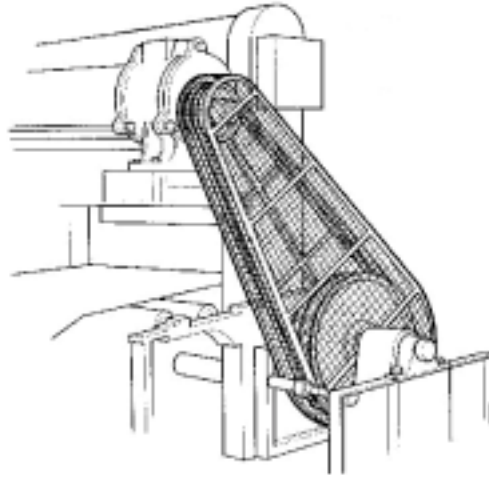
Fixed Enclosing Guard on a Belt Drive Mechanism

- **Distance guards**

    A fixed distance guard does not completely enclose a hazard, but reduces access by virtue of its physical dimensions and its distance from the hazard; for example, fixed perimeter fences which completely surround machinery, as shown in the figure below.
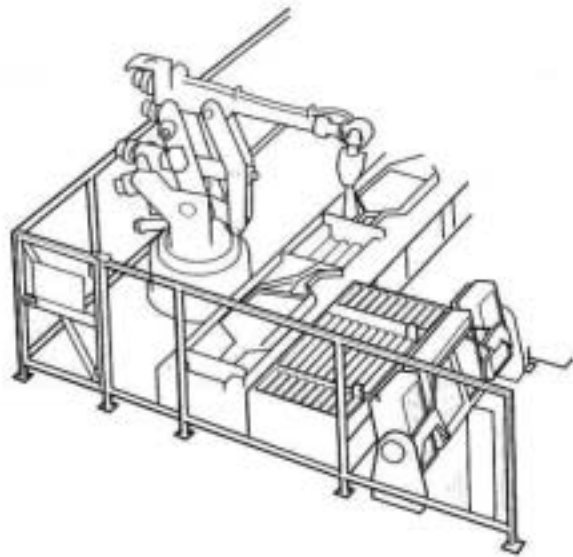
Perimeter Fence Guard with Fixed Panels and Interlocked Access Door

When it is necessary for work to be fed through a fixed guard, openings should be sufficient only to allow the passage of material and should not create a trap between the material and the guard. They should themselves be protected by a further guarding system.

Interlocked Guard Systems

Interlocking guards comprise a system which links the opening of the primary guard to the operation of a second safety device, either to the complete stoppage of the machine or to the operation of another guard. These are the safest means by which access may be allowed to a hazard.

Systems linked to the operation of the machine itself offer the best protection. They work by:

- Preventing operation of the machine, or at least the dangerous part, when the guard is open and there is access to the hazard area

- Preventing access to the hazardous area until the machinery has stopped and the potential hazard has been made safe.

Key factors in the operation of the system are that:

- It must not allow the machinery to operate until the guarding system is fully operational

- If the interlock system should fail, it should fail in such a way that the machinery shuts down or the guard remains in place, either way ensuring the hazard remains safe

- The interlocking system should be difficult to defeat.

The interlock usually operates by being linked to the power supply of the machine and cutting it off when the guard is opened. Other systems operate mechanically or magnetically.

Where the system links two guards together, the opening of the first must automatically bring the second into operation. For example, when access is required to replace a workpiece in a lathe, the action of opening the guard covering the cutting operation will both slide the cutter back away from the access area and bring down a second guard to cover it whilst the replacement is made. The primary guard should not open until the secondary safety device is fully in place.

In complex machines a combination of interlocks may be in place.

Trip Devices

There are operations which make it impossible to fit either a fixed guard or interlock. In such circumstances the best type of system to use is a trip device, defined as a guard which stops or reverses motion when a person enters the hazard area. The trip will operate when a person has to enter the risk area temporarily, or if an entanglement occurs where a person is being drawn onto (or into) the moving part.

The effectiveness of any trip device relies heavily upon the efficiency of the stopping device. Thus, maintenance of such devices is a top priority. When a trip guard is activated by an accident it should not allow further operation of the machinery until it has been reset. Ideally a test circuit should be incorporated so the trip action circuit can be checked without activating the mechanism.

There are a number of different types of device, all based on contact being made with some form of sensor.

Mechanical/Electronic Triggers

One example of these is a trip bar guard fitted to pillar drills. A microswitch attached to the trip bar will, if slightly displaced, cut off *Alternating Current* supply and inject *Direct Current* into the motor, so that it stops instantly or at least very quickly, say within 2.5 revolutions of the drill.
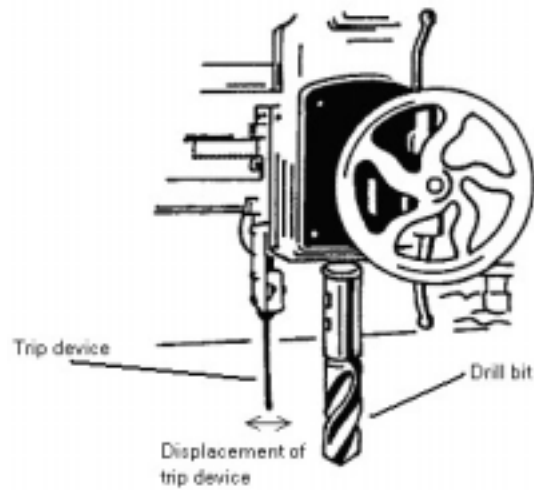
Trip Bar Guard

If a person gets entangled in the drill, the trip bar is displaced and the power to the machine is cut.

Note that this type of device does not prevent contact; indeed, it only operates once contact is made. Instead it serves to reduce the injurious effects of contact. (By contrast, fixed and interlock guards serve to reduce the chance of contact.)

The key points in the use of these systems are:

- Maintenance of maximum sensitivity for the trip bar, that is the minimum of movement is required to activate the microswitch

- Monitoring the microswitch for contact wear

- Ensuring that the trip guard is not being used as an operational brake for the drill.

Photo-Electric Guards

These are often used for press brakes, some guillotines and some hydraulic presses. The guard operates by creating a light-curtain across the hazard area. If any of the beams are broken, the unit is brought to an almost instantaneous stop.
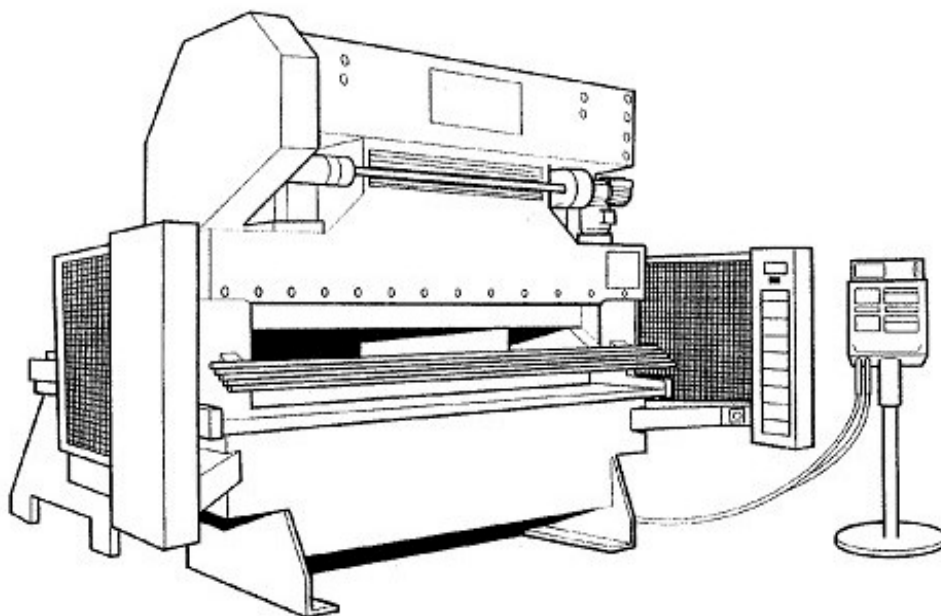
Photo-electric Device Fitted to a Press Brake

Because it has no moving parts (which will wear), the unit is very economical in terms of maintenance costs. The light-screen should incorporate a self-checking system between each operation of the machine so that any defects will cause the equipment to fail safe, that is to stop.

Pressure Pads

You may be familiar with floor mats which cause a door to open as an approaching visitor steps on them. The idea of mat-pressure contact circuits has been applied in the development of safety mats, known as safety *switch mats* or *trip mats*. The mats are positioned round a machine at an appropriate distance from the hazard. Pneumatic or low-voltage electric contacts within the body of the mat are linked to the power circuit of the machine in such a way that stepping on the mat shuts off the power. The rundown time of the machine is important, because once the pressure mat has been activated the machine must stop before the person can gain access to the dangerous part. This is why positioning at an appropriate distance from the machine is important.

The same principle of using contact pressure is found in devices known as *safety edges*, which are narrow strips fitted to sliding doors or machine parts which might close to trap a person. On contact with a person or object, circuits from the pressure strips halt the closing movement and, if desired, reverse it to avoid the trap.

Tripwires

Tripwires are often more convenient and are used to stop long conveyor belts, paper making machines, rope making and printing machines. However, they must be carefully designed to ensure efficient operation; for example, having the wire fixed to a pull switch is not considered adequate because it will only respond to a pull in one direction.
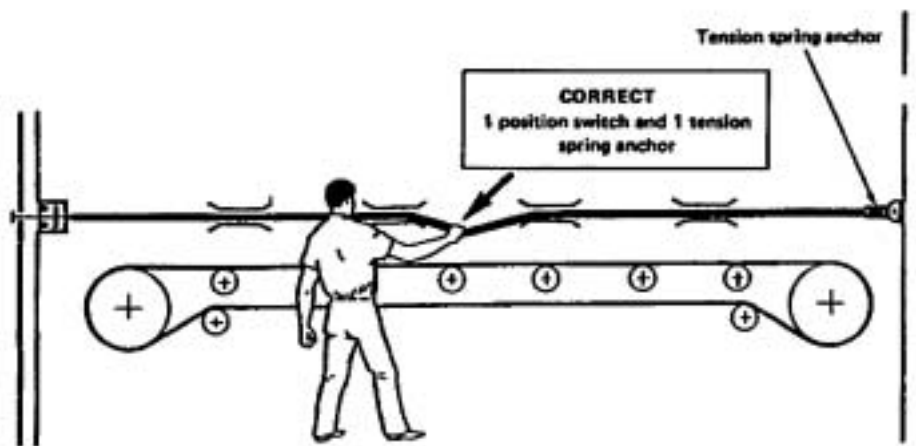
Suitable Design of Tripwire

Adjustable Guards

Where it is impracticable to prevent access to the dangerous parts because they are unavoidably exposed during use – for example, the cutters on milling machines – the use of an adjustable guard may be permissible. These are guarding systems which require manual adjustment to give protection. They should only be used where the conditions are suitable; for example, where there is good lighting to make the adjustment; and following adequate training of the operator.

The adjustable guard protects an opening to the machinery through which material can be fed, the whole guard or part of it being capable of adjustment in order that the opening can be varied in height and width to suit the dimension of the work in hand. It is essential that the adjustment is carried out carefully by a suitably trained person before the guard is used as part of the working process. Regular maintenance of the fixing arrangements is necessary to ensure that the adjustable element of the guard remains firmly in place once positioned. The guard should be designed so that the adjustable parts cannot become detached and mislaid easily.

These types of guarding are used on woodworking machinery, milling machines, lathes, drills, and grinders. Sometimes they are attached as an extension to an existing fixed guard. Many of the guards are designed so the workpiece can be seen during the machine operation. Windows of Perspex, polycarbonate or armoured plate glass allow the operator a clear view. Some systems are made with a telescopic fencing or a slotted movable casting, both systems allowing observation of the workpiece.

The following adjustable guarding systems are in common use:
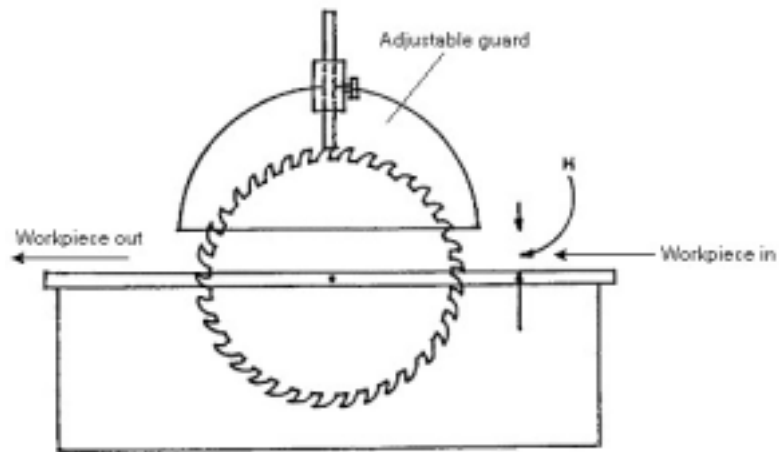
Circular Saw with Adjustable Guard

The cover is adjusted so that the height **H** is large enough for the workpiece to be cut by the saw and at the same time ensuring there is minimum exposure to the dangerous part.
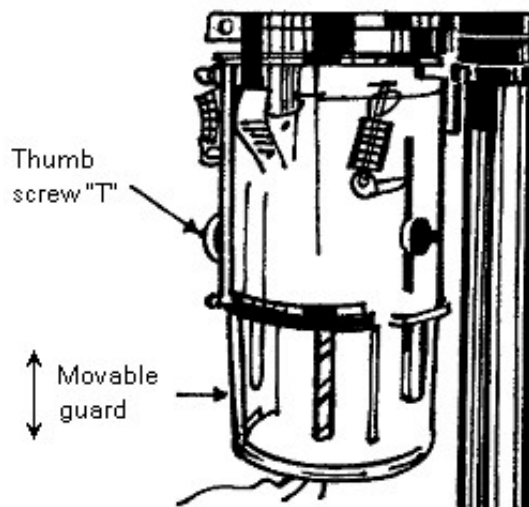
Drilling Machine Chuck Guard

In vertical drills or woodworking moulders, the transparent cover which allows a clear view of the drill or cutter is adjusted and secured in position by the thumb screw **T**.
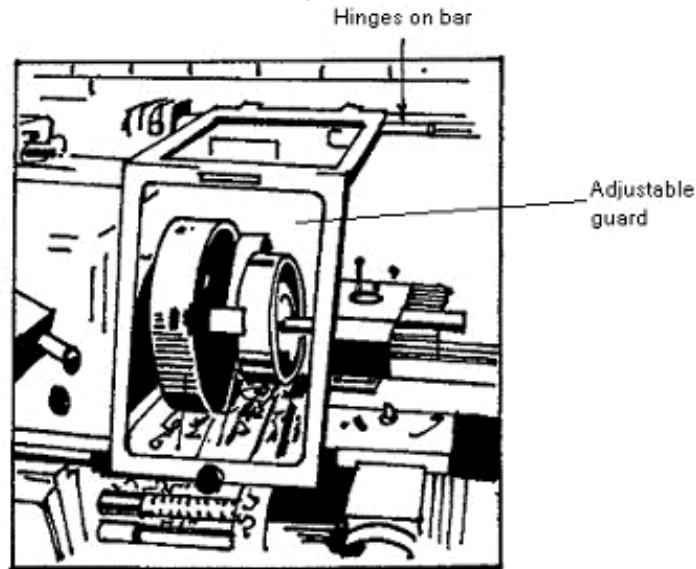
Hinged Lathe Guard

A transparent cover over the cutting area allows the operation to be seen and controlled. It is hinged at the top so that on completion of the operation it can be lifted to gain access to the workpiece.
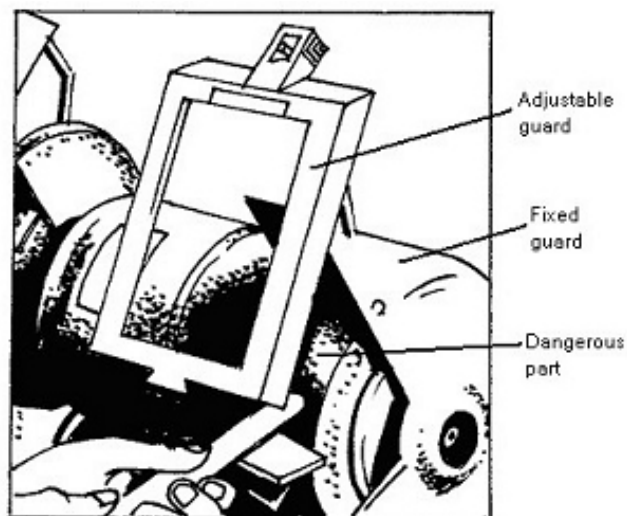
Combination Adjustable and Fixed Guard on an Abrasive Wheel

The use of adjustable guards is allowed in many situations by the inspecting authorities but critical thought should be given before they are used as a guarding system. Their main weakness lies in the fact that they are controlled by the machine operator and not by the person or organisation responsible, by law, for controlling the safety of the workplace. As a consequence there are two potentially serious risks:

- They can easily be defeated

- They rely upon operators being 100% vigilant in providing for their own safety, a condition the guard should provide, not the operator.

Strict training and supervision of operators is of paramount importance where adjustable guards are used.

Self-Adjusting Guards

A self-adjusting guard is a fixed or movable guard, which, either in whole or in part, adjusts itself to accommodate the passage of material, etc.

This type of protection is designed to prevent access to the dangerous part(s) until activated by the movement of the workpiece – i.e. it is opened by the passage of the work piece at the beginning of the operation and returns to the safe position on completion of the operation.

The next figure indicates a metal cutting saw, it may cut rods or pipes. The same principles apply to cross cutting saws (woodworking machines which cut across the grain of the wood).
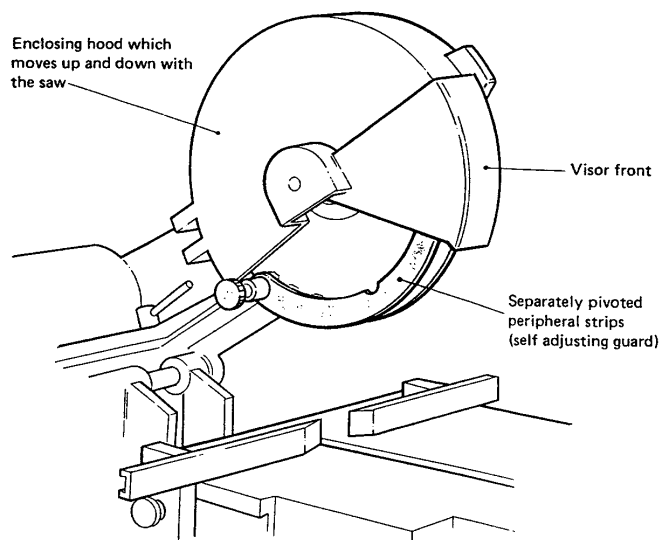
Typical Arrangement of a Self-Adjusting Guard

Most of the blade is enclosed in a metal hood (a fixed guard). The blade and hood are fixed to an arm. The figure shows the arm in a raised position; note that none of the blade is exposed because the self-adjusting guard is spring loaded or falls under gravity to its lowest point relative to the blade.

Some part of the blade must be exposed when in operation or the machine would be useless. As the arm is lowered to make the cut, engaging the workpiece from above, the self-adjusting guard is moved by the actual workpiece. It is moved upwards relative to the blade. The workpiece overcomes the downward force of the spring or gravity allowing the cut to be made. As the arm is lifted and the blade disengaged, the force of the spring or gravity returns the self-adjusting guard to its protective position.

Consideration should be given to the use of feeding and take-off devices, jigs and holders when this type of guard is used (discussed later).

Two-Hand Controls

Where guarding is impracticable, two-hand controls offer a means of protecting the hands of the machine operator. It may also be used as a hold-to-run control.

A two-hand control device requires both hands to operate the machinery controls, thus giving a measure of protection from danger to the machinery operator only. It should be designed to cover the following points:

- The hand controls should be placed, separated and protected so as to prevent spanning with one hand only, being operated with one hand and another part of the body, or being easily bridged.

- It should not be possible to set the dangerous parts in motion unless the controls are operated within approximately 0.5 seconds of each other.

- Movement of the dangerous parts should be stopped immediately or, where appropriate, stopped and reversed, if one or both controls are released while there is still danger from the movement of those parts.

- The hand controls should be situated at such a distance from the danger point that, on releasing the controls, it is not possible for the operator to reach the danger point before the motion of the dangerous parts has been stopped.
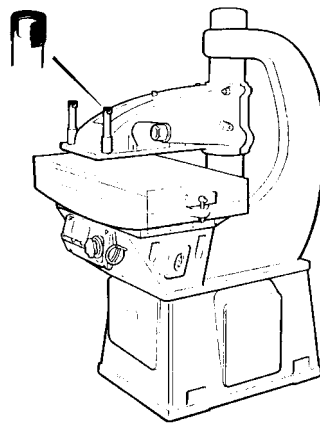
Two-hand Control Device

There are some difficulties with the use of two-handed controls:

- Experience has shown that most two-handed systems will eventually be defeated by a determined operator

- During operation the system protects the operator but third parties are always at risk

- Frequent maintenance is required as most systems require a complex mechanism in order to make them effective.

The use of two-handed control systems as a method of guarding machinery must be considered as having very limited practical value.

Protective Appliances

These are hand-held tools or hand-controlled fixed devices which are used to hold or manipulate a workpiece as it enters the machine, is worked on and/or removed from the machine. They allow the operator to keep control of the piece whilst not coming into contact with the hazardous parts of the machine. They include push sticks, jigs and other types of holder.

Although they offer a far less secure level of protection, the same requirements apply as for guards; that is, they must be adequate for the job they do, allow the user/operator to get on with the job without getting too close to the danger zone and not obscure the user's view of the machinery.

Personal Protective Equipment

PPE is used to control any hazards which remain after designed engineering controls have been implemented. Wearing protective clothing, helmets, visors, boots, etc. provides immediate short-term protection which should, combined with guards and other safety devices, provide full protection from all the hazards associated with operating the machinery.

Note that PPE should only be considered as a last line of defence. PPE only protects the wearer, not other people. It is the responsibility of individual workers to use it and they should be trained in when, where and how to use it.

Information, Instruction, Training and Supervision

Operator error is a major cause of accidents, either as a result of bypassing guards to speed up work or simply by mistake. It is essential that workers are fully aware of the risks associated with operating the particular machinery they work with, exactly how the protective devices work and how they are expected to work safely with them. This applies even where the hazard is protected by fixed guards; operators must be fully instructed in the operational use of adjustable guards. In addition there may be residual risks which can only be eliminated by the operator keeping to set, safe procedures and working practices.

The level of training required will reflect the complexity of the equipment and its associated dangers. Some equipment will require a high degree of training, including the possession of recognised certificates; for example, for abrasive wheel mounters and setters. On the job instruction and training may be sufficient for many operations, such as the operation of machine controls (including emergency controls) and the changing of machine components or workpieces.

Employers have a duty to inform workers of hazards arising in the workplace. With work equipment this can be achieved by suitable markings, as we considered earlier. Toolbox talks or on the job training are other ways of spreading information. They also provide a means for instruction.

Strengths, Limitations and Means of Over-riding Guard Systems

The following table compares the different types of safety devices.

Type of Guard	Strengths	Weaknesses	Means of Over-riding
Fixed	Presents the most effective barrier between operator and hazard. No moving parts. Cannot be interfered with by operator. Virtually maintenance free.	Machine will still operate with guard removed. Size of holes for material feed may limit protection.	Special tool for removal may be too widely available
Interlocked	Less dependent for their effectiveness on the control of human behaviour. Require some effort to defeat.	Design of the interlock is critical – should be designed to fail to safety.	Difficult on well-designed systems, but connectors may be bent out of place. Spare magnets may be used.
Trip devices	Useful when approach by person is required as part of the job.	Trips may not be set to cover all means of access. Time delay in stopping machine may be greater than time from tripping to reaching machine.	Operators can avoid devices if they wish to beat the system.
Manual adjusting guard	Allows different sized workpieces to be used	Relies on people using it properly	Can be adjusted out of range.
Self-adjusting	Allows different sized workpieces.	Easily over-ridden .	Can be adjusted out of range.
Two-handed control	Keeps operator's hands away from moving parts. Rapid manual movement of guard into place.	Protects only operator's hands, not other parts of body or other people.	Two people can over-ride the system by each holding one handle.

MACHINERY – APPLICATION OF PROTECTION METHODS

The table below outlines how each type of guard or safety device is used.

Type of Guard	Application
Fixed	Used where conditions do not change much over time and it is practicable for an adequate fixed guard to be set in position and left. For example, a belt drive mechanism has moving parts but the assembly as a whole stays in one position, making a fixed guard suitable.
Interlocked	Used where frequent access to dangerous parts of machinery is required; for example, interlocked gates to allow access to robot working areas for re-setting the machines. The frequency of access will make constant removal and replacement of a fixed guard impractical.
Trip devices	Used where frequent access to dangerous parts of machinery is required, but an interlocking system is impractical or inappropriate; for example, trip wires surrounding conveyor belts which stop the belt if touched.
Manual adjusting guard	Used where constant access is needed to load and remove the workpiece. Often used in conjunction with fixed guards to allow access to a small part of the hazardous area; for example, where most of an abrasive wheel can be adequately enclosed by fixed guarding, but a small segment has to be exposed for the machine to be used.
Self-adjusting	Used where the hazardous area itself moves as part of its operating cycle or where different sized workpieces are used in a machine; for example, in woodcutting operations.
Two-handed control	Used where other guards are impractical or inappropriate. Most common on equipment where the workpiece has to be manually put into place, such as small presses.

You should realise that each protection method has its limitations and perhaps a combination of guarding techniques will be required to ensure maximum safety. As machinery becomes more complex and production lines more automated, possibly involving robots, the demands on the designer become greater and an overall systems approach is essential.

The type of guard required will depend upon the type of operation the machine is performing, and the same individual machine will sometimes require different guarding systems for different types of operation. For example, a power press that requires close approach and manual loading of each workpiece from the front should be interlocked. The same machine may also

have a facility for automatic loading of workpieces from the side; when in this mode of operation, close approach and access to potentially dangerous parts is not required and fixed guarding offers the best solution. Both types of guard are not used at the same time. As the machine switches from one mode of operation to another, so the type of guarding changes to match the changes in the hazard.

The following table matches the range of equipment we considered earlier with types of protective device. Again, this is by no means exhaustive of either the working environments or the types of machine, but it does show how protection methods are applied to machinery in the workplace.

Machinery	Protection system
Office Machinery	
Photocopiers	Adjustable guard (lid).
Guillotines	Fixed or adjustable guard depending on the type of work, interlocked guards or trip wires on larger machines
Document shredders	Interlocked guards and trip wires
Manufacturing and Maintenance Machinery	
Abrasive wheels and grinding machines	Fixed and adjustable guards, PPE (goggles, gloves and ear defenders)
Drills	Trip guards and adjustable guards, PPE (goggles)
Lathes	Adjustable guards, PPE (goggles)
Robots	Fixed perimeter fencing with interlocked access points
Presses	Perimeter fencing, trip devices and adjustable guards
Agricultural and Horticultural Machinery	
Cylinder mowers	Fixed guards
Strimmers/brush-cutters	Fixed guards, PPE (masks and ear defenders)
Chainsaws	Interlocked guards, PPE (goggles, gloves, mask and ear defenders)
Retail Machinery	
Compactors	Interlocked guards
Checkout conveyor systems	Interlocked guards and pressure pad trip devices
Construction Machinery	
Cement mixers	Interlocked and adjustable guards
Circular saws	Self adjusting guards, PPE (masks, ear defenders and gloves)

You should look at how machines used in your own workplace, or in some others with which you are familiar, incorporate safety devices, in order to extend your understanding of the use of these controls.

Basic Principles for Guards and Safety Devices

When taking action in the design stage to minimise the hazards from machinery by the selection of guards and other safety devices, there are a number of points to consider.

- **Be compatible with process**

  It is necessary to ensure that during operation and maintenance any protection device provides the minimum interference with the function of the machine whilst still providing protection against the hazards. This implies that the use of safety measures is integrated with the working process. Where the process changes, such as on multi-tasking machines, the measures may have to change too, because the same guarding system cannot always be used in all circumstances, hence the variety which exists. Often a combination of methods may be used for one machine.

- **Of adequate strength**

  The safety device must be of sufficient strength to withstand any impact from the hazard. They must be appropriate to the extent of the risk as well as being compatible with the working process. In consequence, guards are usually made of metal or a heavy duty synthetic material such as Perspex.

- **Maintained**

  All guards and safety devices must be checked regularly and maintained in a proper working condition. For example, whilst Perspex guards offer good impact protection and visibility, they can weaken greatly over time and suddenly fail. Depending on the complexity of the device, different levels of maintenance may be necessary to remain effective and reliable, varying from operator checks to regular inspections and servicing by trained staff. Records may have to be kept of maintenance work.

  Any faults should be reported at once and repairs carried out as soon as possible.

- **Not increase risk**

  Many guards bring their own risks; for example, certain types of screen may restrict the view of the machine. A balance must be struck between the benefits which the guards offer and any problems they may bring about; the benefits nearly always outweigh the problems.

- **Not be easily bypassed or disabled**

  As far as possible, it should not be possible to operate the machine without the safety device in place. Where this is impracticable, the design of the device should be as resistant to being bypassed or disabled as possible. Special tools may be required to unlock perimeter fences around machines to gain access to a restricted maintenance area.

REVISION QUESTION 2

(1) What is the hierarchy of protective measures?

(2) What five requirements are there for any guarding system?

(3) Describe the principles of an interlocking guard system.

(4) What is a trip device?

(5) What are the limitations of adjustable guards?

(6) What are protection appliances?

(7) How may two-handed controls be over-ridden?

(8) When are operators required to be trained in the use of safety equipment?

The suggested answers are given at the end of the unit.

UNIT SUMMARY

The key requirement for all work equipment is that it should be suitable for the purpose for which it is used and also appropriate for the work environment in which it will be used.

If the use of work equipment is likely to involve a specific risk to health and safety, then the use of that equipment should be restricted to those people given the task of using it. Employers must take effective measures to prevent their workers coming into contact with dangerous parts of machinery.

All people who use work equipment should receive training on the equipment which they are expected to use, including the health and safety implications, potential risks and precautions.

Employers must ensure that work equipment is maintained in a good state of repair, which is particularly true of any guarding arrangements. Where appropriate, all work equipment should be provided with appropriate controls for safe operation (stating, stopping, emergencies etc). Employers should ensure that the stability of work equipment, lighting, markings and warning are such that it is safe to operate the equipment, and that the operator has a clear and unobstructed workspace.

Hand tools and portable power tools have the same types of hazard of operator error, misuse and improper maintenance, but there is a much higher risk associated with the latter because of additional risks presented by the power source and the speed and force of the tool itself. The safe use of such tools is based on training to ensure competent operation, correct maintenance, inspection and the use of PPE. Because of the greater risk of injury, the measures taken are more extensive than with hand tools and must be more strict.

The hazards arising from the operation of fixed powered machinery include mechanical and non-mechanical hazards. Mechanical hazards arise from the direct interaction of people with the machine itself and generally cause injuries when people come into contact with machinery or a workpiece held in the machinery, particularly when the machine is in motion. Non-mechanical hazards are those associated with the use of machines, the environment within which they are located, the materials used and other aspects of the machine's operation. The injuries caused may be immediate and acute but may also include longer-term damage caused by lengthy exposure.

The hazards from each piece of machinery should be identified through a risk assessment. Most present several hazards and they must all be considered. The risk assessment should evaluate the extent of the risks from the hazards and identify the appropriate measures to control them. A hierarchy of protective measures should be adopted as follows:

- Fixed enclosing guards

- Other guards or protection devices, including interlocking guards, trip devices, adjustable and self adjusting guards and two handed controls

- Protection appliances (including PPE)

- The provision of information, instruction, training and supervision.

Guards and other safety devices should be compatible with the work process, be of adequate strength, be properly maintained, not increase risk and not be easily bypassed or disabled. The type of guard required will depend upon the type of operation the machine is performing. Each

method of protection has its strengths and limitations, and a combination of guarding techniques will be required sometimes to ensure maximum safety.

SUGGESTED ANSWERS TO REVISION QUESTIONS

Revision Question 1

(1) (i) The risks in the use of hand tools arise from operator error, misuse and improper maintenance.

(ii) The additional risks of portable power tools arise from the presence of the power source (and especially the electrical cables) and the speed and force of the tool itself.

(2) To identify it for inspection purposes as part of a routine maintenance system.

(3) There are six general factors:

– Shape of the machine– for example, whether an object has sharp edges, angular parts, etc., which may be a hazard even if not moving.

– Relative motion of machine parts or of a machine part to a body, or part of a body.

– Mass and stability of the machine or parts of it, including the workpiece.

– Acceleration of moving parts of a machine (or the workpiece), either under normal conditions or if something breaks.

– Inadequate mechanical strength of a machine or part of it.

– Potential energy of elastic components which may be translated into movement.

(4) These occur where a part of the body is caught between two moving parts and drawn into the machine.

(5) Noise, vibration, electricity, temperature, hazardous materials and substances (including radiation) and ergonomics.

(6) (i) Bench top grinder: Mechanical – contact, ejection of parts, swarf
                                 Non-mechanical – dust

(ii) Simple robot: Mechanical - impact/crushing
                               Non-mechanical – noise

(iii) Pneumatic drill: Mechanical - impact/crushing
                               Non-mechanical – noise, vibration, dust

(iv) Bench-mounted saw: Mechanical – cutting/severing
                               Non-mechanical – noise, dust

Revision Question 2

(1) The hierarchy of protective measures referred to in the text is as follows:

– Fixed enclosing guards

– Other guards or protection devices

– Protection appliances

– The provision of information, instruction, training and supervision.

(2) That they should:

- Be compatible with the process

- Be of adequate strength

- Be properly maintained

- Not increase risk

- Not be easily bypassed or disabled.

(3) Interlocking guards comprise a system which links the opening of the primary guard to the operation of a second safety device, leading either to the complete stoppage of the machine or to the operation of another guard.

(4) A trip device is a system which stops or reverses the motion of a machine when a person enters the hazard area.

(5) There are two potentially serious limitations:

- They can easily be defeated

- They rely upon operators being 100% vigilant in providing for their own safety, a condition the guard should provide, not the operator.

(6) These are hand held tools or hand controlled fixed devices which are used to hold or manipulate a workpiece as it enters the machine, is worked on and/or removed from the machine. They allow the operator to keep control of the piece whilst not coming into contact with the hazardous parts of the machine. They include push sticks, jigs and other types of holder.

(7) Two people can over-ride the system by each holding one handle.

(8) At all times and in all situations.

NEBOSH International General Certificate

Unit 10 | Electrical Hazards and Control

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INTRODUCTION

In this unit we will look at the hazards which can arise from the use of electrical equipment in the workplace. We all use electrical equipment on a day-to-day basis but rarely consider the hazards. Electricity is a dangerous but very useful source of power. Unfortunately, electrical faults are one of the main causes of fires and many people each year suffer injuries from electric shocks and burns due to faulty equipment and wiring, or from the use of inappropriate electrical equipment in a particular environment. We should ensure that each piece of equipment we use is safe every time we use it.

We start with a brief outline of the basic principles of electricity and the terminology associated with it. We have to understand this in order to appreciate how risks arise, the harm they can do and how some of the protective measures work. We go on to look at the hazards posed by electricity, particularly electric shocks and burns, before examining the measures which can be taken to control the risks.

The unit is designed to meet the following aims and learning outcomes as specified by NEBOSH for this part of the syllabus for the International General Certificate.

Overall Aims

On completion of this unit, you will have knowledge and understanding of:

- The hazards and risks associated with the use of electrical equipment and systems operating at mains voltages
- The measures that should be taken to minimise the risks.

Specific Intended Learning Outcomes

When you have worked through this unit, you will be able to:

- Identify the hazards and evaluate the consequential risks from the use of electricity in the workplace
- Advise on the control measures which should be taken when working with electrical systems or using electrical equipment.

PRINCIPLES OF ELECTRICITY

Electricity is a form of energy associated with the flow of charged particles or electrons from one point to another through a conductor (usually a metal wire). There must be an unbroken path between the two points through which the particles can travel, the complete path being known as the circuit. A switch can be used to complete or break the circuit, thus controlling whether the electricity flows through it or not.

This basic principle is simple, but to appreciate the hazards posed by electricity when it is used to power tools and machinery, and the methods by which these hazards may be controlled, we have to understand the operation of circuits in a little more detail.

Voltage, Current and Resistance

A basic electrical circuit can be made by connecting one end of a conductor to a source of electricity and the other to another point, thus allowing power to flow from one "terminal" to the other. The source can be a battery or a socket in your living room or at the workplace. Both of these incorporate two terminals, the positive and negative terminals on a battery or the live and neutral connections (the two at the bottom) in a three pin socket.

Voltage

Power flows along a conductor where there is a difference in electrical "pressure" between the two terminals. This pressure difference provides the push to move the electrons and is measured in volts (symbol "V"). The higher the difference in pressure (the voltage), the harder the push.

The correct name for this electrical pressure is "electrical potential", so voltage is the measure of potential difference between the two terminals.

To help understand this, it may be useful to compare an electrical circuit to a piped water system. For water to flow along the pipe there must be a supply of water being pumped into the system. The point at which the supply is connected will have a higher pressure than elsewhere in the system and the water will then flow along the pipe towards the point of lower pressure.

Current

This is the flow or speed of power along the conductor. It is measured in amperes (usually shortened to "amps", with the symbol "I").

The current (or the amperage) in a circuit is determined by the voltage. Thus, the higher the voltage, the higher the amperage.

To continue the comparison with the water system, the flow through the pipe can be increased by making the diameter of the pipe larger. Similarly, in an electrical circuit the current flow can be increased by using thicker conductors. Thus the mains cables which carry the electricity supply from a substation to houses and business premises are much thicker than the mains wiring inside a building, and that in turn is thicker than the wiring from an appliance to the plug.

Resistance

If a circuit was made consisting only of the source and conductor connected between the two terminals, the flow of power would continue to be pushed through and speed up. This can be

dangerous, so to ensure that this does not happen there has to be something which slows the rate of flow, usually by removing power from the circuit.

This process is known as resistance and is measured in ohms (symbol "R" or "Ω"). Any item of equipment which is connected to the circuit and uses some of the power flowing through it is a resistor; for example, light bulbs, heaters, power tools, etc. They take the electrons and convert them into another form of energy, such as heat or motion. Other resistances come from the conductor itself where the type of material forming the conductor may slow the current (when it is known as "impedance").

We can show this by comparing the process with a piped water system. If there is nothing to slow the water down it will pick up speed as it flows through the system. However, if part of the flow is diverted to power a water wheel, that will act as a resistance to the flow. Similarly, rough surfaces, obstructions and bends in the pipe will also impede it.

Relationship Between Voltage, Current and Resistance

We can consider the way in which the three elements of a circuit are interrelated by referring to the following simple circuit diagram below.
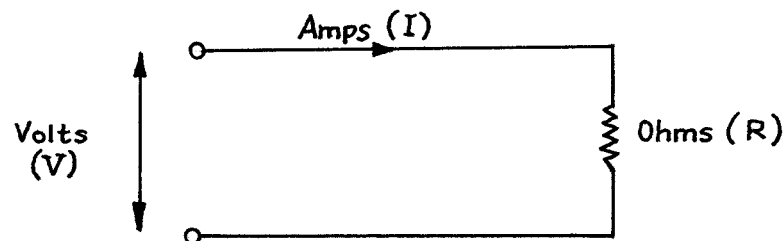
$$V = I \times R$$

Simple Electrical Circuit

As the voltage pushes the current through the circuit, the electrons are used in one form or another by the resistances connected. Thus the voltage applied to a circuit must be just sufficient to push the current all the way through the circuit and all its components. This can be expressed in a simple equation:

$V = I \times R$

This is known as "Ohms Law" and is important in that it provides a means of working out any of the values if we know the other two. Thus:

$I = \dfrac{V}{R}$ and

$R = \dfrac{V}{I}$

The power in a circuit is a product of the voltage and the current and is measured in watts ("W"). Thus:

$W = V \times I$

For example, if the current taken by an electrical heater is 5 amps when plugged into a 240 volt supply, then its power load would be $240 \times 5 = 1,200$ watts.

These equations can be used to calculate the current which flows through any circuit, given the resistance or power loading connected to a known voltage. They can be used to determine fuse

ratings for particular loads or the current flowing through a person who may inadvertently touch a live supply (as we shall consider later).

Basic Circuitry

An electrical circuit consists of a number of components – a source of electrical current, a conductor connected to the source and another terminal, and equipment connected to the conductor and powered by the current (the load).

The conductor should be a material which allows the current to flow with as little impedance as possible and copper wire is usually used for this purpose. The wire will be enclosed in an insulator, a sheath of material which does not conduct electricity such as rubber or plastic. This has two effects:

- It prevents electricity leaking out of the conductor as it passes along it

- It prevents any other conductor touching the enclosed wire and creating a short circuit, as we explain below.

Short Circuits

Once a voltage is applied to the conductor in a perfect circuit current will flow from the terminal with the higher electrical potential to the terminal with the lower potential. Normally this will be from the source terminal (the live terminal) to the return (neutral) terminal.

Electricity will flow to the point of lowest potential in a circuit along any path it can find. If it can find an alternative path to a terminal with a larger potential difference than the neutral terminal it will take it. Thus, if another conductor touches the circuit and provides such a path, at least some of the current will flow along that conductor. This is known as a short circuit.

The lowest potential (zero on the voltage scale) is the potential of the mass of the earth. So any conductor which connects the circuit to earth, deliberately or accidentally, will cause a short circuit. This is a severe danger because the new path may have less resistance to the current, allowing the flow to increase.

In the UK the public electricity supply is based on a 240 volt circuit. This means that at an electrical switch board or fuse box the live terminal has a potential of 240 volts and the neutral terminal is at a potential of zero volts. However, at any point along the conductor connecting them, for example between the live and neutral terminals in a plug, the potential difference at the neutral terminal will not be truly zer0 because of impedance. Any other conductor which connects to earth will immediately cause a short circuit.

The short circuit current which would result if a particular point in a circuit was connected directly to earth is called the fault current and the new circuit created is called the earth fault loop.

Earthing

Providing a connection to earth can be used to safeguard electrical systems as well as representing a hazard. Earthed conductors in a circuit provide a safe path for any fault current to be dissipated to earth. They will be connected to any exposed metal parts of a component connected to an electrical circuit which should not normally carry a current. If a fault develops and they do become live, then the earth conductor will carry the fault current away.

Direct and Alternating Currents

A current which flows in one direction only is known as **direct current (dc).** A battery gives a direct current.

If the direction of flow alters at regular intervals, it is an **alternating current (ac).** The public electricity supply varies in different regions of the world. In the United States the voltage is around 110 volts; in the UK it is 240 volts ac, with the alternating cycle being 50 Hz (cycles per second). Shock injury from dc is generally a lot less severe than from ac.

The flow of ac is cyclic. For instance, the 240 volt public supply peaks at 338 volts. This cyclic variation is not suited to some installations, such as driving electric motors. To overcome this problem a three-phase system is used in which three electricity supplies are fed into the circuit, each of which is out of phase with the others but which in combination produce a steady current. The additional hazards with three-phase systems are that three live terminals are present and an electric shock at 415 volts can result between them.

HAZARDS OF ELECTRICITY

Now we have looked at basic electrical processes, we can consider the problems which can occur in using electrical equipment. In essence they come from situations where the current passing through a circuit escapes from its intended path along the conductors in the circuit and finds another path along a different conductor.

Electric Shock

An electric shock is received when a person makes a contact with a live conductor and the current passes through his/her body. The person's body acts as the conductor for the current, interrupting the circuit and providing an alternative path for it to flow along. Where the person is in simultaneous contact with an earthed object – for example, standing on the ground or also touching an object which is in direct contact with the ground – this results in a fault current with the person (and the other object he/she is in contact with) completing the earth fault loop.

Once an electric current has passed the barrier of the skin, which has a relatively high resistance, the body itself offers little resistance and the current may take one of numerous pathways through it. The effects will depend mainly on the amount of current which passes through and the duration of the connection.

Effects on the Body

An electric shock results in a convulsive response by the nervous system to the passage of electricity through that part of the body. This causes the muscles to contract, often violently. A well known feature is that if you grasp a live wire in the palm of your hand, the shock will cause the hand to close around the wire, gripping it more firmly and being unable to release it.

Depending on the path that the current takes through the body, the muscular contractions caused can have different effects. The most serious involve the current passing through the heart where it may cause fibrillation – interference with the timing of the beats of the heart – and/or cardiac arrest. Interference with the muscles controlling breathing may also be serious and cause respiratory failure. Both of these may be fatal.

Even if the current does not pass through vital life organs, the effects can have serious consequences. The involuntary muscular reaction caused may result in arms, legs, torso or neck convulsing. This is likely to be sufficient to knock the victim off balance and cause a fall, and where this is from a height or in dangerous surroundings, the fall may result in more serious injuries than the shock itself. The force with which the muscles contract may well be sufficient to overstrain and damage the muscles themselves or other moving parts of the body and to cause fractures of bones.

The passage of electricity can also cause burns, both inside and on the surface of the body. We shall consider this later.

Factors Influencing Severity

The severity of the shock and type of injury caused will depend upon the amount and nature of current passing through the body and the parts of the body through which the current passes.

Amount and nature of the current

The amount of electrical current passing through the body is a function of the voltage applied, the resistance of the path through which it travels and the duration of the contact:

- The voltage of the circuit formed by the contact which the body makes with the electricity supply will determine the force with which the electricity passes through the body. No voltage can be considered safe in all circumstances, although low voltages may reduce the risk. We must always assume that a public electricity supply of 240 volts is potentially fatal.

- The electrical resistance of the body varies depending upon the skin condition (moist or dry) and the path travelled through the body between the entry and exit points. Generally, skin resistance is quite high, although it may vary from less than 1,000 ohms for wet skin to over 500,000 ohms for dry skin. Perspiration brought on by fear and shock may increase moisture on the skin and further lower resistance where there is continuing contact with an electrical source. Internally, the resistance is much less; for example, between the ears the internal resistance (less the skin resistance) is only 100 ohms, while from hand to foot it is closer to 500 ohms.

- Many shocks are of very short duration with the person remaining in contact with the live source for less than a second. Depending on the current voltage received this may be long enough to receive a fatal shock. Longer contact will clearly be more damaging.

We can determine the amount of current received from a shock by applying the equations of Ohm's Law noted earlier. If we assume a voltage of 240V from the public electricity supply and a low body resistance of 1,500 ohms, the current received would be:

$$I = \frac{V}{R} = \frac{240}{1,500} = 0.16 \text{ amps}$$

Current at this level is generally measured in milliamps (one thousandth of an amp), so this level of current is expressed as 160 mA. The following table shows the effects of various levels of current for a duration of one second.

Current (*mA*)	Effects
0.5 - 2	Threshold of perception
2 - 10	Painful sensation
10 - 25	Inability to let go
25 - 80	Breathing laboured, danger of asphyxiation, loss of consciousness from heart or respiratory failure
100 - 200	Ventricular fibrillation – fatal

Above 200 milliamps, the muscular contractions are so severe that the heart is forcibly clamped during the shock. This clamping protects the heart from going into ventricular fibrillation, and the victim's chances for survival are good provided that resuscitation is performed immediately. However, this does not imply that such a severe shock will not be extremely serious. Severe burns occur over 200 mA.

The current passing through the body can be either direct or alternating current and the effect is proportional to both its magnitude and the type. Direct current is less damaging.

Current path

The key points are the entry and exit points for the current, the part of the body which comes into contact with the live source and the part from which the current leaves the body. This may be where there is contact with the ground or another conductor which will take the current. The most common points of contact are hands or arms and for departure, the feet or the other hand or arm.

The path that the current takes between the entry and exit points will generally be that of the least resistance. Paths through the heart or through the respiratory organs are the most dangerous.

The effect on the body will vary with the general condition of the person; so, for example, a weak heart will be less able to withstand the effects of the shock.

First Aid Treatment

Electric shock victims should receive quick medical treatment. However, it is important not to touch a person who remains in contact with an electrical source as you will also receive a shock.

- The first action should be to break any continuing contact between the victim and the current. This should be by switching off the supply or disconnecting the equipment. If this is not possible, the victim should be separated from the current using a non-conductive material; for example, a wooden broom handle, piece of cardboard or dry clothing, etc. to push or drag the person away.

- Artificial respiration should start immediately and continue until the victim recovers or qualified medical aid intervenes. In situations where there is a high risk of electric shock accidents, first aid personnel trained in resuscitation methods should be readily available.

- Emergency medical attention should always be sought as there is a risk of internal injury which may not be visible.

Electrical Burns

Burns resulting from electricity may be divided into two groups:

- Those which result from direct contact with a live conductor.

- Those which arise indirectly from situations where there is no contact with a live conductor, – similar to being struck by lightning.

Direct Burns

The passage of an electric current along any conductor is accompanied by the release of heat. Thus, when a current passes through the body, it is likely to cause burns, even though the duration of exposure may be very short.

The heat given off by a current is directly related to the amount of the current and the resistance encountered. So the higher the current, the greater the heat and the more likely it is that burns will result. Similarly the higher the resistance, the greater the heat and the more likely it is that burns will result. As the skin is the site of highest resistance in the body, it is on the surface of the skin at the point of contact with a live conductor that the most severe burning will occur. However, high currents can create internal burns all along the path travelled through the body, causing damage to red blood cells and muscle tissue. Such burns are often deep-seated and slow to heal.

Indirect Burns

The most common cause of electrical burns, excluding situations where a person touches a live conductor, is **arcing**. Arcing can occur when one conductor with a very high potential is brought into close contact with another earthed conductor. The voltage may be large enough for the natural insulation of the air between them to break down and a spark to jump the gap. This ionises the air, considerably lowering its resistance, which in turn allows the current to increase so that an electric arc is set up between the conductors. Very large currents can flow through the arc in a very short time, possibly less than one second, in a similar way to lightning.

Arcing will only occur where the live conductor is uninsulated, where the insulation is insufficient to prevent the force generated by the high voltage or where a fault has developed exposing the live conductor. The other earthed conductor may be a metal object on the ground or a person.

If the arc is connected to a person, which may happen for example when he/she gets too close to an overhead high voltage power line, the victim may be subject to both a flame burn from the arc and electric shock from the current which passes through the body. The burns are often worsened by clothing catching fire.

Even where the arc does not actually touch a person there is a danger of burns. Arcing generates ultraviolet radiation which can burn the skin and the retina of the eye (causing arc eye or eye flash). Additional burns may result from radiated heat, where the body absorbs the heat energy at a distance, resulting in burns located deep in the body.

Common Causes of Electrical Fires

Fires require three elements in order to start: a source of heat, combustible material such as fuel, and oxygen. Electricity may provide the source of heat in two main ways:

- **Arcing** – the generation of electrical sparks or arcs between an uninsulated or poorly insulated conductor and another earthed conductor. This may be on a very small scale – for example, within a plug – but so long as there is some combustible material to burn it may be sufficient to start a fire. Damage to the insulation enclosing a live wire, broken parts or incorrect wiring of a connection may be the cause.

- **Overheating of conductors** – This may be due to poor or inadequate insulation allowing the natural heat created by the flow of electricity to escape, to overloading the conductor with too high a current for the capacity of the wire, or to excessive resistance within the conductor (for example, passing a current through a flexible cable wound onto a drum, where the bends in the cable increase resistance).

If the temperature generated in either of these circumstances is sufficient to ignite any combustible material, either in contact with the source of the heat or nearby, fire may be started. There are special dangers where flammable vapours may be present in the atmosphere; for example, in a paint spray booth.

Fires of electrical origin can be very dangerous since it is not possible to use water to extinguish them; water is a good conductor of electricity and its use would create a live electrical hazard.

Portable Electrical Equipment

Nearly a quarter of all reportable electrical accidents involve portable equipment. Most of these accidents result in electric shock, with the next most common result being fires.

Many accidents are caused by faulty leads to appliances, although faults in the equipment itself are also a major cause.

The conditions and practices likely to lead to these problems are:

- Using equipment in inappropriate conditions – most particularly where cables are liable to be damaged in use and/or where there is water present. For example, using an electric powered pressure water cleaner outside, where the trailing cable may be damaged by vehicles and other equipment, and live wires exposed in a wet environment. In offices, the leads from floor cleaners or kettles are often exposed to damage where they trail across corridors.

- Using damaged equipment – either from a failure to carry out routine maintenance checks and repairs or continuing to use equipment after it has been damaged. This is a particular problem on construction sites where the harsh operating conditions mean there is a high probability of mechanical damage and often many people use the same piece of equipment with few if any checks. Damaged or missing insulation or insulation failure can easily expose people to the risk of electric shock.

- Having incorrect wiring and connections, usually as a result of poor maintenance and repairs.

- Servicing equipment without disconnecting supply.

Secondary Hazards

In addition to the risk of personal injury from shocks, burns and fire as a direct result of electrical problems, any failure in the electrical circuit will have an impact on all machines and other systems on that circuit. The interruption in the power supply, for however short a time, may cause inadvertent mechanical movement of plant or machinery which may pose a risk in itself. There is also the risk of a failure of electrical protection devices such as fire alarms and smoke detectors or machine guards.

Remember too that secondary hazards may arise from electric shocks if they cause a fall from a height or against dangerous objects.

REVISION QUESTION 1

(1)   What is the voltage of a circuit?

(2)   What determines the current in a circuit?

(3)   What is the difference between resistance and impedance?

(4)   What is a short circuit?

(5)   What does arcing do?

(6)   What is the main effect of electric shock on the body?

(7)   If a person receives a shock for one second which passes through the body along a path with an impedance of 10,000 ohms, what would be the current received and what effect might it have on the person if the voltage of the circuit touched was:

  (i)   240 volts

  (ii)   110 volts

  (iii) 50 volts?

(8)   What is the first step in treating a victim of electric shock?

(9)   What is arcing and what risks does it pose?

(10) Why are cable drum extension leads dangerous?

The suggested answers are given at the end of the unit.

CONTROL MEASURES

The golden rules for handling faulty electrical equipment are to ensure that it has been disconnected from the electricity supply and that it cannot be reconnected, whether accidentally or intentionally, and to check that the circuit is dead. Safe handling of electrical equipment in normal conditions depends on:

- Proper selection of suitable equipment

- The use of appropriate protective devices

- Effective inspection and maintenance routines, undertaken by competent people.

Selection and Suitability of Equipment

The selection of suitable work equipment for particular tasks and processes makes it possible to reduce or eliminate many risks to the health and safety of people in the workplace. This applies both to the normal use of the equipment as well as to other operations such as maintenance.

There are basically three points to the safety of work equipment:

- Its initial design and quality

- The purpose for which it will be used

- The place where it will be used.

Integrity and Use

When evaluating the suitability of the construction of electrical systems, several factors should be considered:

- The manufacturer's recommendations

- The likely load and fault conditions

- The probable use of the system(s)

- The need for suitable electrical protection devices, such as overload protection

- The environmental conditions which may affect the mechanical strength and protection required.

No electrical equipment should be put into use where its electrical strength and capability may be exceeded in such a way as may give rise to danger. In other words equipment should not be subject to electrical stresses with which it would be unable to cope. Equipment should be able to withstand normal, overload and fault currents. It should be used within the manufacturer's rating and in accordance with any instructions supplied with the equipment.

The conditions which a piece of equipment will withstand can be found from electrical specifications and tests undertaken by the manufacturer and accredited testing organisations, based on international and national standards.

Hazardous Environments

If it is reasonably foreseeable that electrical equipment may be exposed to adverse or hazardous environments, then it should be constructed and protected to prevent danger arising from the

exposure. The protection necessary will vary depending on the type of hazard and the degree of risk.

It is necessary to select the correct type of equipment for the environment after considering the present and future conditions the equipment is likely to be exposed to. Hazardous environments include the following:

- **Weather**

  Equipment and cables must be able to withstand exposure to weather (rain, snow, ice, wind and dust). There is a particular risk of corrosion of exposed parts. Precautions include containment of equipment in suitably weather-proofed enclosures. Additional protection may be necessary to protect equipment from lightning.

- **Natural hazards**

  These include solar radiation (sunlight) as well as animals and plants which may affect cables; for example, there may be a need to protect against gnawing of cables by rats. Siting is also very important here.

- **Extremes of temperature and pressure**

  The temperature of equipment may be raised by heat generated in the equipment itself or by an external source. It may also be caused by a build-up of debris and dust. Suitable protection includes containment of equipment in a suitably designed container to protect against extremes of temperature and pressure. Also, means of dispersing excess heat can be incorporated into the design of equipment; for example, fans built into motors. In the case of debris, accumulations should be removed or preferably prevented from occurring. Accumulations of waste should be removed or preferably prevented from occurring.

- **Dirty conditions**

  This includes contamination from both liquids or solids. Precautions include containment in a construction to resist the entry of dirt and dust. In less important cases, regular inspection and cleaning as part of a maintenance programme would be acceptable.

- **Corrosive conditions**

  Substances may be corrosive alone or in combination with moisture. Protection may have to be via total enclosure in corrosion resistant housing, that is not ventilated to the atmosphere.

- **Liquids and vapours**

  Electrical equipment must be protected against immersion, splashing or spraying with water and solvent vapours, as well as against condensation. Precautions include housing equipment in waterproof casing and enclosing in airtight containers.

- **Flammable substances**

  The presence of flammable materials, including flammable dusts and vapours, presents a danger in the use of electrical equipment. A dust cloud may pose an explosion hazard, while combustible dusts which settle on electrical equipment can create fire hazards. The selection, construction or installation of the equipment should be such as to guard against the possibility of ignition. If equipment is used in potentially explosive atmospheres, it should be constructed so that it is not liable to cause ignition of the atmosphere.

Mechanical Damage

The susceptibility of the equipment to mechanical damage must be assessed, both in terms of the environment within which it is to be used and the natural operation of the equipment itself. Damage may arise from impact, stress, wear and tear, vibration, hydraulic and pneumatic pressure.

Abrasion may be caused by mechanical movement or the movement of people and can cause extensive damage to equipment, particularly portable equipment and flexible cables. In the case of cables, protection against abrasion includes enclosing them within a protective cover such as flexible armouring, protective braiding or superior forms of sheathing, burying them below ground or placing them at a height.

Movement at the point of entry of a flexible cable into a rigid joint, such as a plug or cable connector, causes much damage. Where it is impossible to avoid rigid connections to flexible cables, a pliable supporting sleeve should be used. Cable joints are also subject to stress and individual wires from which the conductors are made can be pulled loose from their terminals and make accidental contact. Cable clamps within the connectors which take the stress should be used. An additional precaution is the correct use of cord grips located in plugs and connectors which also have moulded-in plastic channels or barriers which can prevent accidental contact.

Protective Systems

Protective devices incorporated into electrical circuits or the equipment itself act to cut off the electricity supply in the event of a fault and/or to reduce the current delivered to a person in the form of an electric shock.

Fuses and Circuit Breakers

Both these devices act to break a circuit in the event of an overload of power:

- A **fuse** forms a weak link in a circuit by overheating and melting by design if the current exceeds the safe limit

- A **circuit breaker** is a mechanical device in the form of a switch which automatically opens if the circuit is overloaded.

Both protective devices should be chosen so that their rating is above the operating current required by the equipment, but less than the current rating of the cable in the circuit. They should be fitted to the conductor as close as possible to the live terminal.

Primarily designed to protect the equipment/circuit/system, these features may also offer secondary protection to a person.

Earthing

By earthing the exposed metal parts which should not normally carry a current, any fault current is provided with a low impedance path to earth should it become live. If all exposed metalwork is properly bonded to earth, it cannot be made live by a fault and the risk of shock is eliminated. The design and quality of the earth conductor is vital because if it fails, the protection is removed.

Earthing measures should be connected so that the fault current will operate protective devices (fuses, residual current devices) and cut off the supply by breaking the circuit.

In certain cases, such as wet environments, additional protection is necessary due to the hazard posed by the close proximity of water, electricity and metal objects; for example, in a central heating system driven by an electric pump. All external metalwork should be connected by a common bonding conductor which ensures that all the metalwork is at the same potential. This measure is called **equipotential bonding**. A current will not flow between two points at the same potential, so if any of the metal fittings become live, any of the other metal fittings may be touched simultaneously without the risk of electric shock. A common connection to earth is usually made.

Isolation

There is a difference between isolation and switching off:

- **Switching off** refers to depriving the equipment of electric power whilst still leaving it connected

- **Isolation** refers to physically separating it from any source of electric power, with the additional step being taken of ensuring that it cannot be accidentally re-energised.

Isolation should establish an effective barrier between the equipment and the supply and ensure that no unauthorised person is able to remove the barrier. In particular, it should:

- Establish an air gap between the contacts in the switch or some other barrier which would prevent the flow of current under all conditions of use

- Include a device such as a padlock or lock which will prevent the removal of the barrier by unauthorised persons

- Be accessible, easy to operate and clearly labelled.

Reduced/Low Voltage Systems

Where environmental conditions are harsh, as on construction sites or in areas which are wet, and there is a high risk of electric shocks, the use of reduced or low voltages is advisable to reduce the effect of any shock.

For hand-held portable tools and the smaller transportable units, the 110 volt centre-tapped (CTE) system is recommended, using a transformer to reduce the voltage from the public supply. The system relies on the mid-point of the transformer to be earthed (centre-tapped). The maximum shock voltage to earth is then half the supply voltage, that is 55 volts in the event of direct contact. As most shocks occur between a live part and earth this is a major step in the reduction of the shock effect. The full 110 volt supply is available to power the equipment.

Lower voltage systems which are called "safety extra low voltage" or SELV are those in which the voltage does not exceed 50 volts ac between conductors in a circuit which is isolated from the supply mains and from earth by means of a safety isolating transformer. These systems represent even less of a hazard and should be used in other environments such as vehicle washing areas and in the vicinity of swimming pools. They are also recommended for hand lamps, soldering irons and other small hand tools where the risk of shock is high.

Residual Current Devices

Sensitive earth leakage protective devices provide another means of circuit interruption in the event of an earth fault and are also intended to provide protection from indirect shock.

Residual current devices (RCDs) or sensitive current-operated earth leakage circuit breakers (ELCBs) detect when a current flows to earth by comparing the currents flowing in the live and

neutral conductors. They are sensitive enough to detect a leakage current too small to operate a fuse, but which may nevertheless be large enough to deliver an electric shock or to start a fire. In that event they interrupt the supply by means of automatic circuit breakers. The sensitivity of the device to the level of leakage can be adjusted so that any shocks experienced are not lethal.

Every RCD has a test button which should be checked regularly to ensure correct operation.

It is important to note that ELCBs only operate when a fault to earth occurs. They do not provide overload protection. They reduce the effects of a shock, not the chances of getting a shock.

Double Insulation

If equipment has a metal enclosure, precautions must be taken to prevent the metalwork from becoming live. This can be achieved by "double-insulation" in which the live parts of the equipment are covered by two layers of insulating material.

Each layer is capable of insulating the live parts alone, but together they ensure that the occurrence of insulation failure and its associated danger is extremely improbable. This method is also suitable for portable equipment which often suffers particularly rough use, but regular maintenance is essential as the insulation only remains effective while it is intact. In addition to maintenance, the insulation must be soundly constructed and the equipment properly used. It reduces the chances of getting a shock.

The principle of double insulation also applies to the use of insulating mats for operators to stand on and use of insulated tools and personal protective equipment, such as rubber footwear, heat resistant face shields, clothing and insulating gloves.

Inspections and Maintenance Strategies

Proper maintenance is at the heart of ensuring the safety of electrical equipment. It is a general term which in practice includes visual inspection, testing, repair and replacement, as both part of the routine of using the equipment and as a specific activity in its own right.

There should be an appropriate system for this which is designed to ensure all aspects of maintenance are carried out. The basic requirements are:

- Identification of the equipment which has to be maintained and where/how it is to be used

- Discouragement of "unauthorised" equipment in the workplace

- Carrying out simple user checks for signs of damage – for example, casing, plug pins and cable sheath

- Formal visual inspections carried out routinely by a competent person

- Periodic testing of equipment by a competent person

- Systems for the reporting and replacement of defective equipment

- Recording of all maintenance and test results along with the inventory of equipment in use.

User Checks

The person utilising the electrical equipment should be encouraged to look at it critically and, after a minimum basic training, check visually for signs that the equipment is not in sound condition; for example:

- Damage to the cable sheath (apart from light scuffing)

- Damage to the plug – for example, the casing is cracked or the pins are bent

- Inadequate joints, including taped joints in the cable

- The outer sheath of the cable is not effectively secured where it enters the plug or the equipment – obvious evidence would be if the coloured insulation of the internal cable cores were showing

- The equipment has been subjected to conditions for which it is not suitable – for example, it is wet or excessively contaminated

- Damage to the external casing of the equipment or there are some loose parts or screws.

These checks also apply to extension leads and associated plugs and sockets. Checks should be undertaken by the user before and during use.

Any faults should be reported to management and the equipment taken out of use immediately. Management should take effective steps to ensure that the equipment is not used again until repaired by a person competent to carry out the task; the defective equipment could be labelled as "faulty" and its associated plug removed.

Formal Inspection and Tests

It is common practice to have formal inspections of electrical equipment and installations. There are two types of formal inspection:

- Routine visual inspections, carried out by a competent person to control immediate risks and monitor the user checks. These will be visual checks similar to those discussed above, but undertaken in a more formal and systematic manner.

- Periodic detailed inspections, including testing the equipment, again carried out by a competent person. Such inspections and tests may also be required in particular situations where there is reason to think that the equipment may have a fault.

Any equipment found to be faulty should be taken out of service and not used again until properly repaired.

In common with all tasks, the inspection and maintenance of electrical appliances and systems should be carried out by a "competent person", who is

> '... a person possessing such knowledge or experience, or who is under such degree of supervision as may be appropriate having regard to the nature of the work'.

Because of the extreme danger of coming into contact with live electrical conductors, any person involved with the maintenance, repair and inspection of electrical equipment must be familiar with the requirements of the particular task undertaken, or be supervised by somebody who is. Therefore, the person should, as part of their competency, have either carried out these tasks before or been specifically trained in them.

The competent person can normally be a member of staff who has sufficient information and knowledge, following appropriate training on what to look for and what is acceptable, and who has been given the task of carrying out the inspection. To avoid danger, competent persons should know when the limit of their knowledge and experience has been reached (this is one of the definitions of a competent person).

Combined inspection and testing should be carried out by someone with a higher level of competence than that required for visual inspection alone, because the results of the tests may

call for interpretation and appropriate electrical knowledge will be essential. However, the same worker can often carry out both types of inspection.

Visual inspections

Regular visual inspections are generally the most important part of a maintenance regime and most potentially dangerous faults can be detected in this way.

Simple written guidance relating to the visual inspection can be produced, summarising what to look for, procedures to follow when faults are found and when unauthorised equipment is found in use. It can help whoever is carrying out the formal visual inspection and also users.

The formal visual inspection should not include taking the equipment apart. This should be confined, where necessary, to the combined inspection and testing discussed below. However, additional checks could include removing the plug cover and checking that a fuse is being used (for example, it is a fuse, not a piece of wire, a nail, etc.), the cord grip is effective, the cable terminations are secure and correct, including an earth where appropriate, and there is no sign of internal damage, overheating or presence of liquid or foreign matter. Checks may also be made to ensure that there is no evidence of overheating (burn marks or staining) and that the correct rating for the fuse and the correct cable rating is being used (to prevent overloading).

The inspections should be carried out at regular intervals. The period between inspections can vary considerably depending on the type of equipment, the conditions of use and the environment. For example, equipment used on a construction site or in a heavy steel fabrication workshop will need much more frequent inspection than such equipment as floor cleaners in an office. In all cases, however, the period between inspections should be reviewed in the light of experience.

Combined inspection and tests

The checks and inspections outlined above will, if carried out properly, reveal most (but not all) potentially dangerous faults. However, some deterioration of the cable, its terminals and the equipment itself can be expected after significant use; for example, a broken earth wire within a flexible cable, deterioration of insulation quality or contamination of internal and external surfaces. Additionally, equipment may be misused or abused to an extent which may give rise to danger.

Inspection and testing are the only reliable ways of detecting such faults and should be carried out on a regular basis to back up the inspection regime. The regularity will depend on the type of equipment, the manner and frequency of use and the environment. In addition, other occasions when testing is likely to be justified are:

- Whenever there is reason to suppose the equipment may be defective, but this cannot be confirmed by visual inspection alone

- After any repair, modification or similar work.

Testing is often carried out at two levels, demanding different levels of competence from the person carrying out the task:

- Simple "pass/fail" types of test where no interpretation of readings is necessary. Providing the appropriate test procedures are rigorously followed and acceptance criteria are clearly defined, the routine can be straightforward.

- The use of more advanced test instruments which give readings that require interpretation. This requires technical knowledge or experience and specific electrical skills.

The inspection carried out in conjunction with the testing should usually include checks for:

- Correct fusing

- Effective termination of cables and cores

- Suitability of the equipment for its environment.

Frequency of Inspection and Testing

If there are no specific legal requirements in your country, deciding on the frequency of maintenance is a matter of judgement for those responsible for the equipment and should be based on an assessment of risk factors, which include:

- Type of equipment and whether or not it is hand-held

- Manufacturer's recommendations

- Initial integrity and soundness of the equipment

- Age of the equipment

- Working environment in which the equipment is used (such as whether it is wet or dusty) or the likelihood of mechanical damage

- Frequency of use and the duty cycle of the equipment

- Foreseeable abuse of the equipment

- Effects of any modifications or repairs to the equipment

- Analysis of previous records of maintenance, including both formal inspection and combined inspection and testing.

Records of Inspection and Testing

It is useful to record maintenance, including test results. A suitable log is a management tool for monitoring and reviewing the effectiveness of the maintenance scheme and indeed to demonstrate that a scheme exists. It can also be used as an inventory of portable electrical equipment and a check on the use of unauthorised equipment (for example, domestic kettles or electric heaters brought to work by workers).

The log can include faults found during inspection and may give an indication of the types of equipment or environment which are subject to a higher than average level of wear or damage. This will help monitor whether suitable equipment has been selected. Entries in a test log can also highlight any adverse trends in test readings which may affect the safety of the equipment, thus enabling remedial action to be taken. Care should be taken in interpreting trends where a subsequent test may be carried out with a different instrument from that used for an earlier test, since differences in the results may be due to differences in the test instruments rather than indicating deterioration in the equipment being tested.

Records do not necessarily have to be on a paper system since test instruments are available which store the data electronically for downloading directly onto a computer database.

It is useful to label equipment to indicate that it has been tested satisfactorily and has been passed as safe, and when the date for the next test is due. Otherwise individual items may be missed on following checks.

Portable Appliance Testing

It is important that portable electrical appliances are maintained in exactly the same way as fixed equipment. By their very nature, electric drills, saws, trimmers, etc. are out in use much of the time and there must be an effective system for keeping track of each item to ensure that the maintenance schedule is followed and use can be monitored.

All pieces of equipment should be identified by a serial number and recorded in a register which specifies when each item should be recalled for inspection. A nominated person should be appointed to ensure that recall and inspection do take place.

As mentioned earlier for fixed equipment, the frequency of inspection will depend on the risk assessment. It should be determined by the type of equipment and its use, the manufacturer's recommendations and the experience of the user. The equipment should either be marked to indicate to the user when the inspection is due or should be clearly indicated on the checking-out sheet used to obtain an appliance from store.

The inspection and any subsequent tests and repairs should be carried out by a competent person experienced in this type of work. A record of inspection should be made and kept for the life of the equipment. Inspection and testing should cover the same points as described above in general, although particular attention should be paid to leads and plugs which are more vulnerable on portable equipment.

REVISION QUESTION 2

(1) What five factors should be used to assess the suitability of the construction of an electrical system?

(2) What protection is offered by the cord grip in a plug?

(3) What is the difference between a fuse and a circuit breaker?

(4) What is the purpose of a fan in an item of electrical equipment?

(5) What is equipotential bonding?

(6) What is the difference between switching off and isolation?

(7) What protection is offered by a reduced voltage transformer in a circuit?

(8) State the main features of a proper system of maintenance.

(9) What checks should be carried out before an item of electrical equipment is used?

(10) What is the safest method of powering electric hand tools which are being used outdoors?

The suggested answers are given at the end of the unit.

UNIT SUMMARY

The basis of an electrical system is a circuit in which a conductor links two terminals, one providing the electricity supply (the live terminal) which then flows along the conductor to the other (neutral) terminal. The force which makes electricity flow is the difference in electrical potential between the terminals and is measured in volts. The current which flows is measured in amperes (or amps). Resistance, measured in ohms, is provided by components connected to the circuit which transform the electricity into other forms of energy, and the impedance offered by the conductor itself.

The relationship between voltage, current and resistance is expressed by Ohms Law and this can be used to calculate the value of any one of the three elements where the other two are known.

Short circuits are formed by another conductor connecting to the circuit and providing an alternative path along which the current can flow, usually to earth. The conductor carrying the short circuit may be an object or a person.

The main hazards of electricity are electric shock, electric burns and fire. There may be secondary hazards caused by the effects of electric shock (such as falls) or by an interruption of the power supply to machinery or protection devices/systems.

Electric shock causes a convulsive response by the nervous system, resulting in the muscles contracting, often violently. The severity of the effect is determined by the amount and nature of the current, the duration of the contact with the live conductor and the path the current takes through the body. Most shocks are potentially fatal where they affect the heart or respiratory organs.

Electrical burns may be the direct result of contact with a live conductor (in which case they may be both external and internal) or be the result of arcing.

Arcing is also a significant cause of electrical fires. The other main electrical cause of fire is overheating of a conductor, either through overloading or excessive resistances.

Control measures to reduce the risk from electrical hazards are based on the proper selection of suitable equipment for the task in the particular operating conditions, the incorporation of specific protective devices and the adoption of systematic maintenance procedures.

Protective devices act mainly to cut off the supply in the event of a fault, or to reduce the current and the effect of any electric shock received. The main measures are:

- Fuses and circuit breakers

- Earthing

- Isolation

- Reduced/low-voltage systems

- Residual current devices

- Double insulation.

Maintenance strategies are based on regular user checks, routine visual inspections and periodic detailed inspection and testing of all items of equipment. Records should be kept of all formal visual inspections and tests.

Portable electrical equipment presents particular hazards, especially in relation to cables connecting to the mains supply and its use in adverse conditions, such as wet environments or where it may be subject to mechanical damage. It is very important to follow strict maintenance strategies to ensure their continued safety.

SUGGESTED ANSWERS TO REVISION QUESTIONS

Revision Question 1

(1) Voltage is the measure of difference in electrical potential between the two terminals of a circuit.

(2) The current in a circuit is determined by the voltage.

(3) In principle, there is no difference as both terms relate to the slowing of the flow of electricity through a circuit. Generally, resistance relates to the components connected to a circuit whereas impedance relates to resistance within the conductor itself.

(4) A short circuit is formed where another conductor touches the circuit and provides the electricity with an alternative path to a terminal with a larger potential difference than the neutral terminal, usually the earth.

(5) Earthing provides a safe path for any faulty current to be dispersed to earth through a designated conductor.

(6) An electric shock results in a convulsive response by the nervous system to the passage of electricity through that part of the body, causing the muscles to contract, often violently.

(7) Using the equation for calculating current from Ohms Law and expressing the result in milliamps:

    (i) $I = \dfrac{V}{R} = \dfrac{240}{10,000} = 24$ mA.   This will cause strong muscle contraction and possibly some breathing difficulties.

    (ii) $I = \dfrac{V}{R} = \dfrac{110}{10,000} = 11$ mA.   This will be painful and there will be some muscle contraction.

    (iii) $I = \dfrac{V}{R} = \dfrac{50}{10,000} = 5$ mA.   This will be barely perceptible, perhaps some mild tingling will be felt.

(8) The first action should be to break any continuing contact between the victim and the current.

(9) Arcing is the electrical bridging through air of one conductor with a very high potential to another nearby earthed conductor. If the arc is connected to a person, the victim may be subject to both a flame burn from the arc and electric shock from the current which passes through the body. There is also a danger of burns from ultraviolet radiation and radiated heat, even where the arc does not actually touch a person. Arcing can also provide a source of ignition for fire.

(10) The bends in the cable increase resistance and may cause overheating of the conductor.

Revision Question 2

(1) The factors to be considered when evaluating the suitability of the construction of electrical systems are:

    – The manufacturer's recommendations

    – The likely load and fault conditions

    – The probable use of the system(s)

- The need for suitable electrical protection devices, such as overload protection

- The environmental conditions which may affect the mechanical strength and protection required.

(2) A cord grip restricts movement at the point of entry of the flexible cable into the plug, thus preventing abrasion of the cable. It also prevents the conductors being pulled loose from their terminals.

(3) A fuse forms a weak link in a circuit by overheating and melting by design if the current exceeds the safe limit. A circuit breaker is a mechanical device in the form of a switch which automatically opens if the circuit is overloaded.

(4) A fan is designed to disperse excess heat generated by the normal operation of the equipment. It is not designed to prevent overheating from electrical faults.

(5) Equipotential bonding is the process of connecting all external metalwork in the system to a common bonding conductor, thus ensuring that all the metalwork is at the same potential and, if any of the metal fittings become live, current will not flow through the system.

(6) Switching off refers to depriving the equipment of electric power, but still leaving it connected. Isolation refers to physically separating it from any source of electric power, with the additional step being taken of ensuring that it cannot be inadvertently re-energised.

(7) Reduced voltage circuits reduce the effect of any shock received from making contact with part of the circuit.

(8) The main elements of a proper system of maintenance are:

- Identification of the equipment which has to be maintained and where/how it is to be used

- Discouragement of "unauthorised" equipment in the workplace

- Carrying out simple user checks for signs of damage; for example, casing, plug pins and cable sheath

- Formal visual inspections carried out routinely by a competent person

- Periodic testing of equipment by a competent person

- Systems for the reporting and replacement of defective equipment

- Recording of all maintenance and test results along with the inventory of equipment in use.

(9) The person utilising the electrical equipment should visually check for signs that the equipment is not in sound condition; for example:

- Damage to the cable sheathes, joints or plugs

- The equipment has been subjected to conditions for which it is not suitable; for example, it is wet or excessively contaminated

- Damage to the external casing of the equipment or there are loose parts or screws.

(10) If they cannot be powered by battery, the electrical power should be delivered through a reduced voltage circuit and/or protected by a residual current circuit breaker.

NEBOSH International General Certificate

Unit 11 | Fire Hazards and Control

INTRODUCTION

In this unit we will look at the basic principles of fire, the risks it presents in the workplace and the main measures that should be taken to minimise those risks. We shall consider measures for the prevention and control of fire, and for the safe evacuation of premises.

The unit is designed to meet the following aims and learning outcomes as specified by NEBOSH for this part of the syllabus for the International General Certificate.

Overall Aims

On completion of this unit, you should understand:

- Basic fire hazards and consequential risks in the workplace

- The main measures that should be taken to minimise fire risks.

Specific Intended Learning Outcomes

When you have worked through this unit, you will be able to:

- Identify basic fire hazards in a workplace

- Evaluate the main fire risks in a workplace

- Advise on basic fire prevention and prevention of fire spread in buildings

- Identify the appropriate fire alarm system and fire-fighting equipment for a simple workplace

- Assess the adequacy and maintenance of existing means of escape in a simple workplace

- Implement a successful evacuation of a workplace in the event of a fire.

BASIC PRINCIPLES OF FIRE

Fire is a rapid chemical process in which oxygen combines with another substance in the presence of a source of heat energy. The reaction of these elements is called *combustion*, and during the reaction, heat, light and flames are given off.

The Fire Triangle

Before a fire can start, three components have to be present in sufficient quantities. These form a structure known as the *fire triangle*. If one of these elements is removed, the fire will go out.

The Fire Triangle

Heat

Heat acts as the source of ignition and anything that gives off heat can start a fire. (Note that the source of ignition is not necessarily a flame, a spark or fire itself, but the heat they give off.)

It is important to be aware that the source of heat can not only be equipment and activities which, by design, involve the production of heat, but may also include a variety of other circumstances with which heat may not be expected at all. We could list a whole range of equipment which generate heat when in proper use; for example, welding torches, blow-lamps, soldering irons, space heaters, hot plates, ovens, electric fires, light bulbs and electric irons. We could also include the use of matches and smoking. However, heat may also be produced as a by-product of other events, intended or not. As an example, grinding wheels can produce sparks, electrical equipment may be overloaded and then overheat, and static electricity or an electrical short-circuit can cause sparking. Heat is also generated by friction, as when two pieces of metal rub together without lubrication.

Fuel

The fuel for a fire does not have to be a recognised fuel in the sense of petrol or gas. It may be any combustible material.

Most substances are combustible under the right circumstances although those circumstances vary for different materials, usually the temperature at which combustion takes place. Carbon or hydrocarbon based materials will burn readily at the sort of temperatures often generated in a workplace or domestic environment. They include solids such as paper and wood, and gases

such as petrol vapour, natural (town) gas or propane (bottled gas). However, other materials may also combust at relatively low temperatures.

The type of fuel is also important because different substances behave in different ways when they burn; for example, the amount of flames or smoke they give off may depend upon the circumstances (temperature and air conditions) and because the means of extinguishing the fire may vary.

We shall consider the types of fuel in a little more detail later when looking at the way in which fires are normally classified.

Oxygen

The oxygen essential for combustion is usually supplied from the surrounding air. However, the naturally present oxygen may be enhanced by the presence of other sources of oxygen such as compressed air, the pure oxygen in gas cylinders used for welding, or by the combustion of peroxides, nitrates, and similar chemicals. (These chemicals give off oxygen as they burn, further aiding their own combustion. They are sometimes known as oxidising agents.)

Note that as the oxygen in an enclosed space is used up by the fire, so the fire will go out.

CLASSIFICATION OF FIRES

Fires are classified into five categories according to the fuel type. The classification also serves as a basis for identifying the means of extinguishing different types of fire:

- **Class A**

  These are fires involving solid materials, normally of an organic nature, such as paper, wood, coal and natural fibres. These fires usually produce burning embers.

- **Class B**

  These are fires involving flammable liquids or liquefied solids, such as petrol, oil, grease, fats and paint.

- **Class C**

  These are fires involving gases or liquefied gases, such as methane, propane, and mains gas.

- **Class D**

  These are fires where the fuel is a metal such as aluminium, sodium, potassium or magnesium.

- **Class F**

  These are fires fuelled by cooking fats, as in the case of deep fat frying.

BASIC PRINCIPLES OF HEAT TRANSMISSION AND FIRE SPREAD

Once a fire has started there are four methods by which it can spread; convection, conduction, radiation and direct burning.

Convection

Convection is the process whereby heat moves through a gas or liquid. When a gas or liquid, such as air or water, is heated it expands and becomes less dense. As a result it rises and cooler air or water is drawn in to replace it, creating a current.

Convection currents created in the air by fire are a major means of fire spread. They may carry burning materials through the air and into contact with other combustible materials and also, depending upon the intensity of the fire and the heat generated, create strong localised winds which may fan the flames and cause flare ups.
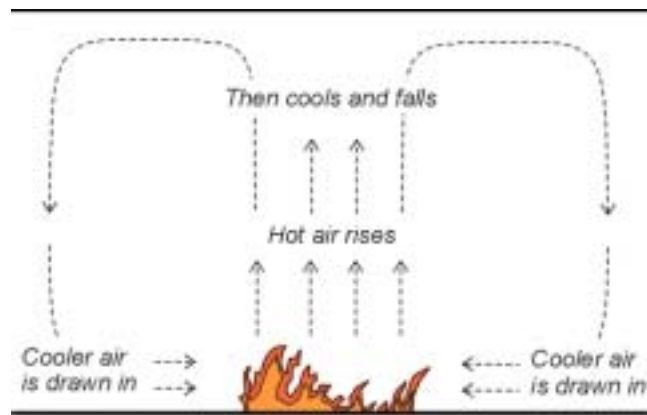
Convection Currents

Conduction

Heat may be transmitted through certain materials, known as conductors, without those materials themselves actually burning. This is particularly the case with metals. Thus, the heat generated by a fire (or any other process producing heat) may be transferred to a separate location where it can act as a source of ignition.

This has important implications for many steel frame buildings which feature widespread use of metal within the structure of the building (for example, steel girders) and the services which run through it, such as pipes and various types of ducting.

Conduction
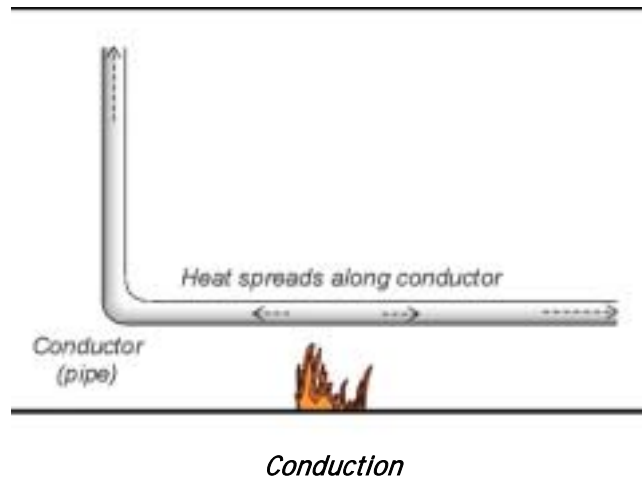
Radiation

Radiation is the general term for the process by which energy is lost from a source without direct contact. Heat radiation refers to the process whereby the heat given off by hot objects passes through air and through certain types of transparent material such as glass. This radiant heat can in itself be sufficient to act as a source of ignition.

For example, radiators are an obvious source of heat and clothes which are left to dry too close to them may catch fire. Similarly, light bulbs give out heat (and in the case of certain types of spot lights, a large amount of heat) and any fabrics or flammable materials which are too close may start to burn.

The intensity of radiant heat diminishes with the distance from its source. However, depending on the temperature of the source, heat transfer may take place over quite large distances. For example, a fire burning on one side of a street may be sufficient to cause materials on the other side of the street to ignite.

Direct Burning

This occurs where heat is transferred directly by contact from one substance to another. Thus, if a piece of paper catches alight then the heat (in the form of flames) can spread to the next piece of paper and then to the next until a whole area is on fire. Similarly, oil based paint on walls can spread fire, as can a pool or trail of flammable liquid.

Note too that direct burning can take place across a gap where the wind conditions allow for flames to be fanned and thereby come into contact with other separate combustible materials. This fanning may be the result of simply opening a window or door, allowing more air into an enclosed space. Note too that localised winds are created by convection.

CAUSES AND CONSEQUENCES OF FIRES

Workplace fires start when the heat generated by a deliberate work process, or by accident, acts as a source of ignition on a combustible material. All such fires are preventable by appropriate safety precautions, as we discuss elsewhere. There is also an increasing incidence of arson which may account for a large proportion of all fires.

Once a fire has started it can spread quickly by means of all four methods of heat transfer. The most usual methods are through direct burning of the materials contained within the building and by convection. Hot gases and smoke can rise up staircases, lift shafts, vertical ducts and floor openings, and can be spread by convection currents under ceilings and other horizontal surfaces, through roof spaces, gaps between floors and false ceilings. Flying brands (particles of burning material) which are carried by the currents may ignite further combustible materials. As more materials are ignited and the heat intensifies, the volume of these gases and smoke grows and the speed of the convection currents increases, aiding the spread of the fire. Heat may also be spread by conduction through structural support materials (particularly steel girders), pipes and air conditioning ducts, and by both radiation and conduction through doors and other apparent barriers, allowing fire to move from one room to another.

Losses due to fire have an enormous cost (both financial and human) to industry and the community and yet most fires are preventable. Disruption to business in the form of loss of production, loss of plant and, sometimes, injury and loss of life can often be crippling. Even a minor fire involves disruption and a reduction in output which benefits no one (except the insurance company requesting higher premiums). Over 70% of businesses which have suffered a major fire either do not re-open or fail within three years of the loss.

REVISION QUESTION 1

(1) What is likely to happen if you open a window to release the dense smoke in a room created by a fire?

(2) Explain briefly how each of the following might start a fire.

   (i) Static electricity

   (ii) Friction

   (iii) Space heater

(3) Identify the process of heat transmission/fire spread shown in the following photographs.

   (i)
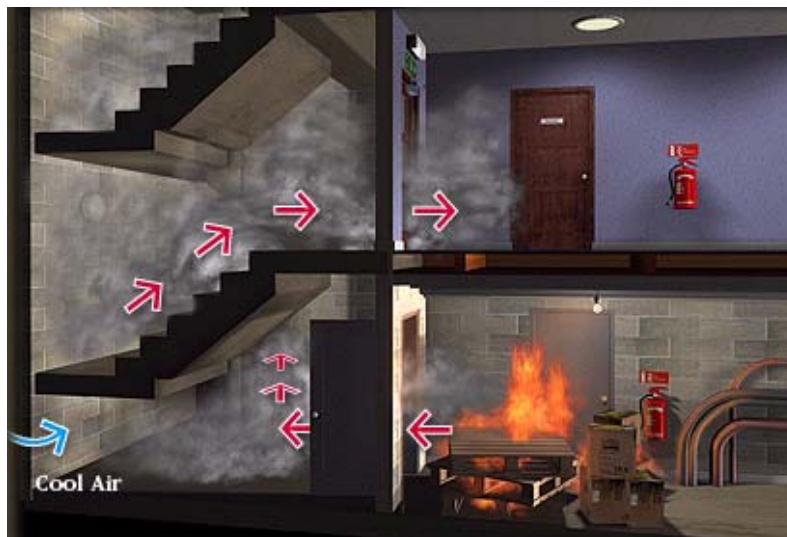
Source: Safe Practice "Fire Safety"

   (ii)

Source: Safe Practice "Fire Safety"

(iii)

Source: Safe Practice "Fire Safety"

(4) What additional method of heat transfer/fire spread is not illustrated by the photographs above?

(5) Identify the fire classification of each of the following types of fire.

    (i) Butane gas cylinders burning in the storage area of a garden centre.

    (ii) Fire in the paint shop of a car manufacturer.

    (iii) Fire in an office.

The suggested answers are given at the end of the unit.

FIRE RISK ASSESSMENT

Prevention and control of fire spread is a high priority issue. This is nearly always reflected in legislation designed to cope specifically with this threat. Different countries tackle this in different ways (for example through fire department inspections and more recently the use of specific risk assessment for fire). Primary responsibility for workplace fire safety is placed on employers and those in control of workplaces. They must provide the measures necessary to prevent or control the risks from fire and, in particular, must ensure the following points:

- That the workplace is equipped with appropriate fire-fighting equipment, fire detectors and alarms and that any non-automatic fire-fighting equipment is easily accessible, simple to use and indicated by signs.

- That appropriate measures are taken for fire-fighting, the nomination and training of workers to implement those measures, and the arranging of contacts with external emergency services.

- That emergency routes are kept clear and comply with any rules or regulations relating to routes, doors and signs.

- That there is a suitable system of maintenance for fire precautions in relation to workplace procedures in general and to specific equipment and devices, which must be kept in good working order and repair.

These requirements may be enforced by local fire authority inspectors. The following basic points must be addressed to fully assess the adequacy of any site fire precautions. Here we take a risk assessment based approach. These will be supplemented with any fire specific legislation in your own country.

Site Plan

A site plan is useful for identifying all principal sources of ignition; they should be clearly marked on the plan. The plan should show all electrical appliances, heating plant, site of hazardous processes, location of the electric mains switches and the main gas control valves. It should also show waste disposal areas and the location of fire extinguishers.

In premises where much of the work is carried out within a single area, it may be adequate to carry out the assessment of a building as a single unit. However, in most cases it will be necessary to subdivide the building into discrete areas or rooms. It is particularly important not to lose sight of the effects that adjacent work or storage areas, or some normally inaccessible areas, may have on the rest of the building; for example, roof voids, boiler rooms or fuel storage.

Identification of Hazards and Assessment of the Level of Risk Each Presents

In all cases the assessment should consider how the risk may be minimised. This should take the form of a review of:

- General working policies – for example, no smoking

- Specific working practices – for example, the removal of waste on a more frequent basis, reducing the use of flammable substances where alternatives are available, or using fixed electrical installations (as opposed to portable appliances)

- The physical condition of the premises – for example, the sealing of any gaps around the pipe work running between rooms.

Identification of the Fire Control and Evacuation Measures

Although the main effort must be to reduce the likelihood of fire arising, consideration must be given to how a fire should be dealt with if the precautions are ineffective. This should cover the following points:

- Warning systems – alarms and detectors

- Fire-fighting equipment

- Evacuation procedures and escape routes, including signs and emergency lighting

- Testing, maintenance and inspection procedures, including fire drills.

FIRE CONTROL MEASURES

Fire can start only when a source of ignition comes into contact with some combustible material. Fire prevention is based on two principles:

- Controlling potential sources of ignition

- Controlling combustible materials.

If fire does break out it is important to prevent or minimise its spread.

The measures that may be taken in the workplace to prevent the outbreak of fire and control its spread overlap to some extent. They involve specific systems of work, general working practices (which we discuss here) and the structural design of buildings and the use of particular materials within buildings which is considered elsewhere.

Central to these measures is the need to recognise the dangers of fire and to adopt safe working practices. Fire safety is therefore the responsibility of everyone in the workplace.

Use and Storage of Flammable and Combustible Materials

All materials which present a risk of fire or explosion must be stored, transported and used correctly. This applies to solids (such as magnesium), liquids (such as petroleum and its derivatives, paints, solvents, etc.) and gases (such as hydrogen, liquefied petroleum gas (LPG), oxygen).

In use and when being handled in any way, flammable and combustible materials must be treated with great caution. Staff must be aware of the potential dangers for each type of material and the conditions under which they may ignite, and should be trained in the correct procedures to be applied. The containers used for flammable materials should be marked.

Storage areas for flammable and combustible materials should be:

- Detached, secure, single-storey, ventilated buildings of non-combustible constructions, used for no other purpose

- Separate from other parts of the premises

- Accessible to fire fighters

- Large enough to allow clear spaces to be maintained around stacks of materials

- Large enough so that sprinkler systems are not obstructed by stacking up the stored materials too high; there should be a space of at least 0.6 metre below sprinkler heads.

Control of Ignition Sources

Most fires in the workplace are caused by a lack of control over sources of ignition. These are always preventable by carefully designed working systems and practices.

Perhaps the most important practice to have been adopted in recent years has been that of "no smoking" policies. They have been in place for many years in areas where there is a particular fire risk; for example, with flammable materials, but they have now been extended to many other work and public areas. Where smoking is permitted, sufficient metal ashtrays should be provided. Discarded cigarettes or matches have been responsible for very many fires, resulting in considerable loss of life, injury and financial loss.

Systems of Work

Safe systems of work should be specific to the type of work and the equipment used.

Working with Hot Processes or Implements

Most workplaces employ some processes and equipment which by their very nature produce sufficient heat to act as a source of ignition in the right circumstances. However, good working practices can minimise the risk of fire. Examples include:

- All appliances and processes which produce heat or fire should be located or carried out a safe distance away from paper, wood and other combustible materials.

- Nothing should be placed or stored on heaters. Portable space heaters should be guarded and placed or fixed to prevent them being knocked over.

- Appliances such as soldering irons or pressing irons should be provided with stands to prevent them contacting work surfaces and surrounding materials when not in use. They should be switched off when not in use.

- Hot surfaces, such as boilers and associated pipe work, should be lagged to prevent radiant heat becoming a hazard.

- There should be fire watches during and after hot work.

Machinery

Poorly maintained machines may overheat or cause sparking and a planned maintenance programme is necessary in order to minimise creating a fire risk.

There should be regular inspections of all machinery and equipment, with checks on the proper lubrication of bearings and correct tensioning of drive belts to prevent friction and overheating.

Electrical Equipment and Systems

Inadequate safeguarding of electrical equipment and systems, along with inefficient maintenance, presents a considerable fire risk. Electrical faults (faulty earths, loose connections, short circuits) are the cause of many industrial fires.

All electrical equipment and systems should therefore be inspected and maintained on a regular schedule. This should include circuits being tested regularly to ensure that there are no faulty components or cables, especially in the roof of a building, and that plugs are not loose, sockets not worn or damaged, and cables not frayed or rubbing on the edges of benches.

Electrical equipment should always be switched off and unplugged when not in use as it can overheat. It is easy to lay a soldering iron down on the bench and then have it set material alight.

Good Housekeeping

The control of highly combustible materials and sources of ignition must be coupled with high standards of housekeeping to ensure that combustible materials in any form, but particularly waste, do not present a fire risk. This applies to all areas of work since waste materials can accumulate in any circumstances and a build up of dust and dirt can easily provide the fuel for fire in the right circumstances.

The accumulation of process waste, contaminated rags, packing materials and other paper products, and general refuse and dust must be prevented. Oily, flammable and combustible rags are a particular problem in many workplaces as they are easily ignited and may even ignite spontaneously; they should be placed in metal containers with fitting lids.

Routine housekeeping should ensure that:

- Waste bins are emptied regularly so that there is no accumulation of combustible materials

- Cupboards, lift-shafts, spaces beneath conveyors, stairs, benches and gratings are regularly cleaned and kept free of litter and rubbish

- Safe disposal of all waste materials is arranged. "Unofficial" rubbish burning must be banned.

In addition, good housekeeping extends to other general "tidy" working practices which ensure that combustible materials do not come into contact with sources of heat. These include control of work clothing to ensure that items do not come loose and catch fire, and the general storage of clothing and paper away from any potential source of ignition.

At the end of a work period all equipment not required to operate should be switched off and portable equipment should be unplugged. If equipment is in use overnight it should be checked for safety. Other checks which should be made include ensuring that no cigarettes are left smouldering, fire doors and windows are closed and the premises are secured against intruders.

Precautions against arson should also include appropriate security to prevent unauthorised access to storage areas (both during and outside of work times) and the screening of new workers. Opportunities for fire-setting can be reduced further by keeping waste and rubbish to a minimum and out of reach.

Storage of Small Quantities of Flammable Liquids

When flammable liquids are exposed to the atmosphere they give off flammable and toxic vapours. Correct storage and use are therefore essential to prevent accidental ignition or explosion and they should never be exposed to potential sources of ignition.

Non-flammable substances should be used instead wherever possible. When in use in the workplace, the quantity of flammable liquids should be minimised and contained in appropriate (usually metal) containers with secure lids. These must be correctly labelled. The need to decant highly flammable liquids from one container to another should be minimised, thus reducing the risk of spillages.

PREVENTIVE STRUCTURAL MEASURES

Building design can be a significant factor in preventing both the outbreak and spread of fire. The main features which influence this are:

- The layout and construction of the building or the site premises

- The materials with which buildings are constructed and those used in decoration and furnishings.

Structural Measures to Prevent the Spread of Fire and Smoke

Ideally, to reduce the risk of fire spread, high fire risk processes and the storage of highly combustible and flammable materials should be sited some distance away from other (particularly, occupied) buildings. Unfortunately, due to restricted space this is not always achievable. The main alternative is the enclosure of such activities within *fire-tight cells*. This principle can also be used within any building to prevent the spread of fire and smoke, with the building divided into compartments or cells using fire resistant materials.

There are essentially two types of fire compartment or cell, although both have the same effect in terms of design:

- Compartments which are designed to keep a fire *in* – applied to areas of high risk which are those where highly flammable materials are used, transported and stored, where toxic fumes are produced or where gas cylinders are used or stored.

- Compartments which are designed to keep a fire *out* – applied to high loss effect areas where essential records or documents are kept, or where essential equipment, plant or stock are located, and to fire-protected "place of safety" areas (see later).

The walls, floors and doors which form the boundary to a fire compartment must generally provide a 60 minute resistance to fire, but this may vary depending upon the level of risk within the compartment and may even be as much as six hours.

For the walls, floors and doors which subdivide fire compartments, the requirement is that they must generally provide a 30 minute resistance.

Fire doors, where fitted, should be clearly labelled "Fire Door – Keep Shut". Nowadays self-closing fire doors are used in many buildings. They may be held open but will be automatically closed by a door release mechanism triggered by:

- The activation of a smoke-sensitive device on either side of the door

- The activation of a fire alarm system incorporating automatic smoke detectors in the vicinity of the door

- A fault in either of these systems or in the door release mechanism itself.

Where such mechanisms are provided it should be possible to release them manually. The doors should be labelled with the words "Automatic Fire Door – Keep Clear".

A fire door will only perform its function if it is properly designed, installed, operated and maintained; failure may be fatal. A survey on 1,583 fire doors of various types (Factory Mutual International, 1990) produced an 18% failure rate, mostly attributable to poor maintenance and damage. The following table gives a summary of the causes of failure.

Causes of Fire Door Failure (FMI, 1990)

Type of door	Main failure mechanism
Steel roller shutter	Incorrect spring tension or snagged chain
Horizontal sliding on inclined track	Blocked opening, damaged track or snagged cable
Horizontal sliding – counterweight	Damaged track, snagged cable or counterweight
Horizontal sliding – spring closure	Damaged track or spring tension
Swinging	Faulty closer, missing latch or binding on wall or floor
Vertical sliding	Blocked opening, damaged track or snagged cable

Additionally, some doors failed due to dirty, painted or un-lubricated components.

If any services or ducting passes through a compartment wall, floor, ceiling or roof, then the joints around the services etc. must be *fire stopped* to prevent the passage of fumes, smoke or gases.

Properties of Common Building Materials

The types of material used for both the structure and decoration of a building is a significant factor in the manner and rate of fire spread, affecting the safety of both the occupants and the building contents. There are many different types of building materials available and selecting which to employ depends on the specific use and circumstances of the building. It always involves a compromise between the various properties of the materials, mainly their combustibility, structural strength when subject to heat and the products of combustion (harmful or otherwise) – and of course their cost. We shall consider here the properties of the main types of building materials.

The most common materials used in construction and their application to different parts of a building are as follows:

Structure	Linings and Divisions	Services and Decoration
Bricks	Timber	Plastics (pipes, cables and coatings)
Building blocks	Building boards	
Concrete	Insulation	Paint
Stone	Glass	
Steel	Plaster (Lime)	
Timber		

Steel Frames

Steel has a high strength/weight ratio and is used extensively as load-bearing, structural members such as columns, beams, portal frames and roofs, etc. It can also be used as "profiled" sheets or light-weight roof members (purlins).

Unprotected steel will rapidly lose its designed shape in a fire and also its structural strength; mild steel loses half its cold strength at about 550°C and high-tensile steel at about 400°C. A typical effect of this is that, for example, heating a steel cross-beam will cause it to expand, pushing vertical columns out and causing floor slabs to collapse onto the floor below which, not being strong enough to carry the extra load placed upon it, may itself collapse and hence lead to the whole building falling through.

Steel is also a very efficient conductor of heat and so extensive unprotected steelwork can be a significant cause of the spread of fire.

As a result of these weaknesses in the face of fire, steel is generally used in combination with concrete, where the concrete provides a measure of protection for the steel.

Reinforced Concrete Frames

Almost all concrete used for structural purposes is reinforced with steel rods. Their fire resistance is determined mainly by the protection offered by the concrete cover against an excessive rise in the temperature of the steel. This in turn depends on:

- The type of aggregate used – all concrete is likely to "spall" (break away) when hot, particularly when hit by a jet of fire or hot air, although the use of lightweight aggregate or aerated concrete can minimise this.

- The thickness of concrete over the reinforcing rods.

The fire resistance of reinforced concrete is good. In contrast to unprotected steel, structural concrete may deflect under fire conditions but does not normally collapse suddenly. Indeed, many structures have been able to be reinstated after severe fires.

Timber

Timber burns but in a predictable manner. If designed with an adequate factor of safety there can be a reasonable time lag before failure occurs, particularly if the timber is protected with plasterboard or other coverings. Applied heat will not cause expansion to stress the structure nor does wood collapse suddenly.

The fire resistance of timber depends on the "four Ts":

- The *thickness* or cross-sectional area of the piece

- The *tightness* of any joints involved – in general, the fewer joints, the better

- The *type* of wood – generally, denser timber has better resistance (the surface chars, but because conduction is poor the internal timber still performs structurally)

- Any *treatment* received – for example, flame-retardant treatment is often applied to such materials as plywood or chipboard sheets.

For several years now the use of laminated timber members has been on the increase, simply due to the fact that it can be designed to almost any profile and has excellent fire resistant properties. Excess material (known as "sacrificial timber") is often added to exposed beams and columns, providing a protective layer which is consumed by a fire before the structural core is attacked.

Bricks

There are three types of brick in common usage – fired clay, calcium silicate and concrete. Fired clay bricks usually respond better in a fire situation due to their composition (clay) and the fact that during the manufacturing process they have already been exposed to very high temperatures and there will therefore be little reduction in their strength in any subsequent fire.

However, no distinction is made between the three types in classifying their behaviour in fire when incorporated as a wall. The key features which affect the fire resistance of a wall are:

- Its thickness

- The applied rendering or plastering, especially if lightweight plaster is used

- Whether the wall is load-bearing or not

- The presence of perforations or cavities within the bricks.

Building Blocks

Blocks may be of clay or concrete:

- Clay blocks are usually hollow. The greater the thickness and the smaller the voids, the better the fire resistance. Spalling (blistering and exploding) is likely to occur on the face exposed to fire.

- Concrete blocks may be made of dense or lightweight aggregates and can be either solid or hollow.

Both types give high fire resistance (which can be improved by the application of plaster) with little risk of collapse, so they can be safely used for the walls of a fire compartment.

Building Boards

Boards are generally combustible but are not easily ignited. The main types are:

- Fibre building boards – either softboard (often called insulating board) which is non-compressed in manufacture or hardboard of both low and high density which, if tempered by impregnation with oils and resin, has high strength and water resistance and is not easily ignitable

- Plaster boards which retard fire spread until the paper face burns away

- Asbestos boards which have a high asbestos content and consequently have good fire-resistance properties (but the use of which is now forbidden in many countries due to the carcinogenic properties of asbestos)

- Asbestos cement sheets which have a low asbestos content and usually fail by shattering under fire

- Plywood and block boards which offer variable fire resistance depending on the type of wood, thickness, treatment, etc.

- Plastic board of variable resistance depending on the surface treatment.

Building Slabs

Slabs are similar to building boards but are much thicker. "Wood-wool" slabs and compressed straw slabs are combustible and are often treated to give improved resistance. These are usually found as underlays for roofing materials.

Stone

Often used for cladding, the type of stone used in buildings is generally one of the following:

- Granite – which is likely to expand rapidly and shatter at 575°C, and has a risk of spalling (although this is reduced by the use of large blocks)

- Limestone – which is likely to spall if hit with a high temperature jet of fire or air

- Sandstone – which generally comes between limestone and granite in behaviour, and is likely to shrink and crack.

Stone has a tendency to crack when subjected to continuous heat or to sudden cooling by a jet of air.

Glass

Glass is susceptible to breakage and cannot therefore be used as a barrier to fire. There are two exceptions to this – wired glass and copperlight glazing – which offer some fire resistance.

Other types of glazing are:

- Armour plate – toughened glass which is incapable of providing fire resistance and will not stand temperatures above 300°C

- Double-glazing – two or even three sheets of glass which are mounted within a frame, but which are still likely to shatter in a fire and cannot therefore be considered fire-resistant

- Glass blocks and glass lenses which are used for internal and external wall panels.

Fire resistant glazing is a recent development whereby glass incorporates clear intumescent (swelling) interlayers or laminates and which will provide fire resistance of up to 90 minutes.

Insulating Material

Most modern insulating materials are non-combustible but unfortunately in many older buildings combustible materials (such as sawdust) have been used. Their location in concealed spaces can aid fire spread considerably.

Lime (Plaster)

Lime is made by heating limestone (calcium carbonate) which is converted to quicklime (calcium oxide) and then slaked with water to make slaked lime (calcium hydroxide). Lime is a

component of plaster and mortar. It is used for plastering internal walls and, if supported by lathing or expanded metal, has good fire resistance.

Paint

Most paints are flammable and a layer of many coats built up over years may be a fire risk. Flame-retardant paints and intumescent paints are also available. These bubble up to protect the timber beneath.

Plastics

There are two types of plastic:

- Thermosetting plastics, which are formed by the action of heat and compression – these will not soften and melt when involved in a fire, but will decompose

- Thermoplastic plastics, which are moulded into the required shape by heating and on cooling remain in that shape – if involved in a fire they will melt and flow.

Plastics are used primarily in building services and surface fascias. The principal hazards they present in fires are the dripping of molten plastic and giving off products of incomplete combustion in the form of toxic smoke.

Protection of Openings and Voids

Ceiling and floor voids, as well as openings around pipe work and other services, can allow air to feed a fire as well as assisting in the spread of fire and smoke. Debris should not be allowed to accumulate in voids. When necessary such openings should be bonded or fire-stopped with non-combustible material.

Ventilation ducts and gaps around doors must have the facility to be stopped in the event of a fire. This can be achieved by the use of baffles, self-closing doors and intumescent material which expands when subject to heat thereby sealing the opening.

REVISION QUESTION 2

(1)   How might you minimise the risk of fire in a woodworking area?

(2)   What precautions should be taken when using flammable liquids?

(3)   Upon what does the fire resistance of each of the following building materials depend?

   (i)   Timber

   (ii)   Reinforced concrete

   (iii) Brick walls

(4)   Describe the effects of fire on an unprotected steel beam.

(5)   Describe how flame retardant paint protects covered timber.

(6)   What three elements should be addressed in any assessment of fire risk?

The suggested answers are given at the end of the unit.

FIRE DETECTION, WARNING AND FIRE FIGHTING EQUIPMENT

All workplaces must have arrangements for:

* Sounding an alarm in the event of fire

* Fighting the fire.

Detection and Alarm Systems

There are many systems for raising an alarm on detecting an outbreak of fire, ranging from simple hand bells (or even just shouting) to sophisticated electronically-triggered systems. However, whatever system is employed, all staff must know how to raise an alarm on discovering fire and what to do when the fire alarm sounds.

The general principles of an alarm system are shown below.

```
┌─────────────────────────────────────┐
│          Fire detection             │
│        (manual or automatic)        │
└─────────────────────────────────────┘
                  │
                  ▼
┌─────────────────────────────────────┐
│ Alarm activated in immediate        │
│ vicinity of fire/                   │
│        fire compartment             │
│   (lights, bells, public address)   │
└─────────────────────────────────────┘
                  │
                  ▼
┌─────────────────────────────────────┐
│     Alarm activated in other areas  │
│ (lights, bells, public address, phone)│
└─────────────────────────────────────┘
                  │
                  ▼
┌─────────────────────────────────────┐
│        Fire brigade notified        │
└─────────────────────────────────────┘
```
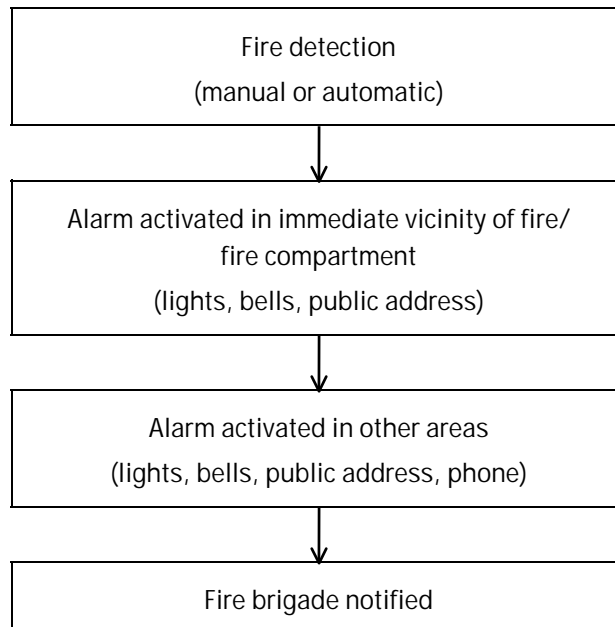
Fire Alarm System

Depending on the size and layout of the premises and upon the type of fire hazard faced, the alarm system activated on detection of a fire may proceed in stages (as shown above and described below) or may cover all the stages at once.

In order to avoid unnecessary disturbance in hospitals and other large installations it may be preferable to restrict an initial alarm to the locality in which it arises (zoning) or restrict it to a small number of responsible personnel. A general alarm would then be sounded only if it was considered desirable. Such restricted alarm systems must have a control point which is under continuous and competent watch during the whole time the premises are occupied. An over-riding switch should also be provided to enable the responsible person to raise a general alarm for complete evacuation. If an alarm is to be restricted it will also be necessary to have some additional means of summoning fire fighting staff to the affected area.

The alarm signal itself is usually a bell or siren sounded loudly throughout the buildings and premises affected. It must be clearly audible to all staff in those buildings and premises, which means that careful thought must be given to the siting of alarm bells or sirens – for example, fitting fire doors to a building cuts down the distances over which call bells are heard and may mean additional bells must be fitted or noise levels raised. In some circumstances, audible devices on their own may not be sufficient to act as clear signals and emergency lighting patterns may be required. Further, to comply with the requirements of disability discrimination legislation it may be necessary to use lights or vibrating devices in addition to bells and sirens. Recognising the alarm signal will be an important part of staff training in relation to fire precautions.

All equipment and systems used for fire detection and for raising an alarm (even the basic manual devices described below) must be maintained and tested regularly and the results recorded. Any faults discovered must be rectified and the system rechecked.

Manual Systems

Manual systems are suitable for small workplaces and involve the use of the following basic devices:

- Rotary gongs – which are sounded by turning a handle around the rim of the gong

- Hand strikers – for example, iron triangles suspended from a wall accompanied by a metal bar which is used to strike the triangle manually

- Hand bells

- Whistles

- Air-horns.

These devices are normally located on the walls of corridors, entrance halls and staircase landings, etc., where they are readily available to anyone who may have to raise an alarm.

While these types of manual systems provide for an alarm over a limited area, operation of one of them is rarely adequate to give a general alarm throughout the premises. Also, as a person is required to operate them, a continuous alarm cannot be guaranteed for as long as may be necessary.

In order to raise a more general alarm it is also possible to use facilities which may already be installed in a building for other purposes – for example, a telephone or public address system. With automatic telephone systems, arrangements can be made for a particular dialling code to be reserved for reporting a fire to a person responsible for calling the fire brigade and sounding the general alarm. Alternatively it can be arranged that use of the code automatically sounds the general alarm.

Manual/Electric Systems

These are systems which, although set in motion manually, operate as part of an electrical alarm circuit. When an alarm call point is activated, the alarm signal is automatically sounded throughout the premises (or a particular part of them). The alarm system may also sound an alarm outside the building and possibly relay an alert to the fire brigade.

The call points in a manual/electric system are usually small red wall-mounted boxes which are designed to operate either automatically when the glass front is broken or when the glass front is broken and a button pressed. Most available models are designed to operate immediately the glass front is broken.

Automatic Detector and Alarm Systems

Usually mounted on ceilings or in air ducts, an automatic fire detector identifies one or more physical changes in the protected environment which indicate an outbreak of fire. All such systems will sound an alarm within the affected area, as well as outside the building and direct to the fire brigade. Many will also be linked to containment and/or extinguishing devices, such as activating automatic door releases, closing down ventilation or air conditioning plant, or activating sprinkler systems.

Fire may be detected in one of three main ways:

- By sensing the presence of *smoke* or *other fumes* (often invisible) given off by combustion

- By detecting the presence of *flame* and a degree of illumination

- By sensing *heat* – an actual temperature or the rate of a rise in temperature.

There are different types of detector for each of these three conditions.

- **Smoke detectors**

    There are two types of automatic smoke/fumes detector.

    – *Ionisation* devices – These are sensitive in the early stages of a fire when smoke particles are small, and their sensitivity tends to drop as particles grow in size. It should be borne in mind, however, that the detector may mistake dust for smoke, resulting in a false alarm.

    – *Optical* devices – These are effective in situations where there is dense smoke (i.e. large particles) which obscures or changes the normal levels of light in the protected area.

- **Radiation detectors**

    The flame of a fire emits visible light, also ultra-violet and infra-red radiation. Flame detectors operate on the basis of sensing the presence of these forms of radiation.

    They are capable of very rapid detection because of the almost instantaneous transmission of radiation to the detector head. However, their effectiveness depends on the detector having a clear "view" of all parts of the protected area.

- **Heat detectors**

    There are two main types of automatic heat sensors:

    – *Fusion* – where special alloys melt and either break or make a circuit and sound an alarm, with the alloys requiring replacement after each time that the detector operates.

    – *Expansion* – where a contained metal, air or liquid sensor expands to create a circuit and sound the alarm. They usually reset themselves after having operated and the conditions have cooled.

    Heat detectors may be designed to operate at a pre-selected temperature ("fixed-temperature" type) or on a rapid rise in temperature ("rate-of-rise" type) or both. With both types, but more particularly with fixed-temperature ones, "thermal lag" has to be considered when choosing the operating temperature. This is the difference in temperature between that at the sensor itself and that at the source of the fire at the point when the

sensor is triggered, which could be quite great depending on the distance between the two and the intensity of the fire.

Not all detectors will be equally sensitive in every possible situation and in some cases a combination of different detectors may be required. Smoke and heat detectors are suitable for most buildings. However, particular types of building and particular fire hazards may make specialised detectors more effective. For example, radiation detectors are particularly useful for high-roofed buildings (such as warehouses) and in situations where clean-burning flammable liquids are kept, and laser beam infra-red detectors may be used where there are tall compartments or long cable tunnels.

Other factors to be considered in determining the type of detectors used include:

- The conditions in the area to be protected – A more robust detector is necessary, say, in an industrial setting than is required for hotel purposes. Dusty or damp atmospheres will affect some detectors more than others.

- The sensitivity required – It would obviously be undesirable to install a smoke detector set at high sensitivity in a normally crowded hotel bar (or similar conditions) because of false alarms caused by cigarette smoke.

- The availability of suitable locations – The detectors should be located so they are in the best possible position to perform their function.

- The potential for false alarms – False alarms can happen for many reasons and are often unavoidable (for example, dust may be mistaken for smoke by smoke detectors or strong sunlight can be reflected from windows or puddles which can be mistaken for a flame by ultra-violet radiation detectors). The choice of detection system should take account of the potential for such false indications in the particular circumstances.

Portable Fire Fighting Equipment

The main types of portable fire fighting equipment are fire extinguishers. These are appliances designed to be carried to the point of the fire and operated by hand. They contain an extinguishing agent which is expelled by internal pressure on operating the release mechanism and can be directed by means of a horn or tube onto the fire. The pressure may be by compression within the extinguisher or may be the result of a chemical reaction or release of gas from a cartridge, triggered by the operation of the extinguisher.

The correct type of extinguisher should be available for the risk it is going to protect against, with the type of extinguishing agent clearly marked. Extinguishers must also be well maintained and be sited in an easily seen and reached position, usually by an escape route. To ensure that these conditions are always met there are a number of important requirements relating to fire extinguishers, many of which are included in a fire risk assessment or form part of the conditions for a fire certificate (see elsewhere).

Marking

In most countries portable appliances must be coloured red and display a distinguishing coloured label, usually on its collar, to identify the type of extinguishing agent contained. These are as follows:

Water   –   Red

Chemical foam   –   Cream

Carbon dioxide   –   Black

Dry powder   –   Blue

In addition, each appliance has to have the date of its last inspection marked on it.

Siting

The location should be clearly marked and should not be further than 30 metres from the next location. There should be a minimum of two locations on any floor.

The siting of extinguishers should make them readily visible on escape routes and placed close to, but not too close, to the point of any potential fire risk.

The extinguishers should be properly mounted, sited to avoid temperatures beyond their operating range and protected from corrosive environments.

If necessary more than one extinguisher should be provided in each location to enable different types of fire to be extinguished. Thus many locations have water extinguishers, along with carbon dioxide or dry powder extinguishers which should be used in the case of electrical fires.

Maintenance

Regular inspections and examinations must be carried out by a suitably qualified technician. The requirements vary for different types of extinguisher. Here are some typical requirements (the actual detailed requirements may vary between countries):

- **Water extinguishers**

    Stored-pressure extinguishers must be checked to ensure that the pressure is correct, that the hoses and nozzles are not blocked and there is no corrosion. They should be discharged annually.

    Gas-cartridge extinguishers should be opened annually and the working parts and contents checked. The gas cartridge should be weighed to check for losses and the sealing washer examined. They should be discharged every five years.

- **Foam extinguishers**

    These should be opened annually and checked to ensure that no clogging has occurred and all the working parts are in good order. Gas cartridges should be weighed and losses in excess of 10% will require replacement. The extinguisher, if pre-mixed, should be discharged every two years, or if the compound is kept separate, every four years.

    All foam extinguishers must be thoroughly washed out after discharging.

- **Dry powder extinguishers**

    Examination should be once a year for all the features covered for the other extinguishers. With the gas cartridge type, which can be opened, the powder should be checked to ensure it has not caked. They should be discharged every five years.

- **Carbon dioxide extinguishers**

    The contents should be checked by weighing or by gamma ray to ensure there is no loss. The working parts should be examined and the horn checked for freedom of movement. Every 10 years, or when discharged, the cylinder should be hydraulically tested. After 20 years the test should be every five years.

- **Vaporising liquid extinguishers**

  Annual working order checks are required by weighing the contents. The extinguishers should be checked by discharge every five years.

Training

The ability to carry out fire-fighting with portable extinguishers may not only control the rate at which a fire spreads, thereby giving those precious few moments which mean the difference between a person escaping or becoming a victim, but often reduces fire damage to a lower level than would have been the case if the fire had proceeded without being checked. It is therefore very important that all personnel are familiar with the available fire-fighting equipment and are able to use it correctly.

The following points form a general scheme for training in the use of fire-fighting equipment:

- General understanding of how extinguishers and other appliances operate.

- The importance of using the correct extinguisher for different classes of fire (which should not be a problem as only the correct type of extinguisher should be available for use in any particular situation). Staff should be aware that using the wrong type of extinguishing agent on a fire may increase its intensity.

- Recognition of whether the extinguisher has to be used in the upright position or in the upside-down position.

- Practice in the use of different extinguishers. This can be done with or without a practice fire, although dealing with a live fire is obviously the better method. Opportunities for training may arise during the inspection process – when appliances are being tested or discharged. (Training in using carbon dioxide extinguishers is particularly important as they can be frightening to use – they start off with a bang and the horn gets freezing and can cause the skin to stick to it, pulling the skin off if you try to remove your hand.)

- When to and when not to tackle a fire. If the fire is small and does not involve the building structure, then portable extinguishers can usually be used. It must be understood that extinguishers can only provide a "first-aid" treatment for small fires and evacuating the building must take priority over fighting a fire if the conditions demand it. A means of escape must always be maintained

- When to leave a fire that has not been extinguished. As a general rule, once two extinguishers have been discharged, the fire requires the Fire Service. When leaving an unextinguished fire, all doors and windows should be closed if possible to help contain the fire.

Other Types of Fire Fighting Equipment

- **Fire blankets**

  These are portable fire fighting devices designed to smother a fire. There are different types of fire blankets suitable for different types of fire – light-weight ones suitable for class A and B fires, and heavy duty blankets for industrial use, including those that can be used for class D fires. They are especially useful in a kitchen for extinguishing deep fat frying pan fires and other types of small fat and oil fires (class F).

  When using a fire blanket, the corners must be turned towards you so that you do not get burnt as the blanket is laid over the fire. It should be kept in place until all the heat has been removed.

- **Hose reels**

  These are very effective as a first line of attack against class A fires.

  Reels should be located near exits, stairways or lobbies and arranged so that no part of the building is beyond the reach of the jet (6 metres). If the hose reel is fitted into a recessed installation the doors, whether glazed or not, should bear the words "FIRE HOSE REEL". The hose has a shut-off nozzle and the supply is via a control valve at the connection to the main, which must be opened before the reel is pulled out. Some reels operate this valve automatically as the hose is rolled out.

  Reel installations have a number of advantages:

  – Only the required length of hose has to be run out

  – The hose is light and only one person is required to operate it

  – The lack of back pressure from the nozzle makes it easy for persons of limited strength to handle it

  – The control of the water at the nozzle of a hose reel will limit water damage.

- **Automatic sprinklers**

  There are several different types of sprinkler system but essentially they all involve fixed pipe work in the ceiling of each part of the protected building. The pipe work is connected via control valves to a water supply and sprinklers are spaced at intervals along the pipe work so that the discharge patterns overlap and leave no part unprotected. They are activated by automatic fire detectors.

  The quantity of water discharged is designed to at least control any fire in the protected area, if not to extinguish it.

- **Drenchers**

  These are designed to provide a coverage of water over areas of a building or structure which could be damaged by radiant heat from a fire close by. Normally adequate spacing limits the radiation hazard and therefore only vulnerable areas need be covered, such as unprotected doors and windows.

- **Hydrants and foam inlets**

  These are provided on the outside of buildings to allow the fire brigade easy access to a supply of water or foam close to a potential fire hazard, with the type of extinguishing agent being appropriate to the type of hazard.

Extinguishing Media

Extinguishing a fire is based on removing one or more sides of the fire triangle.

- **Removing the fuel**

  Extinction by this process is known as *starvation*. This can be achieved by taking the fuel away from the fire, taking the fire away from the fuel and/or reducing the quantity or bulk of fuel available. Thus materials may be moved away from the fire (to a distance sufficient to ensure that they will not be ignited by any continuing radiant heat) or a gas supply may be turned off.

- **Removing the oxygen**

  Extinction by this process is known as *smothering*. This can be achieved by either allowing the fire to consume all the available oxygen, whilst preventing the inward flow of any more oxygen, or adding an inert gas to the mixture. The most usual method of smothering is by use of a blanket of foam or a fire blanket.

- **Removing the heat**

  Extinction by this process is known as *cooling*. Cooling with water is the most common means of fighting a fire and this has a dual effect in terms of absorbing heat and thereby reducing the heat input into the fire, and reducing the oxygen input through the blanketing effect of the steam produced.

Although water is the most common medium used to fight fires, it is by no means the only or the most suitable substance. Indeed, using water on certain types of fire can make the situation worse.

The main different types of extinguishing media are described below and you should note their application to the classification of different types of fire.

Water

Water applied as a pressurised jet or a spray is the most effective means of extinguishing class A fires, and may also be used as a spray on class B fires involving liquids and liquefied solids which are miscible (capable of mixing) with water, such as methanol, acetone and acetic acid. Whilst ineffective on class C fires themselves (those involving gases), water may be used to cool leaking containers.

It must never be used on fires involving electricity, as the current can flow up the stream of water, nor on non-miscible liquid fires as only a cupful of water can cause the whole fire to erupt into a conflagration.

Foam

Foam is a special mixture which forms a smothering blanket over the fire, cutting off the supply of oxygen. It can be used on class A and B fires (although there are some restrictions in its use on class B fires since certain types of foam break down in contact with alcohols) and also on small liquefied gas fires (which make up certain class C fires).

Using foam as an extinguishing agent demands considerable skill when dealing with anything but very small scale liquid fires, since the procedure is to start at the rear and to lay a blanket of foam across the surface of the liquid.

Dry Chemical Powder

The powder is sprayed as a cloud over the fire, again acting to smother the supply of oxygen. It can be used on class B fires and on small liquefied gas fires (within class C). Specialised dry powders using inert substances are also used on class D fires, where they form a crust over the burning metal and thus exclude the oxygen.

Dry powders are also effective on fires involving electricity.

Carbon Dioxide Gas

This works by means of smothering the supply of oxygen. It is effective on class B fires and also for electrical fires as the gas can enter into the inside of the equipment.

Vaporising Liquids

When applied to a fire these agents produce a heavy vapour which extinguishes the fire by excluding oxygen. They are safe to use on class A and B fires and are particularly effective on fires involving live electrical equipment, since they interfere with electrical combustion reactions.

Extinguishing Agents and Fire Classification

Fire class	Description		Examples	Extinguishing agents
A	Solid – carbonaceous-based		Wood, paper, fibres, rubber	Water, also dry powders, CO_2 and vaporising liquids
B	Flammable liquids and liquefied solids	Those miscible with water	Alcohol, acetone, methyl acetate	Dry powders, special foam, vaporising liquids
		Those immiscible with water	Petrol, diesel, oil, fats and waxes	Dry powder, foam, vaporising liquids
C	Gases and liquefied gases		Natural gas, liquefied petroleum gases (butane, propane)	Turn off the supply. Liquid spills may be controlled by foam
D	Flammable metals		Potassium, sodium, magnesium, titanium	Inert dry powder, dry sand
F	Oils		Oils used in deep fat frying	Damp blanket

Note that there are no effective means of extinguishing gas fires (class D). The correct procedure is to shut off the supply (i.e. remove the fuel from the fire) before extinguishing any residual flames.

REVISION QUESTION 3

(1) What are the limitations of manual alarm systems and how may they be overcome?

(2) Identify the three ways in which fire may be detected and state the types of automatic detector associated with each.

(3) Identify the three ways of extinguishing a fire.

(4) Identify the classes of fire for which each of the following extinguishing agents/devices are suitable.

    (i) Water

    (ii) Carbon dioxide gas

    (iii) Dry powder

    (iv) Foam

    (v) Fire blankets.

(5) State the four colour coding requirements for portable fire extinguishers.

(6) Outline the main points to be covered in training in the use of fire extinguishers.

The suggested answers are given at the end of the unit.

MEANS OF ESCAPE

Irrespective of the level of risk associated with premises, suitable means of escape must be provided. The general principle to be adopted is that, except in very small premises or those presenting low fire risk, there should be alternative means of escape so that in the event of fire, people present can turn their back on the flames and escape to a place of safety.

An escape route provides the means by which people in any given area can reach a place of safety – a protected area where there is no fire risk, or the risk is considerably reduced. This place of safety will be an assembly area or muster point under the evacuation procedure.
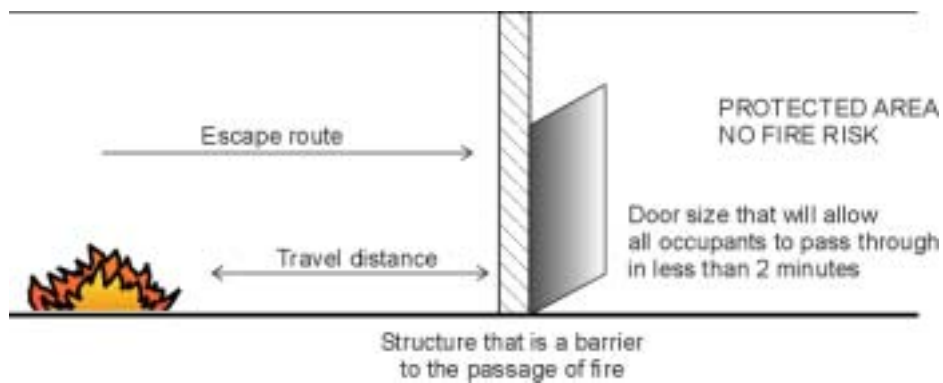
Fire Escape Route

Legislation or best practice places a number of very specific requirements on escape routes. The details may well vary depending upon which part of the world we are talking about. However, the basic idea remains the same –getting people out of a building safely, the escape route being protected for long enough to get everyone out. Below we consider the escape route requirements enforced in the UK. These are good principles to use anywhere because they are based on times rather than on strict distances.

Travel Distances

If escape times are to be kept to a minimum, some limit must be placed on the travel distance. Where there is more than one escape route then the maximum escape times and the subsequent distance of the escape route should be:

- For high risk areas – one minute or 12 - 25 metres

- For normal risk areas – three minutes or 18 - 45 metres

- For low risk areas – five minutes or 45 - 60 metres.

The times given take into account the time taken to respond to the alarm and to close down equipment. Where all people affected may be considered to be familiar with the building and with the evacuation procedure, the further distances may be acceptable.

Stairs

From the upper floors, escape should be by stairs – the use of lifts and escalators is forbidden since these may well be disabled by fire. Therefore the same conditions as apply to passageways and doors, as set out below, apply to stairs in buildings.

Note too that a protected stairway may serve as a place of relative safety and may therefore form an assembly point (see later).

Passageways

The escape route should be as straight as possible, clear of obstruction and free of materials which could pose a fire hazard.

A checklist for escape routes would include the following points:

- Corridors should be at least 1 metre wide, and 1.2 metres is required for wheelchair users.

- Corridor walls should not be decorated with heavy flock wallpaper, carpet material or other combustible materials.

- Large notice boards should not be located along escape routes. Although a limited number of smaller boards are acceptable, they should be maintained regularly to minimise the amount of loose paper.

- Escape routes should be kept clear of portable heaters, gas cylinders and electrical appliances such as photocopiers, shredders and microwave cookers, vending and games machines. Furniture should be kept to a minimum.

Doorways

Escape routes should have no doorways or openings which would restrict the flow of people. In short, there should be no bottlenecks:

- Doors on escape routes should open in the direction of travel if more than 50 people have to pass through, if it is at the bottom of a stairway or if it leads into an assembly point. Otherwise people may get trapped by the weight of people pushing forward behind them.

- Doorways should be a minimum of 0.75 metres wide, although as a general rule a width of over 1 metre is desirable. A doorway which is 0.55 metres wide will allow one person to pass through at a time (and this is called one unit width). This is equivalent to 40 people a minute passing through and is acceptable as an escape route.

We have seen that fire doors are crucial to fire protection in buildings because they provide permissible openings between fire compartments. They are also an integral part of the means of escape. They have two functions:

- Smoke control doors serve a life-saving function in that they prevent the spread of smoke in the immediate vicinity of the fire and also protect more distant escape routes. Such doors do not have to have any specified fire resistance, but they should be of substantial construction. They must be capable of preventing all smoke intrusion at ambient temperatures and of only allowing limited amounts of smoke through at medium temperatures.

  Protection against cold smoke must be by flexible edge seals and not intumescent strips because the latter will not operate in time and smoke seals depending on rebated frames are unreliable because the door may warp.

- Fire doors themselves are required to meet the same conditions as smoke control doors, as well as having 20 minutes fire resistance (integrity) and both flexible seals and intumescent ones.

Fire doors create obstructions in corridors and there is a risk of injury as people try to get through them. They must be easy to open (although with automatic closure devices). Glass panel doors should be wired to increase their visibility.

All types of fire door must be kept closed at all times. Because they are an obstruction, in some buildings where there is a poor understanding of the risks presented by fire, it is not uncommon to see them propped open. Safety officers should be vigilant to the appearance of wedges and especially the bad habit of propping fire doors open with fire extinguishers. Many fire doors are fitted with magnetic catches linked to the fire detection system which hold the door open in normal use, but which close automatically when the alarm is sounded.

Emergency Lighting

Emergency lighting, which operates even though the main lighting circuits may have been shut down, should be provided so that fire exit signs are visible and to illuminate changes in direction or floor level. It will also be required in large open plan areas or where it is necessary to close down hazardous processes. Such lighting may be provided in the form of "borrowed light" from outside street lamps, and this is acceptable.

Not all premises require such installations. In small businesses of low or normal fire risk a supply of torches may be adequate, providing staff are familiar with the floor layout and the torches are maintained.

Exit and Directional Signs

Escape routes must be identified clearly – this is particularly true where sites are open to public access. The public may not be familiar with the layout of the building and so need more direction. The following "running man" type symbols are common throughout Europe and many other parts of the world. They use a rectangular green background with white lettering and white pictogram to indicate the escape route.
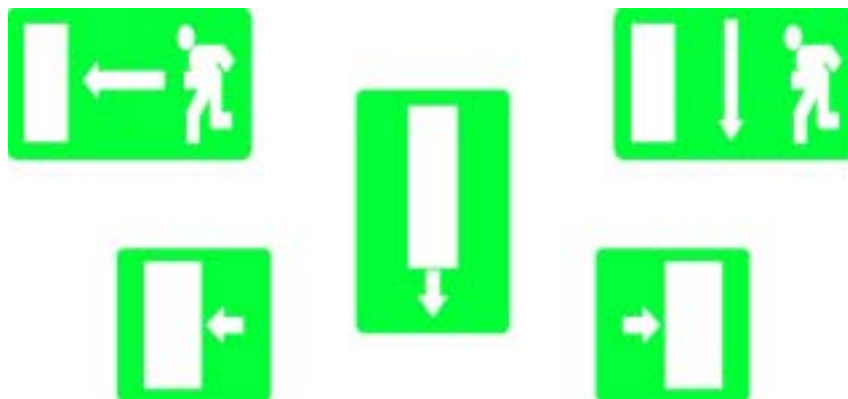
Emergency Exit/Escape Route Signs

The signs should be visible from any point within the floor area. They should be placed above escape doors, between 2 and 2.5 metres above floor level, or if this is not possible, beside the door. If the door is at right angles to the escape route, a hanging sign with directional arrows should be used.

For obvious reasons all emergency exit and escape route signs should be illuminated. Continuous operation should be incorporated in the emergency lighting systems by using both

lamps external to the sign and lamps incorporated within the sign. Some signs are self-powered, using a radioactive source which has a limited range of about 25 metres. These also have a definite useful life and will require replacement. Remember that an excess of signs may lead to confusion, and if there are doors or routes which could pose a danger in an emergency, they should be marked clearly.

Assembly Points

Escape routes lead to an assembly point. This will usually be a place of safety outside the building in the open air, away from any further danger from the fire. However, it may also be a place of comparative or relative safety, in a fire-protected area such as a secure staircase or corridor. Where this is the case the following conditions must apply:

- It should be accessible from each location in the area which it serves

- It should, in itself, have a continuous escape route to the open air

- It should be protected from the fire by fire-resisting construction which provides protection for a minimum of 30 minutes and be protected from smoke and gases by fire doors

- It should be finished with non-hazardous materials

- It should be ventilated

- It should be free of fire risks itself within the structure, which excludes such locations as boiler rooms and kitchens, or proximity to refuse chutes, etc.

Assembly points must be designated for every area of the premises and their location and the escape route to them clearly displayed.

EMERGENCY EVACUATION PROCEDURES

Should it become necessary to evacuate the premises there should be a pre-arranged plan which will enable all workers to leave safely and quickly. The aim of any evacuation procedure will be to enable all people on the premises to leave as quickly as possible along designated escape routes and report to their designated assembly point for a roll call and further instructions.

It is very important that every worker should be familiar with the evacuation procedure and the escape routes to be used, no matter where they happen to be in the building at the time. They should also know of alternative routes should their own be impassable. All staff should therefore be given specific instructions about what to do in the event of a fire – this is usually done as part of a worker's induction training. There must also be written instructions, prominently displayed, to ensure that casual visitors are also aware of the requirements. These instructions should be precise and relate directly to the particular workplace in question.

Any evacuation must be orderly and conducted in such a manner that the escape facilities – for example, the capacity of escape routes – can handle the numbers of people using them. In addition, where there is a great number of people present, the procedure should also aim to prevent panic as this will slow evacuation and may cost lives.

A massed crowd will cause congestion and is likely to slow the flow. One method of avoiding this is "*zoned evacuation*", where evacuation takes place by one compartment or floor at a time. The compartments must be evacuated in sequence, with the one at highest risk leaving first. (This approach has implications for sounding an alarm throughout the whole premises, as this would imply that the whole premises should react together and at once.)

Fire Marshals

Whatever the number of workers it is vital that responsibility for action in the event of fire is assigned to specific people. All premises should have designated and trained fire marshals or fire wardens who are responsible for the following actions:

- Ensuring all members of staff (and other persons on the premises, including the general public in the case of shops and public buildings) leave by the designated escape route

- Searching all areas, including toilets, to ensure that the area is clear

- Ensuring that fire escape routes are kept open and clear at all times

- Ensuring all doors and windows are closed on leaving the area

- Conducting the roll call at the assembly area

- Meeting the fire department on arrival and informing them of all relevant details.

In addition, premises with a large number of occupants or where there is a high fire risk may have trained personnel who will carry out first aid and fire-fighting. They will also have a nominated senior person – for example, a safety officer or senior manager – who is responsible for all aspects of fire safety including training, overseeing of fire contracts (such as for equipment maintenance) and record-keeping.

Deputies should be nominated to take over all these responsibilities when the marshal/warden or senior person is absent.

Fire Drills

Having specific staff responsible for particular actions in the event of fire is not sufficient. All staff must be aware of and be trained in using the correct procedure to follow in the event of fire.

Fire drills are practice evacuations and should take place at least once a year and preferably once every six months. More frequent drills may be held in areas of high risk. Records should be kept indicating the date, evacuation time, number of participants, etc. Any problems apparent should be analysed and resolved.

Roll Call

On evacuation, a roll call of all those reaching the designated assembly point must be held in order to establish that complete evacuation of the premises has occurred. The roll call will be conducted by fire marshals using a register of everyone who is on the premises – including staff, visitors, contractors, etc. The register must therefore be updated continually to reflect the comings and goings in the workplace. This is a management responsibility. Many workplaces may do this roll call electronically – if they have some form of addressable site security access system which automatically records when individuals enter/leave the building. The system may then be able to print out an exception list of who is apparently unaccounted for.

If anyone is not accounted for in the roll call the Fire Officer in charge must be notified as soon as the Fire Services arrive. In the case of premises where there is random public access (shops, etc.), it may be necessary for the Fire Services to undertake a search.

Provision for the Infirm and Disabled

Staff with hearing or other physical disabilities must be accommodated within an evacuation plan. Thus plans must be in place to assist people in wheelchairs who cannot use stairs if a lift is inactivated (and in most escape plans, lifts and escalators are not appropriate as escape routes). Provision must also be made for the needs of other groups with limited mobility, such as children and elderly people.

REVISION QUESTION 4

(1)   What areas may be used as assembly points?

(2)   What should take place in an assembly point following an evacuation?

(3)   State the escape times and distances for

    (i)   High fire risk areas

    (ii)   Normal fire risk areas

    (iii)   Low fire risk areas.

(4)   What is the purpose of signs used on escape routes?

(5)   Outline the main requirements for an escape route.

(6)   List the actions for which fire marshals/wardens are responsible when an evacuation takes place.

The suggested answers are given at the end of the unit.

UNIT SUMMARY

Fire is caused by the interaction of three elements, known as the fire triangle: heat, fuel and oxygen. The fire triangle is fundamental to understanding the prevention, control and extinction of fire.

Fire spreads by means of direct burning, heat radiation, conduction and convection.

Fires are classified into five categories based on the fuel type. This classification is fundamental to identifying the means by which each type of fire may be extinguished.

Fire prevention is based on controlling the use and storage of combustible materials, particularly those which are flammable, and on minimising the risk associated with potential sources of ignition. This is mainly through safe working practices and good maintenance procedures. The design of buildings and the types of materials used in their construction are also crucial to the prevention and control of fire.

All premises must have effective systems to detect fire and raise an alarm, which may be manual or automatic.

All premises must also have effective facilities for fighting a fire. Different extinguishing media are appropriate for different types of fire and it is important that the correct one is applied. Fire-fighting equipment may be fixed or portable. The main portable devices are hand-held fire extinguishers and detailed requirements apply regarding their marking, siting and maintenance. Staff require training in their use.

All premises must have evacuation plans in place in the event of fire and the plans must be understood by all occupants. Evacuation takes place by means of designated escape routes leading to fire-protected assembly points where a roll call will be held.

SUGGESTED ANSWERS TO REVISION QUESTIONS

Revision Question 1

(1) The smoke may begin to clear but by allowing fresh air into an oxygen-depleted environment the fire is likely to burn with increased intensity.

(2) (i) Static electricity is an electrostatic charge produced by friction or induction. The charge may be transported a considerable distance from the point of origin and a spark may be produced when sufficient charge accumulates. This spark may have enough energy for ignition.

   (ii) Friction is the process whereby heat is given off by two materials moving against one another. In the absence of a lubricant or cooling substance it can result in the surfaces of the materials becoming hot or actually producing sparks, either of which may be sufficient to cause ignition. Friction can be caused by impact (one material striking another), rubbing (when moving parts of a machine contact stationary surfaces) or smearing (for example, when a steel surface coated with a softer light metal is subjected to a high specific bearing pressure with sliding or grazing).

   (iii) A space heater is designed to give off considerable heat and, close to the heater, temperatures may be very high. Fire may be started by combustible materials being placed too close to the source of the heat (through radiation) or by actually touching the hot surfaces of the heater itself.

(3) (i) Convection

   (ii) Radiation

   (iii) Conduction.

(4) Direct burning

(5) (i) Class C – fires involving gases or liquefied gases..

   (ii) Class B – fires involving flammable liquids or liquefied solids.

   (iii) Class A – fires involving solid, mainly carbonaceous, materials (here, most likely paper and furniture, etc.).

Revision Question 2

(1) Fire risk can be minimised by ensuring that wood shavings and dust are cleared regularly and ignition sources such as cigarettes and sparks from electrical equipment do not come into contact with combustible materials.

(2) The volume of flammable liquids in use at any one time should be minimised and it should be held in appropriate (usually metal), correctly labelled containers with secure lids. The need to decant highly flammable liquids from one container to another should be minimised, thus reducing the risk of spillages.

(3) (i) The fire resistance of timber depends on the "four Ts": the thickness or cross-sectional area of the piece, the tightness of any joints involved, the type of wood and any treatment received.

(ii) The fire resistance of reinforced concrete depends on the type of aggregate used and the thickness of concrete over the reinforcing rods.

(iii) The fire resistance of a brick wall depends on its thickness, the applied rendering or plastering, whether the wall is load-bearing or not, and the presence of perforations or cavities within the bricks.

(4) The beam will distort, possibly causing the collapse of any structure it is supporting. It will also conduct heat and increase the possibility of fire spread.

(5) When exposed to heat the paint bubbles rather than burns and thus gives additional protection to the covered timber.

(6) A site plan, the fire hazards and their level of risk, and fire control and evacuation measures.

Revision Question 3

(1) Manual systems alone can only raise an alarm over a limited area and for a limited time. There has to be some means for the person raising the alarm to make it general – by using the phone or public address system, or a manual/electric system.

(2) (i) Detection of smoke or other fumes by ionisation or optical smoke detectors.

(ii) Detection of flames by ultra-violet and infra-red radiation detectors.

(iii) Detection of heat by fusion or expansion heat detectors.

(3) Starvation (removing the fuel), smothering (removing the oxygen) and cooling (removing the heat).

(4) (i) Water – class A

(ii) Carbon dioxide gas – classes A and B

(iii) Dry powder – classes A, B, and D

(iv) Foam – class B

(v) Fire blankets – classes A, B, D and F

(5) Water – Red

Chemical foam – Cream

Carbon dioxide – Black

Dry powder – Blue

(6) General understanding of how extinguishers operate.

The importance of using the correct extinguisher for different classes of fire.

Practice in the use of different extinguishers.

When to and when not to tackle a fire.

When to leave a fire that has not been extinguished.

Revision Question 4

(1)   An assembly point should be a place of ultimate safety (outside the building, in the open air, away from any further danger from the fire) or a place of comparative or relative safety, in a fire-protected area.

(2)   There should be a roll call to ensure that all people in the affected area are present.

(3)   (i)   High fire risk areas – one minute or 12 - 25 metres

     (ii)   Normal fire risk areas – three minutes or 18 - 45 metres

     (iii)   Low fire risk areas – five minutes or 45 - 60 metres

(4)   To direct occupants to the means by which they can safely leave the premises.

(5)   The escape route should be as straight as possible direct to the assembly point, clear of obstruction, free of materials which could pose a fire hazard, and be wide enough throughout (including at doorways and openings) to provide for the unrestricted flow of people.

(6)   Ensuring all occupants leave by the designated escape route.

Searching all areas to ensure that the area is clear.

Ensuring that fire escape routes are kept open and clear at all times.

Ensuring all doors and windows are closed on leaving the area.

Conducting the roll call at the assembly area.

Meeting the fire brigade on arrival and informing them of all relevant details.

NEBOSH International General Certificate

Unit 12 | Chemical and Biological Health Hazards and Control

Contents   Page

INTRODUCTION

This unit is concerned with the very broad subject of "substances hazardous to health", mostly in the form of the wide range of chemical and biological agents which are used in work activities or may be present in the workplace. The first parts of the unit consider the hazards posed by chemical and biological agents, both in terms of the ill-health effects they may produce and the ways in which they may be explained to those working with the substances. We then go on to look at how information about the risks is provided and the ways in which the presence of such risks in the workplace may be monitored. The last parts of the unit are concerned with the ways in which workers and others are protected from the hazards, firstly in relation to workplace control measures and finally in relation to the discharge of hazardous substances into the environment.

In doing so, the unit is designed to meet the following aims and learning outcomes as specified by NEBOSH for this part of the syllabus for the International General Certificate.

Overall Aims

On completion of this unit, you will have knowledge and understanding of:

* The ill-health effects of exposure to chemical and biological hazards

* The options to control these hazards in the workplace.

Specific Intended Learning Outcomes

When you have worked through this unit, you will be able to:

* Recognise chemical and biological hazards in the workplace

* Explain the significance of the physical form of a substance to the related health hazard and the relationship between the route of entry into the body of a hazardous substance and its associated risk

* Distinguish between acute and chronic ill-health effects

* Make a preliminary assessment of the health risks from substances and biological agents commonly encountered in workplaces using basic survey techniques, suppliers' safety data sheets and simple environmental monitoring and testing methods.

* Apply a hierarchy of control measures to reduce the risk of ill-health caused by the exposure to chemical or biological agents

* Outline the basic principles relating to the disposal of waste and effluent and the control of atmospheric pollution.

FORMS OF CHEMICAL AGENTS

When we consider chemicals in the workplace we are not solely concerned with substances and preparations which are used directly in work such as paints or cleaning materials. We are also concerned with chemicals which arise from the work, such as the dusts or fumes given off during a process, for example when grinding or heating solid metals.

A chemical may be in the form of a substance or a preparation. Firstly, some definitions:

- A substance is a chemical element or a compound, including any impurities

- A preparation is a mixture of substances, usually with a deliberately proportioned composition.

Chemical substances and preparations exist in a variety of physical states and it is important to understand these as they affect the way in which chemical hazards arise in the workplace. Note that different forms of the same substance may present different hazards:

- **Liquids**

  Many chemicals are supplied and used in the workplace in liquid form. They can vary from relatively harmless cleaning fluids through to highly toxic and corrosive acids and alkalis.

- **Gases**

  A gas is a formless chemical which occupies the area in which it is enclosed. Its volume and state can be changed by the combined effect of increased pressure and decreased temperature. There are many toxic gases used in industry, such as chlorine, hydrogen sulphide, etc.

- **Vapours**

  Vapour is the gaseous form of a liquid below its boiling point. There is an equilibrium or balance between the two phases or states. Heating a liquid causes evaporation. Solids also exist in equilibrium with vapour, hence we can smell them, but in most cases the amount of vapour is negligible.

- **Mists**

  Mists consist of finely suspended droplets formed by condensation from a gas or the atomising of a liquid or from aerosols. Mists are created by many industrial processes, such as chromium plating or charging lead acid batteries and car paint spraying.

- **Fumes**

  Fumes are fine particulate solids, which are created by condensation from a vapour, often after a metal has been converted to the molten state. The metallic fumes are usually the oxide of the metal and produce highly toxic fumes.

- **Dusts**

  Dusts consist of solid particles of varying size and are created by such operations as grinding or sieving of solid materials, controlled detonations and various drying processes. In still atmospheres, dusts tend to settle under gravity and accumulate on surfaces. Where there is turbulence or air movement at least some element of the dust will remain airborne.

- **Aerosol**

  Fine suspension of solid particles or droplets in a carrier gas.

FORMS OF BIOLOGICAL AGENTS

Biological hazards relate mainly to illness contracted from exposure to harmful micro-organisms. We are concerned here specifically with biological agents which are directly connected with the work undertaken or which are incidental to it; for example, relating to farming, sewage treatment or healthcare. Examples include the following.

Fungi

A fungus is a plant lacking chlorophyll and reproducing by spores. Examples include mushrooms, mould and yeasts. Fungal diseases manifest themselves as an allergic or immune response in the form of asthmatic and/or influenza-type symptoms from inhalation of dust or air contaminated by fungi, such as dry rot in roofs.

Bacteria

A bacterium is any of a large group of single celled microscopic organisms of various shapes that are often agents of fermentation and putrefaction and which may cause disease. There are countless bacteria present in the world, but those we are concerned with here are those which may be present because of the particular nature of the work processes themselves. Examples include:

- **Legionella** – caused by the bacterium *Legionella pneumophililia*, which may be present given certain conditions in cooling towers and water systems and air conditioning systems. The bacterium may be spread by aerosols from the contaminated water source. It affects the lungs and is deposited in the alveoli and can be fatal.

- **Zoonoses** – animal bacterial infections which may be transmitted to people in the course of their working with animals, either on farms or in their transport and slaughter. Common examples include:

  - **Anthrax –** a virulent bacterial infection which may occur in those who are in contact with live animals suffering from the disease or more often from handling infected animal skins or carcasses.

  - **Brucellosis** – caused by a pathogen contracted from cattle or pigs.

Viruses

A virus is a pathogenic (disease causing) agent capable of multiplying rapidly inside a living cell. Examples include:

- **Hepatitis B** – This severe form of jaundice is most common amongst medical staff and refuse disposal workers as a result of contact with blood or excreta of patients suffering from viral hepatitis, or in whom the disease is still in its incubation stage, or from carelessly discarded syringes and other 'sharps' in disposable plastic sacks. The disease is normally self-limiting with recovery in about six weeks. In about 5% of cases chronic infectious hepatitis follows, leading to cirrhosis and possibly death.

- **HIV** – Acquired Immune Deficiency Syndrome (AIDS) is caused by the Human Immunodeficiency Virus (HIV) which attacks the immune system by which the human body can resist infections. The virus is found in most body fluids of sufferers and is transmitted by the passing of infected fluids into the blood of another person. It is a delicate virus and relatively easily destroyed outside the body. It is not easily transmitted and requires direct contact.

MAIN CLASSIFICATION OF SUBSTANCES HAZARDOUS TO HEALTH

Most governments have some form of hazard communication standards. These include some form of labelling of dangerous chemicals to enable the user to quickly identify the hazards of the product. Some countries use risk-based labelling, others use hazard-based labelling. There is no truly global way of classifying hazards of chemicals. However, significant progress has been made recently in the form of the "Global Harmonisation of Systems for Classifications of Chemicals (GHS)". This is a United Nations (UN) backed initiative aimed at a common approach to classification. This ultimately will combine all the different ways of classifying dangerous chemicals into a single standard which will then be available as a model for adoption by national and regional governments. For the moment there are several different ways.

In general there are two basic "user groups" envisaged in hazard communication – the actual user of the chemical and the transporter/haulier. Hazard communication to the latter group is through a pretty well globally harmonised set of regulations already, based on the UN Recommendations on the Transport of Dangerous Goods (with its modal variations). We are not concerned with classification for transport in this unit; we will only be concerned with user-aimed systems.

Hazard communication to the chemical user is through regulations which vary quite a lot between countries. For example, in the US the standard is 29CFR1910; this is very different from the system used throughout Europe under the Dangerous Substances Directive (67/548/EEC) and the Dangerous Preparations Directive (1999/45/EC).

Categories of Danger

There are some basic threads of commonality regardless of the differences between different regions of the world.

Categories of Danger

There are three general groups of chemical hazards, each of which contain a number of sub classifications:

- **Physico-chemical effects** – those that are caused by the intrinsic physical or chemical properties of the substance; for example, flammable, oxidising or explosive

- **Health Effects** – those that arise from a chemical causing harmful effects to living organisms, which in practice normally means death, injury or adverse effects in humans when ingested, inhaled or absorbed through the skin. Toxic effects may be acute or chronic (e.g. cancer), local or systemic, and reversible or irreversible.

- **Environmental effects** – those which relate to the potential of a chemical to damage one or more environmental compartments (i.e. the air, soil or water, including groundwater). This type of classification is a relatively new concern as the world becomes more concerned with environmental stewardship.

The commonly used terms used within the three basic categories are outlined below.

Health Effects

- **Toxic**

  Toxic substances and preparations are those which in small quantities cause death or acute or chronic damage to health when inhaled, swallowed or absorbed via the skin. Some substances (such as potassium cyanide) can cause death in extremely small quantities. Insecticides are toxic to insects but the quantity used is restricted so they are not harmful to humans, though it might be necessary for persons applying it extensively to wear protective equipment to reduce their exposure.

- **Corrosive**

  Corrosive substances and preparations are those which may on contact destroy living tissues. The following examples of corrosive substances may be encountered in the course of industrial processes:

  - *Acids* – Sulphuric acid; hydrochloric acid; nitric acid; phosphoric acids.

  - *Alkalis* – Sodium hydroxide (caustic soda); potassium hydroxide (caustic potash).

  - *Gases and vapours* – Hydrogen chloride is a colourless gas that in moist air appears as a white mist which is poisonous and corrosive. Many corrosive liquids expel damaging corrosive vapours which are irritating or cause burns to the eyes or respiratory tract.

- **Irritant**

  These are non-corrosive substances and preparations which through immediate, prolonged or repeated contact with the skin or mucous membrane may cause inflammation.

- **Sensitising**

  These are substances and preparations that may cause an allergic reaction.

- **Carcinogenic**

  Carcinogenic substances and preparations are those which if inhaled or ingested or absorbed by the skin may induce cancer or increase its incidence.

- **Mutagenic**

  Mutagens are substances and preparations which alter cell development and cause changes in future generations.

- **Toxic to Reproduction ("Reprotoxic")**

  These are substances which may affect male or female fertility or harm a foetus, including those which cause abnormal development of an embryo producing stillbirth or birth defects (called teratogens).

The last three items are commonly grouped together and known collectively as "CMR" effects. Note that in classifying a particular chemical the hazards it presents may lie within any or all of the general classifications and more than one class of danger may be identified. Thus nitric acid in high concentration is classified as both oxidising and corrosive.

Acute and Chronic Health Effects

Acute health effects arise where the quantity of a toxic or harmful substance absorbed into the body produces harmful effects very quickly, that is within seconds, minutes or hours.

In an occupational setting acute toxicity does not often occur because the conditions required to produce it are either too complicated, or the results would be so serious that stringent safety measures are observed, thus preventing its occurrence. Gassing accidents producing toxic conditions are an exception.

The term chronic toxicity describes a condition where the harmful effects of a substance absorbed into the body take a **very long time** to appear, perhaps months or years. The conditions produced by the toxin usually result from absorption of small quantities over a period of time. In terms of occupational safety, chronic toxicity or at least its prevention presents the most difficult control problems.

This is particularly true if materials have little-known or poorly-documented toxicity levels, or if hygiene control strategies are breaking down. The following points illustrate how deceptive are the effects of chronic toxicity and gives an indication of the difficulties of achieving effective control:

- The effects occur over a long period, so the hazard is not recognised.

- The level of contamination required to produce chronic effects is often tolerated by people because they do not experience acute symptoms.

- Symptoms occur slowly so they are not recognised until an advanced condition of harm has developed.

- When symptoms are recognised the harm may be too advanced for full recovery; sometimes no recovery is possible.

- Symptoms are often confused with "normal" ill-health or with "getting older".

- Symptoms are not always easily identifiable in groups of people with the same exposure owing to the effect of differing "personal" metabolisms.

It is important to note that for both acute and chronic toxicity, **time** is involved in relation to their definition, but that the **level** of toxic action is **not** defined. Acute toxic action does not necessarily mean death. Intoxication from drinking alcohol is an acute toxic condition but only in rare cases is it the direct cause of death. Cirrhosis of the liver related to intoxication by alcohol is a chronic toxicity condition from which death can occur.

Some toxic substances such as cyanide and paraquat are generally considered to be acute toxins only.

HEALTH HAZARDS OF SPECIFIC AGENTS

In this section we consider a number of toxic chemicals and biological agents and the hazards which they pose, together with the circumstances in which the hazards arise. We also describe the body reaction to entry of these agents, both in respect of the immediate superficial response and the longer term body defence mechanisms.

Ammonia

Ammonia is a colourless gas with a pungent odour, readily soluble in water. It is used as a refrigerant, in petrol refining, metallurgy, water purification, and in the manufacture of fertilisers, drugs and chemicals.

It is a strong mouth and lung irritant and corrosive substance, either as a gas or when combined with water as a liquid. Entry is by inhalation into the lungs or absorption through the eyes or the skin.

Exposure to ammonia vapour to any extent can produce very serious damage. However, the irritant effect is such that a very mild unprotected exposure causes immediate discomfort and hasty withdrawal from the area. Severe exposure may result in pulmonary oedema, in which tissues of the air passages in the lungs swell with excess fluid and the victim "drowns".

If ammonia in liquid form is splashed onto the skin it may lead to severe or even fatal burns and ulceration.

If ammonia gets into the eyes (as a liquid or a vapour) there is an immediate effect on the conjunctiva (the membranes in front of the eye and inside the eyelid) causing severe pain. Ulceration of the conjunctiva and cornea (front part of the eyeball), scarring of the tissues and lenticular opacity (clouding of the lens) may interfere with vision, even causing blindness.

Chlorine

Chlorine is a gas with low solubility in water. At very low concentrations it is used in swimming pools as an antibacterial agent, though rarely is the gas itself now used for this purpose, but rather solid or liquid substances which decompose in water to generate chlorine. Domestic bleach releases chlorine, rapidly in the presence of acids, and this is a common source of chlorine gassing accidents both in the workplace and at home. Chlorine has been used in warfare, and was known as mustard gas.

It is an irritant at low levels but can produce highly corrosive effects on reaching the lower respiratory areas at a high concentration and can be very harmful. The immediate effect is choking but it may also damage the lining of the lungs.

Organic Solvents

Solvents such as dichloromethane, toluene, xylene and styrene are widely used throughout industry. They are common ingredients in industrial paints and used as degreasers and cleaners to remove oils, etc., from metal components. They are also used in many chemical processes. Many organic solvents are highly flammable.

Solvents most commonly enter the body by inhalation of vapours, but alternatively can be absorbed through the skin, and occasionally are drunk, either intentionally or unintentionally.

Solvent vapours enter the body by inhalation and can have wide-ranging, very harmful, effects. Many are narcotics (e.g. toluene) progressively causing drowsiness, nausea and unconsciousness, and some are carcinogenic (e.g. benzene).

The immediate effect may be loss of consciousness resulting from inhaling significant quantities in a short space of time. Long-term exposure can affect the central nervous system causing memory loss and loss of motor co-ordination (dexterity) skills as well as causing lung damage. Solvent vapours also damage the skin by stripping it of its natural oils and causing dermatitis.

Carbon Dioxide

When anything organic is burned, carbon dioxide (CO_2) is produced. This includes petrol in cars and fossilised fuels used at power stations to generate electricity. It is one of the greenhouse gases that absorbs heat in the atmosphere, keeping the earth warm.

Carbon dioxide is also formed in the body and expelled in the air we breathe out. However it acts as a simple asphyxiant on inhalation. This type of asphyxiant does not cause any direct injury to the airway, but displaces air and reduces the oxygen level from its normal 21% to a lower level, depending on the extent of the concentration of the gas. Human life can be supported at levels of less than 21% oxygen but below 17% serious problems begin.

The reduction of oxygen in the lungs gives rise to giddiness, chest pains, breathlessness and loss of consciousness. Eventually the prevention of oxygen transport in the blood may lead to toxaemia (blood poisoning) and death.

Carbon dioxide is also used industrially in its solid form (freezing point $-58^{\circ}C$). This causes "burns" on contact with skin.

Carbon Monoxide

Carbon monoxide (CO) is a colourless odourless tasteless gas and is toxic. Like carbon dioxide, it is formed in the combustion of organic material, but usually in very small amounts unless there is a deficiency of oxygen (air).

It combines with haemoglobin in the blood impairing the transport of oxygen. Concentrations above 5% cause immediate loss of consciousness, but far more people are killed by exposure to much lower concentrations over a period, typically when a gas-fired heater is used in a poorly ventilated room.

Isocyanates

Organic di-isocyanates compounds are used to make adhesives, synthetic rubber, polyurethane paints and lacquers, and quick-drying printing inks. The most important industrial applications are in the manufacture of plastics and paints to make them harden quicker.

They can cause problems in industrial use where the vapours may have severe irritant effects and may be sensitisers.

- Hexamethylene di-isocyanate (HDI) is very volatile and causes significant respiratory problems, although it has now been largely replaced with less volatile isocyanates.

- Toluene di-isocyanate (TDI) is responsible for severe respiratory problems because of its irritant effect. It is still widely used in the manufacture of flexible foams and paints.

A more recent introduction with virtually no vapour hazard at ambient temperature is methane diphenyl isocyanate (MDI).

Immediate irritant effects include inflammation of the mucous membrane of the nose and throat and bronchitis. In most cases the symptoms and signs clear rapidly after the worker is removed from contact with the isocyanate. However, in many of those who have shown a quick initial recovery, the symptoms have recurred, often violently, after further contact with even very low concentrations of isocyanate (a condition known as sensitisation). Others are known to suffer from a chronic form of asthma.

Lead

Lead is a soft heavy metal and is relatively inert. Its use dates back to the earliest metal working technologies and it was for centuries used in plumbing, a trade which gets its name from the Latin word plumbum meaning lead. Because of the slight health hazard this poses, such use has been discontinued, though much lead piping still exists. Lead is still used to some extent in buildings and extensively in lead/acid batteries for cars.

Lead compounds have been and are still used as raw materials in manufacturing processes. They can be classed into:

- Inorganic compounds such as lead oxide (red lead) and lead chromate (chrome yellow) used as pigments, though because of toxicity no longer in paints for domestic use;

- Organic lead which was extensively used as an anti-knock agent in petrol, lead tetraethyl, but is rapidly being replaced again because of health concerns.

Organic lead compounds are far more hazardous to health than the inorganic forms since they are chemically mobile, able to participate in biochemical reactions and pass through the food chain.

Metallic lead in its massive solid state cannot be readily absorbed into the body through any of the normal modes of entry. Inhalation of lead dust does present a significant risk and is the most frequent route by which inorganic lead is absorbed. For organic lead compounds, entry is by inhalation and skin contact, although ingestion as a result of work activities poses a minor risk.

Intoxication by inorganic lead compounds leads to general symptoms related to the gastrointestinal tract (the gut), the nervous system and the blood:

- Acute intoxication, resulting in general from inhalation of high concentrations of lead fume or dust produces nausea, vomiting and headaches. This is often followed by constipation and severe intermittent colic. If the brain becomes affected then dullness, restlessness, tremor, convulsion or coma may develop.

- When exposure has occurred over long periods and chronic intoxication takes place, other clinical symptoms develop. The classic symptoms are headaches, anaemia, palsy, gastrointestinal problems and the appearance of a blue line on the gums.

The absorption of organic lead can have fatal consequences. Its absorption into the body mainly affects the central nervous system producing restlessness, a raised level of excitement and talkativeness, muscular twitching and possible delusions, acute and violent mania. These conditions are accompanied by a fall in body temperature and a drop in normal blood pressure.

Where the level of intoxication is lower, headaches, vertigo, fatigue, a sense of physical weakness and insomnia with disturbing dreams are classic symptoms.

Where death is delayed or the absorption is not fatal, extensive damage may occur in the kidneys, liver, pancreas and spleen. A pulmonary oedema (a build-up of fluid in the lungs) could also occur following inhalation.

There is a risk of exposure to lead associated with the following work activities.

- Lead smelting
- Lead chemical manufacture
- Lead/acid battery manufacture
- Shipyards
- Petrol manufacture and handling
- Plumbing
- Painting
- Welding.

Asbestos

Asbestos has been a widely used natural material which, although now banned in many countries, is much in evidence in many workplaces. Previously used as an insulation and fire-resistant material in building construction, it was also a common friction lining in machinery (brakes, clutch plates, etc.).

The inhalation of asbestos fibres causes incurable respiratory diseases, mainly cancers of the lung and chest lining. Death occurs only 15-60 years after exposure although the initial symptoms (breathlessness and coughing) can appear sooner. Although the use of asbestos is now banned in most countries, many people are still dying each year due to earlier exposures and this number is still rising. Three main types of respiratory disease associated with asbestos can be distinguished:

- Asbestosis is formation of scar tissue (fibrosis) in the walls of the alveoli (air sacs) causing thickening and hence slowing the passage of oxygen into the blood, so causing breathlessness on exertion.

- Mesothelioma is a type of cancer of the lining around the lungs and of the abdomen (through swallowing asbestos fibres).

- Lung cancer occurs particularly amongst smokers exposed to asbestos. Fibres protecting the lungs are flattened after inhaling cigarette smoke, so there is less protection against asbestos fibres.

We still have the legacy of thousands of tonnes of asbestos in existing buildings. Some of it is bound up in products such as asbestos cement and sprayed coatings. So long as it is in good condition and not disturbed then it does not pose a significant risk. Most countries have some legislation pertaining to the management of asbestos (and also banning future use) because of its previous widespread use and the special risks it poses. To manage the risk of asbestos in any business premises, the following are useful guidelines:

- Find out if there is asbestos in the premises, its amount and what condition it is in

- Presume materials contain asbestos unless you have strong evidence that they do not

- Make and keep up to date a record of the location and condition

- Assess the risk

- Prepare a plan to manage the risk

- Take steps to put the plan into action

- Review and monitor the plan and arrangements

- Provide information to anyone who is likely to work on or disturb the asbestos.

Eventually it will have to be removed by specialist contractors.

All air we breathe is contaminated to some degree with asbestos fibres, but this background level is not a cause for concern and in any case there is nothing we could do about it. What we have to avoid is further contamination.

Asbestos is a naturally occurring mineral containing silicates. There are many types. The most common is serpentine asbestos such as chrysotile, commonly known as white asbestos. Note that the others may also look white. This is the least harmful form and its use has only been banned totally in many countries comparatively recently. Nevertheless it is not without some risk to health, partly because often it contains some of the other types.

Amphibole asbestos includes blue asbestos (crocidolite) and brown asbestos (amosite), which have a higher risk of health effects, as well as tremolite, anthophyllite and actinolite. They have been banned for some time, but still exist in older buildings. Anywhere they are identified they should be removed by specialist contractors taking appropriate precautions.

Originally the group of workers most at risk were those mining the mineral, those processing it, and those applying it in a loose form such as lagging. They still comprise a high percentage of new cases. Since its use was banned, building maintenance, refurbishment and demolition workers have become most at risk.

Silica

Silica (Silicon dioxide) is a naturally occurring compound present in many rocks and stones, particularly sandstone, quartz and slate. It exists in several different forms, the crystalline varieties being of most concern. It is an irritant when inhaled as a dust and can cause numerous chest and respiratory tract diseases.

Pneumoconiosis is the general term for an accumulation of dust in the lungs and the tissue reaction to its presence. There are two basic forms:

- **Collagenous pneumoconiosis** – which causes permanent alteration or destruction of the structure of the alveoli and permanent scarring of the lungs as a result of exposure to fibrogenic dust. Silicosis is a collagenous pneumoconiosis caused by inhalation of respirable particles of free silica.

- **Non-collagenous pneumoconiosis** – which results from exposure to non-fibrogenic dusts and involves no change to the structure of the alveoli tissue. The effect caused by the dust is potentially reversible in that the affected area may return to its original state if the dust is removed from the lung structure.

Mixed dust fibrosis results after the inhalation of dusts with variable proportions of silica and other materials.

In the early stages of infection there may be only limited areas of collagenous pneumoconiosis, which develops as the condition intensifies. Symptoms include:

- Breathlessness on exertion

- Coughing with associated sputum (lung mucus)

- Chest pains.

In its later stages, impaired lung function puts a strain on the heart and death usually results as a combination of lung and heart failure.

Occupations at risk include quarrymen, masons, stone-cutting machine workers and stone dressers, and slate quarrymen. The use of quartz in firing pottery has been replaced by alumina; silica grinding wheels have been superseded by carborundum.

Leptospira

Weil's disease is an infectious jaundice with symptoms of fever, jaundice, enlargement of the liver, haemorrhages and feverish relapses. The organism causing it is a bacterium of the genus *Leptospira*.

Rats are the primary cause of the disease. *Leptospira* is found in the kidneys of rats (which are resistant to the disease) and is excreted in their urine and it is from this source that humans are infected. The primary routes of infection are through drinking or eating contaminated water or food, and absorption where the skin is broken, although there is evidence that the bacterium can pass through intact skin. People at risk include canal workers, sewer workers, fish cleaners, tripe scrapers, pig workers, butchers, workers in abattoirs, rat catchers and agricultural workers.

Primary control is through systematic destruction of rats in infested areas. Control of the disease in sewer workers is difficult, but prophylactic immunisation (injecting a vaccine) seems to offer the best solution, together with a campaign of antibody testing. In addition all "at risk" workers should carry a card warning of the dangers, stressing personal cleanliness and hygiene, explaining the need for protective clothing and alerting doctors to the possibility of the disease.

It is essential that people subject to potential risk are aware of the causes and symptoms, given instruction in suitable first-aid precautions (such as covering existing skin wounds, cleaning and disinfecting all fresh wounds), notify a medical practitioner if influenza-like symptoms occur and notify the relevant authorities if rat infestation is noticed in a work area.

Auto-immune Diseases

Auto-immune diseases include AIDS (Acquired Immune Deficiency Syndrome), which is caused by the Human Immunodeficiency Virus (HIV). HIV attacks the person's immune system. This means that resistance to infection is greatly reduced. HIV has relatively low infectivity, usually requiring repeated exposure.

Occupationally, the risk of contracting HIV may be through inoculation or contamination of cuts with body fluids/blood of an infected person. Medical personnel (and support staff) are therefore most at risk because they have daily potential exposure to body fluids. In an industrial setting, first aiders would be at risk.

Precautions include – covering of cuts/abrasions where exposure to body fluids is likely; disinfection and containment to control surface contamination; proper disposal of contaminated waste/sharps.

Legionella

Legionnaires' disease is caused by the bacterium *Legionella pneumophilia*, as is Pontiac fever, a shorter more feverish illness, without the complications of pneumonia. Legionellosis is the generic term used to cover Legionnaires' disease and Pontiac fever.

The bacterium thrives in certain wet conditions:

- Water temperatures in the range of 20-45°C; it does not survive above 60°C and the organism remains dormant in cool water.

- The presence of sediment, sludge, scale and/or organic material in the water, all of which can act as a source of nutrients, as can organisms such as algae, amoebae and other bacteria.

- Slime on the surface of water, where the incorporation of Legionella can protect the slime organisms from biocides.

Legionnaires' disease is a type of pneumonia affecting the lungs and other organs of the body. Infection is caused by inhaling airborne droplets or particles containing living *Legionella*, which are small enough to pass deep into the lungs and be deposited in the alveoli. The disease has an incubation period of three to six days and the initial symptoms include high fever, chills, headache and muscle pain. A dry cough soon develops and most patients suffer difficulty with breathing. In certain cases this can lead to death, particularly among those with reduced resistance such as smokers, alcoholics and patients with cancer, chronic respiratory or kidney disease.

Exposure to *Legionella* can also lead to **Pontiac fever**, a milder condition with an incubation period between five hours and three days. Symptoms of Pontiac fever are similar to those of moderate to severe influenza, with headache, tiredness and fever.

Legionella is most commonly found in the water systems of buildings, with those potentially at risk being:

- Cooling towers
- Evaporative condensers
- Hot/cold water services in premises where the occupants are susceptible, such as health care premises
- Humidifiers and air washers creating a spray of water droplets above 20°C
- Spa baths and pools.

Employers can manage the risk of *Legionella* by:

- Identifying and assessing sources of risk, taking into account potential for drop formation, water temperature, exposure probability and adequacy of control.

- Implementing control measures to avoid conditions where *Legionella* can proliferate and to avoid creating sprays or aerosols; for example:

    – Keeping the system clean and preventing a build-up of sediment and slime

- Avoiding the use of materials which provide nutrient for the organisms

- Using appropriate water treatment chemicals

- Avoiding stagnant or still water temperatures between 20°C and 45°C

- Monitoring the water quality of "susceptible" systems (those in premises which contain a high proportion of susceptible people (hospitals or nursing homes) and situations where there is a large number of such people at risk.

Hepatitis

Hepatitis is a virus causing similar symptoms to Weil's disease – fever, jaundice, enlargement of the liver, haemorrhages and feverish relapses. It is contracted primarily through injection, although ingestion of infected substances may also be a route of entry.

In recent years infectious hepatitis has become the most common occupational disease amongst medical and hospital staff – doctors, surgeons, nurses and ancillary staff such as hospital porters. Refuse disposal workers form another group increasingly at risk. Infection amongst health workers is a result of contact with blood or excreta of patients suffering from viral hepatitis or in whom the disease is still in its incubation stage. Hospital porters and refuse disposal workers appear to be at risk from carelessly discarded syringes and other "sharps" in disposable plastic sacks. The problem is becoming more severe with the increase in drug addiction and the use of shared needles.

The course of the disease is very much like that of Weil's disease but is usually much less severe and normally self-limiting with recovery in about six weeks. In about 5% of cases chronic infectious hepatitis follows, leading to cirrhosis and possibly death.

People exposed to the risk, who may include firemen and ambulance workers in addition to those already mentioned, can be protected with injections of gammaglobulin. In all cases protective disposable gloves should be worn and hands and arms washed regularly with disinfectant.

ROUTES OF ENTRY INTO THE BODY

The **process** of entry into the body for a toxic or harmful agent is by **absorption** across the skin of the body (the outer skin) or across the lining (epithelium) of the lungs or gastrointestinal tract.

The **route** of entry is the way along which the agent is transported to, or arrives at, the site where absorption and entry occur. Note that absorption may take place anywhere along the route.

Substances can enter the body in many different ways:
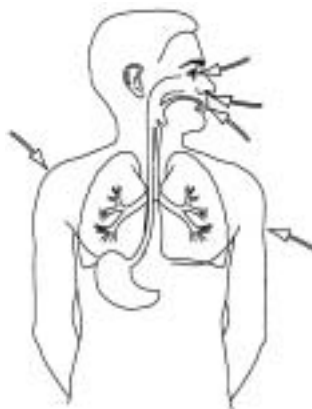
Routes of Entry

• **Inhalation**

Entry is through the nose or mouth and along the respiratory passages to the lungs. The lung is the most vulnerable part of the body as it can readily absorb gases, fumes, soluble dusts, mists and vapours. This is the main means of entry of biological agents.

Note that there is a difference between inhalable substances and respirable substances. Inhalable substances are capable of entering the mouth, nose and upper reaches of the respiratory tract during breathing. Respirable substances are capable of deeper penetration to the lung itself. It is the size of the individual particle that determines whether a substance such as a dust is inhalable or respirable. Gases and vapours will be respirable because of their tiny particle size. Many fumes and mists will be respirable but again it will depend upon how small they are.

Particles of a size which penetrate only as far as the thorax (chest) before becoming trapped are described as thoracic dust.

• **Ingestion**

Entry is by the mouth and along the whole length of the gastrointestinal (gut) tract through the stomach and the intestines. Note that contamination may occur as a result of swallowing the agent directly from eating/drinking contaminated foods or from eating with contaminated fingers. All forms of chemicals may be ingested and some biological agents may also find their way into the body by this route.

• **Absorption**

Entry is through the skin or via the eyes, either from direct contact with the agent or from contact with contaminated surfaces or clothing. It is mainly chemical liquids which enter

the body in this way, although other forms of chemical may either sufficiently damage the skin to gain entry or find their way through the eyes.

- **Aspiration**

  This describes the process whereby liquids or solids go direct into the lungs other than by inhalation. Entry occurs while the epiglottis (the flap immediately below the root of the tongue which covers the entrance to the lung passage) is open; for example, solid/liquid material originally ingested can run into the lungs when vomiting occurs, or liquids can be sucked into the lungs when using a pipette if there is a sudden inrush of air at the bottom of the pipette.

- **Injection**

  Entry is direct into the body by high pressure equipment or contaminated sharp objects piercing the skin. Chemical liquids and sometimes gases and vapours may enter the body in this way. There is also a risk of biological agents being injected, either on needles, etc. or by biting from an infected animal.

Note that the route of entry into the body is critical in determining the appropriate control measures. Thus, where there is a risk of direct absorption, workers should be protected with appropriate clothing to prevent contact between the agent and the skin, or where the key entry route is through inhalation, respiratory protection must be provided.

REVISION QUESTION 1

(1)   State the forms of chemical agents which may arise in the workplace.

(2)   Identify the three general classifications of chemical hazards.

(3)   Distinguish briefly between acute and chronic ill-health effects.

(4)   Identify the routes of entry of chemical and biological agents into the body.

(5)   What are the conditions which allow the *Legionella* bacterium to develop?

(6)   What is the difference between the effects of CO_2 and CO?

(7)   What is the difference between an inhalable substance and a respirable substance?

(8)   What is pneumoconiosis?

The suggested answers are given at the end of the unit.

BODY DEFENCES AGAINST HAZARDOUS SUBSTANCES

The body has a number of defence mechanisms.

Natural Defences

The lungs are designed to allow gaseous transfer in and out of the body. The alveoli tissue is very delicate and therefore vulnerable to physical damage.

Consequently, the alveoli are potentially at risk from a naturally dusty environment. In order to protect the lungs, the body has developed special defence mechanisms which can be divided into 2 parts: physical filtration and biochemical clearance (or phagocytosis).

Similarly, the skin, eyes and other organs which can be affected by external factors have their own methods of defence. These are discussed below.

Airway Filtration

Air is inhaled through the nose and because the airway is transversed with moist hair, it is able to trap any large particles. Mucus-forming cells in the nose and nasal sinuses bathe the hair, so that trapped particles are washed out.

As the air passes through the nasal sinuses, particles collide with the sticky mucus lining and become trapped. They are then washed down into the pharynx, where they are either swallowed or expectorated (coughed out). Where dust concentrations are high, or have irritant characteristics, sneezing often occurs. This provides a protective mechanism for removing unwanted solid material.

Air breathed in via the mouth and containing particulate impurities joins the partially-cleaned air inhaled via the nose. This passes into the trachea, on into the bronchi, to the bronchioles and then to the alveoli.

The physical structure of the airway gradually changes to ever-narrowing diameters (see the next diagram). Extensive branching also occurs, so the airway changes direction many times before it reaches the alveoli.
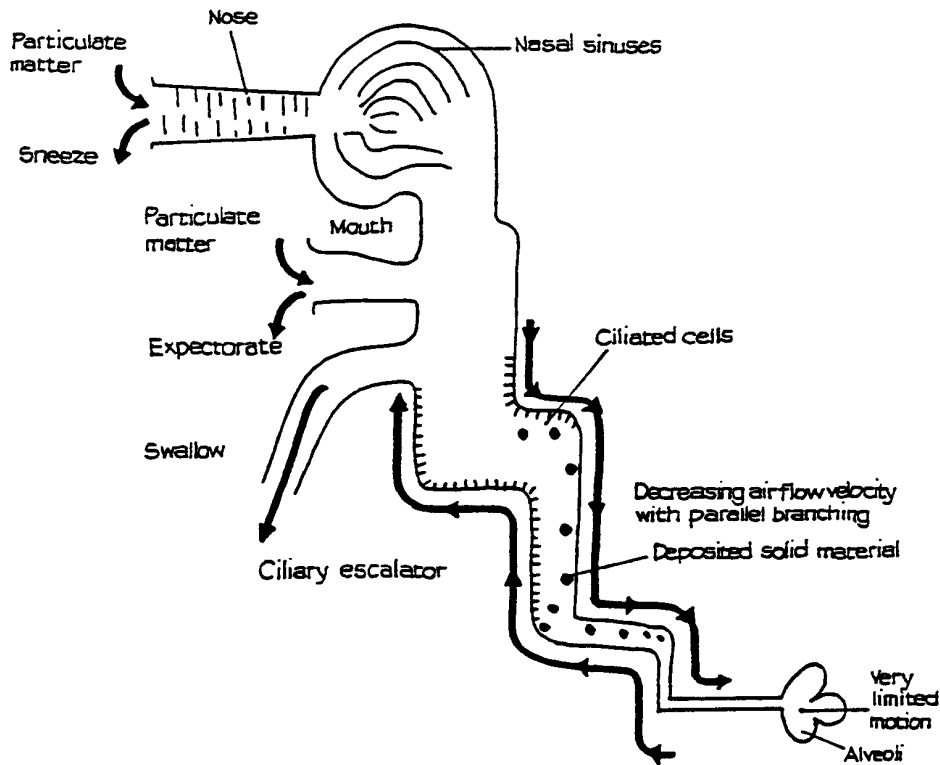
Respiratory Filtration System (Section Through One Airway)

Lachrymation (tear production)

The eye is protected from injury by the bony structure which houses it. The eyebrows protect by diverting liquids to their outer side and away from the eyeball itself. The eyelashes on the upper and lower eyelids prevent particles from entering the eyes and also cause the lids to close rapidly if touched.

The exposed surface of the eye is continuously moistened by tears (lachrymation), secreted by a gland in the outer corner of the eye, and which drain from the inner corner onto the nose. Any irritation of the eye causes an immediate increase in secretion and the irritant is diluted, if it is a liquid, or washed away. This action is aided by the movements of the upper and lower eyelids.

Immune Response

The skin is an important immunological organ and can exhibit a hypersensitive response to certain agents which trigger the release of inflammatory substances, such as histamine. The result is the skin condition called **urticaria** which produces a widespread itchy rash. Agents significant to occupational health include exotic woods, latex, ammonia and sulphur dioxide.

Certain individuals can develop a specific allergy to a substance. Potential allergens penetrate the epidermis and, after repeated exposure over a period of months or years, sensitisation occurs and the body develops a store of sensitised lymphocytes. Once sensitisation has occurred, further exposures to the substance even at low concentrations will cause an outpouring of sensitised lymphocytes to the site of exposure, causing local inflammation.

Inflammatory Response

Inflammation is the reaction of tissue to a harmful agent which is insufficient to kill the tissue. It can follow when a foreign body enters the body by way of inhalation, ingestion, absorption, pervasion, implantation, surface penetration, trauma, or energy transformation. Although inflammation is a defensive process of great importance, if called upon to act for too long, it can sometimes result in disease.

Acute inflammation (swelling) is the immediate defensive reaction of tissue to any injury.

Skin

Inflammation of the skin is much the same as for any other body organ; there are blood capillary changes, there is increased permeability and there is migration of cells. Inflamed skin is painful, sometimes itchy, often red and fissured, sometimes accompanied by oozing of liquid.

APPLICATION OF WORKPLACE EXPOSURE LIMITS

Workplace exposure limits (WELs) provide the basis for controlling airborne contamination of the working environment. They define standards for air quality in terms of the amount of a particular substance which is acceptable in the atmosphere. The air quality standard is usually a time weighted average value rather than a single measurement. It may be an obvious point but the standards also relate to personal exposure, or that to which a worker is actually exposed.

International Variations

Different countries throughout the world have different terminology for WELs. In the UK the term Occupational Exposure Limit (OEL) is used. In the USA the term used is Threshold Limit Value (TLV). In other countries the term "Maximum Allowable Concentration" is used. In the EU, individual member states are beginning to adopt EU-wide limits called "Indicative Limit Values". Regardless of the term, the basic idea is the same; there are limits on what is considered acceptable, safe (or if not safe at least achievable) for airborne concentrations of contaminants in the workplace. Monitoring air quality can then take place to ensure that the limits are not being exceeded.

The WELs for substances hazardous to health are published by governments or organisations (e.g. the UK publishes OELs in HSE Guidance Note EH40; USA TLVs are published by the American Conference of Government Industrial Hygienists (ACGIH)).

The actual values for a given substance do vary between countries. Thus, the TLV for substance "x" is not necessarily the same as the OEL for substance "x". Increasingly, values are converging.

Measuring Exposure in Units

The two main units used for measuring airborne concentrations are:

- Parts per million (ppm)

- Milligrams per cubic metre of air (mg/m^3, or mg m^{-3}).

The gaseous state (vapours and gases) is measured in ppm and refers to the number of parts of vapour or gas of a substance in a million parts of air by volume, measured at a standard temperature and pressure (usually 25°C and 760 mm Hg, respectively). Particulate matter in dusts, fumes, etc. is measured in mg/m^3, which refers to the milligrams of the substance per cubic metre of air.

One further unit of measurement is used in relation to fibres (such as asbestos). Concentrations of fibres are expressed in:

- Fibres per millilitre of air (fibres ml^{-1}).

Long Term and Short Term Limits

The effects due to exposure to hazardous substances depend on the nature of the substance and the length of the exposure; some effects require prolonged or accumulated exposure whilst other effects become apparent very quickly. WELs are therefore usually stated as:

- Long Term Exposure Limit – the level of airborne contaminant allowable over an eight hour period, used for substances producing chronic effects

- Short Term Exposure Limit (15 minutes) – the level of airborne contaminant allowable over a 15 minute period, used for substances producing acute effects.

The concentration levels are expressed as time-weighted averages (TWA). This means that measurements are taken over the period in question and the airborne concentrations are then averaged out.

The concept of a TWA allows concentration levels to exceed the limit, provided that there are equivalent exposures below it to compensate. There are often no stated levels of the extent to which the limits may be exceeded, but the general rule is that in exposures of one-and-a-half times above the limit require urgent improvement in control strategies.

Limitations of Exposure Limits

Whilst WELs provide a general basis on which to assess what may be a safe level of concentration of airborne contamination, it should not be assumed that provided the level does not exceed the stated limit, it is necessarily safe in all circumstances. WELs do not pretend to provide complete protection and there are a number of limitations:

- WELs are designed only to control the absorption into the body of harmful substances following inhalation. They are not concerned with absorption following ingestion or through contact with the skin or the eyes.

- They take no account of human sensitivity or susceptibility. This is particularly important in the case of substances which produce an allergic response; once a person has become sensitised, the exposure limit designed to suit the average person has no further validity.

- They do not take account of the synergistic (or combined) effects of mixtures of substances; for example, the use of multiple substances in pest control or the presence of other harmful substances in the atmosphere (such as radiation).

- They do not provide a sharp dividing line between "safe" and "dangerous" conditions, although that is often assumed. If this was true the concept of time-weighted averages could not be used since levels about the limit would not be permitted.

- As long-term exposure limits are based on an eight hour TWA they cannot be applied directly to working periods which exceed this; for example, long shifts or overtime.

- They may become invalid if the normal environmental conditions are changed; for example, changes in temperature, humidity or pressure may increase the harmful potential of a substance.

Principle of Reducing Exposure Levels

The operation of WELs is based on the concept of controlling risk by reducing the time exposure to the contaminant. Ideally, a "no exposure" limit is the best possible strategy for controlling risk. Although this has been adopted for certain chemicals, especially where carcinogens are concerned, this is impractical in most situations when we take into account the requirements of working processes. Thus limitation of the risk becomes the next best strategy.

In practice, reducing exposure may mean more than simple compliance with the stated WEL.

SOURCES OF INFORMATION (HAZARD COMMUNICATION)

The most obvious source of information about the chemicals used in industry is the container label and the Material Safety Data Sheet provided by the supplier.

Product Labels

Any substance or preparation which meets a legally defined criterion as "dangerous" must be labelled in accordance with that country's requirements. With the rise of global companies it is increasingly common for labels to be applied which comply with the requirements of more than one country (yet at the same time they must avoid any conflicting messages). Usually a label will at least carry the following information:

- The name of the substance/preparation

- Some idea of the components which make the product hazardous (though this often depends on the overall classification of the product and any provisions for confidentiality or "trade secret" in the country)

- Some indication of the danger, which may be by specific warning phrases or symbols or a combination of both

- Some basic precautions to take (things to avoid or PPE to wear etc.)

- Name, address and telephone number of the supplier.

OLD BILL'S CITRIC THICK BLEACH

contains Sodium Hypochlorite and Sodium Hydroxide

IRRITANT

Keep out of reach of children.
Irritating to eyes and skin.
Avoid contact with skin and eyes.
In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
After contact with skin, wash immediately with plenty of water.
If swallowed, seek medical advice immediately and show the container or label.

Prepared by G and F Cleaners Ltd
431 Ocean Drive, Blackpool BL47 2FN, UK
Tel: 018050 999111

An example of a product label designed to illustrate the points mentioned in the text.

Published Lists of WELs

We have noted that governments publish lists of WELs. They can usually be found on the Internet too.

Manufacturers' Safety Data Sheets

Hazard communication legislation requires suppliers of hazardous substances to provide safety data sheets. The basic design and section headings for this document generally follow a globally used standard (based on an ANSI/ISO standard). The detailed content can vary significantly over the world; this is not surprising since the classification systems also vary throughout the world. Safety Data Sheets are intended to provide users with sufficient information about the hazards of the chemicals for them to take appropriate steps to ensure health and safety in the workplace in relation to all aspects of their use, including their transport and disposal.

Safety data sheets must contain the following information in 16 sections:

1. Identification of the substance or preparation and supplier – its commercial name, identical to that on the label. The supplier – name, address and emergency contact phone numbers.

2. Composition and information on ingredients – chemical names.

3. Hazard identification – a summary of the most important features, including likely adverse human health effects and symptoms.

4. First aid measures – separated for the various risks, and specific, practical and easily understood.

5. Fire-fighting measures – emphasising any special requirements.

6. Accidental release measures – covering safety, environmental protection and clean-up.

7. Handling and storage – recommendations for best practice, including any special storage conditions or incompatible materials.

8. Exposure controls and personal protection – any specific recommendations, such as particular ventilation systems and PPE.

9. Physical and chemical properties – physical, stability and solubility properties.

10. Stability and reactivity – conditions and materials to avoid.

11. Toxicological information – acute and chronic effects, routes of exposure and symptoms.

12. Ecological information – environmental fate of the chemical and its effects, which could include patterns of degradation and effects on aquatic, soil and terrestrial organisms, etc.

13. Disposal considerations – advice on specific dangers and legislation.

14. Transport information – special precautions.

15. Regulatory Information – overall classification of the product and any specific legislation that may be applicable.

16. Other information – any additional relevant information not captured in preceding sections (e.g. explanation of abbreviations used, product disclaimers).

Use and Limitations of Information in Assessing Risks to Health

Product labels, safety data sheets and the WELs provide detailed information about the hazards and risks associated with a wide variety of hazardous substances. They ensure that users are well briefed on the properties of materials used in the workplace and such essential requirements as exposure limits, toxicological effects, first aid and safety precautions such as any personal protective equipment necessary. This is an essential first step towards putting in place effective control measures necessary to prevent harm.

However, it is important to remember that this information is not all that is required to establish effective controls. The basis of determining control measures is the risk assessment. Whilst information from the sources discussed here feeds into a risk assessment, it is only one part of it. It must be complemented by further information about the nature of the work and working practices before any evaluation is made about the risks to health posed by substances used at work.

Remember that product labels, safety data sheets and WELs are general statements of the hazards. They do not allow for the localised conditions in which the substances are to be used which affect the risk.

Assessment of Health Risks from Chemical and Biological Substances

Noting the limitations of the information sources listed above, they are nonetheless essential for a proper assessment of the risks from chemical and biological agents. The basic idea of risk assessment for these agents is no different than that for general risk assessment.

Assessing the risk involves establishing how likely health is to be affected by the substances and, if the risk is significant, identifying appropriate measures to reduce the risk. To do this, firstly, you must identify the hazardous materials in the workplace – both those you are supplied with and those which may be released or produced by workplace processes. The above mentioned data sources (like labels and MSDSs) are important here – they tell you the potential harm that the hazardous substances can do to health.

Secondly, you must establish the level of exposure. A substance may be very hazardous but if no-one is ever exposed, then the risk of ill health from that source is zero. Key to this are: the quantity involved (grams or tonnes); the form of the exposure (dust, vapour etc.) and the entry route into the body. In addition you also need to consider the personnel who might be exposed (some may be especially vulnerable).

Finally, you can assess whether the actual or probable level of exposure is likely to lead to significant health effects in individuals. This will then lead to a decision to eliminate or reduce risks by using appropriate controls.

BASIC SURVEYS FOR HEALTH RISKS

We have seen that workplace exposure limits are the basis for ensuring that exposure to airborne substances hazardous to health is reduced to the lowest possible level. In order to ensure that these are being followed, there must be a programme of monitoring to measure levels of contamination.

Monitoring consists of sampling and testing the air quality by a variety of means, as discussed below. This may be in respect of the general atmosphere in the workplace or of the immediate environment around individual workers who may be at particular risk. In addition, monitoring will also be carried out to test the effectiveness of specific control measures, such as ventilation systems.

Monitoring exposure levels and testing as part of the maintenance of control systems may be specifically required as part of chemical control regulations in your country.

Sampling Techniques

The first task in monitoring air quality is to collect the sample of air so that it may be analysed. There are a number of considerations here, with the decision of the approach to be used depending on the risk level of the contaminant being assessed.

- **The location of the sample**

    Samples may be taken in the general working atmosphere, in the operator's breathing zone, or at a position close to the contaminant generation.

- **Method of analysis**

    The procedure may involve sampling and analysis in the same instrument, or taking the sample collected and analysing it using different equipment, perhaps in a laboratory away from the point of collection.

- **Frequency of the sampling**

    There are two approaches to this:

    – A **spot** or **grab** sample – which is a single sample collected at a particular location or in a limited area and represents only that location or area at that point in time. Such samples may be analysed on the spot by the same instrument or be taken away.

    – A **continuous monitored** sample – where a sample is collected continuously over a period of time. Here the sample will be analysed during the monitoring, either by the sampling instrument itself or by direct connection to another instrument which carries out the analysis continuously. Such systems may be linked to an alarm system so that if a set level is reached the alarm is activated.

    The frequency with which spot samples are collected will depend on the type of contaminant and/or the results of the last sample. Thus, for example, if an initial sample was borderline to an WEL on entering a confined space for inspection purposes, further samples may be taken very frequently until a satisfactory reading is obtained. On the other hand if the initial sample showed that the atmosphere was safe, no further readings would be necessary.

To obtain time-averaged levels either a series of spot samples may be taken over the period in question or spot readings may be taken from a continuous sample.

Both the frequency of sampling and the method of analysis are also influenced by the main purpose of the monitoring. There are basically two general purposes:

- To indicate the presence of, and identify, contaminants – which requires a **qualitative** analysis of the sample to determine its exact constituents.

- To determine exact concentrations of a particular contaminant – which requires a **quantitative** analysis of the sample in respect of a known agent. This type of analysis is easier to achieve within the same instrument as is used to collect the sample since it is only testing for the presence of one particular agent. This type of analysis is used to assess compliance with WELs and to activate alarm systems.

Finally, we have to distinguish between the two basic methods of sampling based on the way in which the sample is collected:

- **Diffusion** or **passive sampling** – Here the contaminant passes over the sampling system in natural air currents and diffuses into a chamber containing an absorbent material which can be removed for later analysis. These systems are used for continuous sampling over a period of time and can only produce cumulative results for that period as a whole.

- **Mechanical** or **active sampling** – These systems use a pump to provide air flow through the sampling device or analysing instrument. They can be used for both spot and continuous sampling and in the case of the latter, individual readings at particular points in time over the period may be extracted, depending on the type of instrument used.

Stain Tube Detectors

These detectors are simple and easy to use and are perhaps the most convenient method of analysing gaseous contamination of the workplace air.

The principle of operation is very simple – a known volume of air is drawn over a chemical reagent contained in a glass tube. The contaminant reacts with the reagent and a coloured product, a stain, is produced. To illustrate the principle, consider the breathalyser –the "contaminated air" is blown into the tube and if the concentration of alcohol in the air is high enough, the reagent in the tube changes colour.

Stain tube detectors used in the workplace give a direct reading of the concentration of the contaminant being measured. The instrument comprises a glass tube containing the chemical reagent fitted to a hand-operated bellows pump or a manual or motorised piston-type pump. Many types of tubes are available with different chemicals that react to different gases. To operate, the appropriate detector tube is placed in the pump and the bellows pump is squeezed or the handle of the piston-type pump is pulled back for a specified number of strokes. This draws air through the detector tube, the chemical in the tube changes colour and the concentration of the gas can be read from the scale marked on the tube.

The following diagram illustrates the principle.

Scale Detector Tube

unused

used

contaminant stain
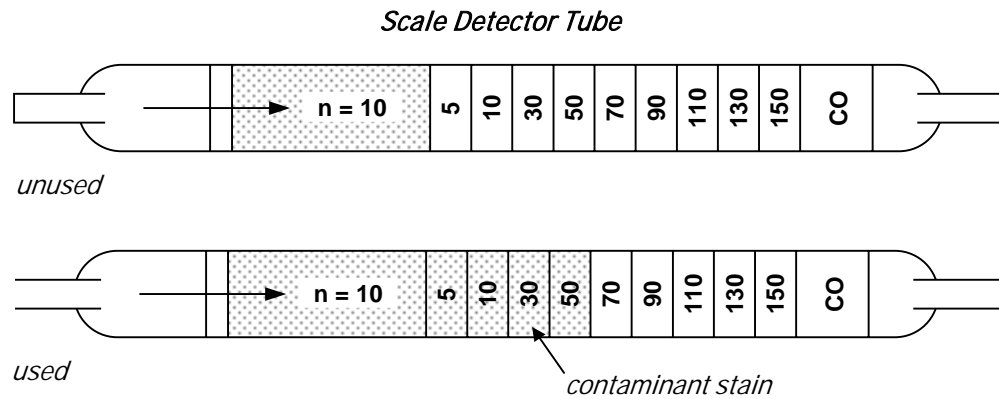
Stain Tube Detector

Note the colouration on the used tube indicating a concentration of 50 ppm carbon monoxide, the number of strokes (n = 10) necessary to pass the required amount of air through the tube, and the arrow showing the direction of air flow.

The instrument can be used for spot or continuous sampling, depending on the number of strokes or time for which the pump is operated.

There are a number of different types of stain detector tube, including:

- **Draeger multigas detector** – the basic type of instrument comprising a bellows pump and the Draeger tube, selected to suit the particular measurement to be carried out.

- **Automatic multigas detector** – this has an electrically-operated bellows-pump model which can be set to switch off when the selected number of strokes for the particular tube is complete. It is useful where an operator has to be free during testing and where the measurements require a high number of strokes.

- **Polytest tubes** – these are designed to make qualitative measurements to determine only the presence of potentially harmful substances. Varying colour and stain length sometimes gives an indication of the possible contaminant.

- **Toxicator gas detector** – this system draws air across a chemically impregnated tape which changes colour in reaction to the level of contaminant. The key difference here is that the tape is automatically moved on to expose a clean section for the next measurement.

Stain detector tubes can be quite flexible in the way in which they are used. Reading off the measurement may be carried out manually by an operator or it may be automatic by means of an electronic optical sensor. Also an extension hose can be placed between the pump and the tube so that the air inside a structure can be measured without the operator having to enter the structure.

There are certain limitations on the use and reliability of stain tube detectors, including:

- The rate of flow of air is important, so the instrument must be assembled correctly; the joint between the bellows/pump and the tube must be sealed and the ends of the tube should be removed properly.

- The accuracy of the sampled volume is critical, so the bellows/pump action must be fully operated for every stroke. The number of strokes must be recorded accurately, hence the need for an effective counter.

- There may be the possibility of cross-sensitivity of tube reagents to other substances than the one being analysed. This will be indicated on the data sheet accompanying the particular stain tube.

- There may be problems caused by variations in temperature and pressure. Stain tubes are designed to operate at about 20°C and one atmosphere pressure. Variation in atmospheric pressure will probably be within the limits of accuracy of the system, although changes in altitude could cause problems. Normal variations in temperature are more problematic because a change of 10°C can cause a reaction rate to be doubled or halved, and with ambient temperature ranging between 0°C and 30°C, the margin for error is considerable.

- Because of the complexity of the indicating reagent, tubes have a shelf storage life, so care must be taken to turn over stock and use only current date tubes.

- Reagent complexity also causes a variation between each tube, so judgments cannot be made on one spot sample.

- Hand-operated stain tube systems are capable of only a single "point in time" spot sample.

Passive Samplers

Passive devices employ absorbent material to sample concentrations of airborne pollutants without using a pump to draw air through the collector. The absorbent material is contained in a holder designed to allow the gases to diffuse and/or permeate to the absorbent surface. At the end of the sampling period, the holder is returned to the laboratory, where the absorbent material is removed and the amount of gas or vapour collected can be analysed.

There are two main types of design:

- The dish-type sampler has a flat, permeable membrane supported over a shallow layer of sorbent (see diagram (a) below).

- The tube-type sampler has a smaller permeable membrane supported over a deep metal tube filled with sorbent (see diagram (b) below).

These types of sampler are very versatile. They can be left open for varying periods of time, so can take both spot samples (although not instantaneous ones as with active samplers) and continuous samples. They can be made to virtually any size and, free of any pump, tubing or need for an operator, can be positioned anywhere there is an appropriate fixing point. The smaller dish-type samplers can be worn like a lapel badge to provide a personal monitoring device, giving a quite precise indication of the actual exposure the wearer is subject to. (It is also easy to ensure that they are used as it can be seen immediately whether the person is wearing it.)

(a) Badge Sampler

(b) Tube Sampler
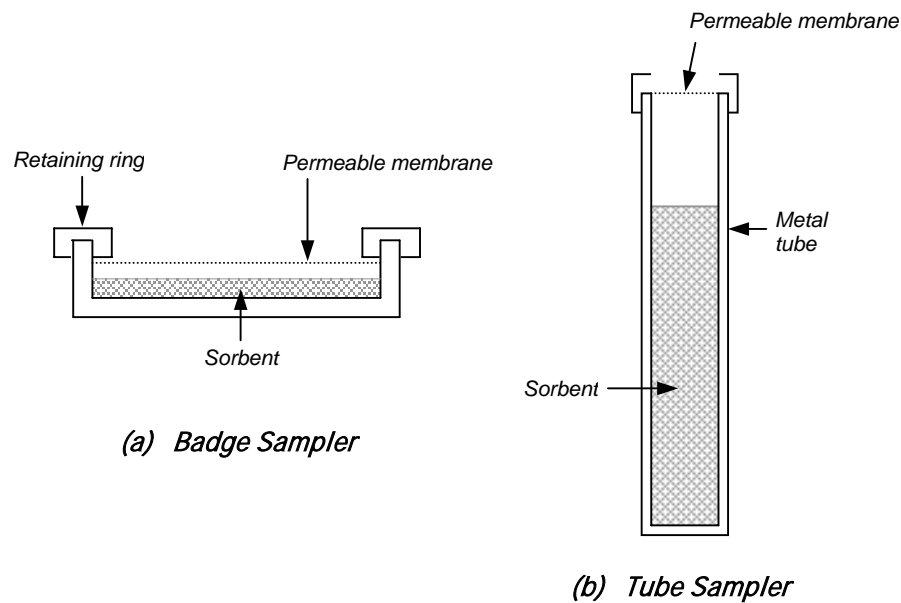
Passive (Diffusion) Samplers

There are limitations on the effectiveness of passive samplers for monitoring purposes, including:

* They do not provide any immediate indication of the contamination concentration because the results have to come back after analysis and therefore relate to a past period.

* They only measure accumulated concentrations over the period for which they are in use and they cannot be easily used to calculate time-weighted averages.

* They only sample contamination at the fixed point at which they are located or, in the case of badges, where the wearer is; they cannot be easily used to take spot samples in various parts of the workplace.

* They are easy to take off, which makes them ineffective.

* The size of the sample is critical. If the samplers are only used intermittently or only a small sample is used then the results may be misleading.

Smoke Tubes

Smoke tubes are used to assess the strength and direction of air flow. They release a wisp of smoke which is then carried away by the air currents in the local environment and its movement is observed.

Such smoke tests are ideal for checking the effectiveness of ventilation or air conditioning systems and chimneys, or to detect leaks in industrial equipment. They are also used to assess relative air pressures which are used to force air flow in a particular direction through certain types of local ventilation systems (such as fume cupboards). They also provide general information about air movements in a work area, which can be very useful when assessing the best locations for sampling devices.

Different types of smoke tubes are available to produce varying consistencies and colours of smoke, enabling the test to be tailored to the conditions in the workplace. They can also produce small single clouds as well as continuous smoke.

The major drawback of this method of testing is that it does not take account of the particle sizes of contaminants actually encountered in individual workplaces. The smoke may be more easily captured by a ventilation system than the contaminant particles. As a consequence, a false sense of security may be created. Open doors and windows can affect the direction and rate of airflow.

REVISION QUESTION 2

(1)   What do you understand by the term time-weighted average in relation to an WEL?

(2)   Give three examples of the limitations of WELs?

(3)   What information is generally provided on the label of a substance or preparation which has been classified as dangerous?

(4)   What is the purpose of safety data sheets?

(5)   What is the difference between passive and active sampling devices?

(6)   Give three examples of limitations in the use of stain tube detectors.

(7)   What are smoke tubes used for?

The suggested answers are given at the end of the unit.

CONTROL MEASURES

The precautions taken to control risks arising from chemical and biological hazards should be established following an appropriate risk assessment. This will involve both the analysis of the nature of the risks present in the workplace and a critical evaluation of existing control measures. After this, a decision must be made as to what if any improvements or additional measures are necessary to reduce the level of risk further.

It is widely accepted that the following hierarchy should be followed in choosing control measures:

- Eliminate the hazard

- Use physical or engineering controls which reduce the risk at source and provide protection generally rather than individually

- Control the risks to the person by job design, management, or (as a last resort) personal protective equipment.

Elimination or Substitution of Hazardous Substances

Elimination

The first priority for control of any significant risk to health is to try to eliminate completely the agent responsible in the first place. For each of the agents we have examined, the option usually exists to eliminate the hazard at source by replacement with materials which do the same job but present no risk to health. Improvements in technology often present the opportunity to replace older hazardous processes or activities with those involving no risk to health; for example, the use of new water-based materials such as paints or adhesives can eliminate completely the risk to health of exposure to solvents.

Elimination requires a careful examination of the work activity and process, and demands a good understanding of the properties and behaviour of alternative substances and materials. It may also be the most costly method of risk control, since it may involve a radical change in the way in which the work is carried out. However, the elimination of hazards is the key objective of the health and safety programme and the opportunities available should be re-examined every time an assessment is reviewed.

Substitution

Although elimination of risk is the ideal it is often not practicable. The next option then becomes reducing the risk by substituting the hazard with a different one with less potential for harm; for example:

- Using the same material but in a different physical form, such as using granulated pottery glazes rather than powders to reduce the risk of dust inhalation

- Using a similar, but different substance altogether, such as one with a lower volatility and/or higher WEL.

Since the risk is not completely eliminated but only reduced, it is essential to ensure that the potentially harmful properties of any proposed replacement are fully taken into account to ensure substitution does not introduce different but equally unacceptable risks.

Process Changes

In some circumstances an analysis of the process itself may identify specific activities which produce harmful substances or agents. In these cases changing the work method may minimise or suppress the generation of the agents of concern; for example:

- Brush painting rather than spraying will considerably reduce the level of airborne contaminant

- Vacuuming, rather than sweeping up (which pushes dust into the air), reduces dust levels

- Damping substance during mixing or when clearing up also reduces dust levels.

In general the aim is to identify the particular element of the process or work activity which is responsible for the harmful agent and try to replace it with one with less potential for harm. The opportunities for this may be limited by practicability from a production point-of-view.

Reduced Time Exposure

The ill-health effects arising from hazardous substances and agents in the workplace are often related to the length of time of exposure as well as the severity (the concentration of the contaminant) of the hazard. So reduction of exposure can be used as a means of minimising possible ill-health effects.

As a general principle, when a hazard exists from a substance or a physical agent, the cumulative dose should be reduced to as low a level as possible by organising the work pattern to provide periods of zero exposure. There are two methods of achieving this, based on establishing safe exposure time limits:

- Providing for regular breaks away from contact with the hazardous substance

- Job rotation, where the exposure of any particular individual is reduced by sharing the dose with other workers, such as having a number of workers performing a task in rotation, with strict control over length of time of exposure in order to ensure that dose limits are not exceeded.

The working time limits will be based on an assessment of the average exposure over a period of time, whether it is 8 hours or 15 minutes. Within this period, variations in the exposure levels above the average are allowed provided there are equivalent exposures below so that the overall average is not exceeded. For instance, the limit set may be 20 parts per million (ppm) for an airborne substance; so there may be periods where the levels are as high as, say, 25 ppm, provided there is an equal time where levels are 15 ppm, ensuring that the time weighted average meets the 20 ppm level.

There are often limits to how far above the WEL an exposure may be allowed to go, which are set by short-term exposure limits, say no longer than 5 minutes above 25 ppm. These short-term exposure limits should never be exceeded.

Enclosure and Segregation

The control measures we have looked at are all based on either preventing the risk or reducing it in some way to an insignificant level. If this approach is not possible then we have to consider physical controls which enclose the hazard and segregate people from the process involving it.

Total enclosure or containment of the hazard is the best form of control since no one can then be exposed to it; for example, total enclosure of a process which generates dust or fumes will prevent the escape of airborne contaminants which could be inhaled by operators nearby. When an area has been totally isolated, it may still be necessary to access equipment or material within that area; for example, remote controlled robot handling systems may be used, allowing access without physically entering the enclosed danger area.

Where isolation of the source is difficult it may be more practical to enclose the workers to ensure that they remain segregated from the hazard.

There will always be situations where it is not possible to totally enclose the process or the workers at all times; for example, when cleaning or maintenance work has to be carried out, or access is necessary to introduce raw materials or remove the product. Special measures will then be necessary to prevent any escape of the substance during periods when the security of the enclosure will be broken; for example, through the use of ventilation systems to carry away any airborne contaminants.

Local Exhaust Ventilation

Local exhaust ventilation (LEV) is the standard control measure for dealing with dusts, vapours and fumes which are generated from a point source. The harmful contaminant is extracted at the point of generation using engineered systems to ensure that the direction of the ventilation flow is away from the breathing zone of any operators.

Examples of LEVs include:

- **Glove boxes** – total enclosures, often used in laboratories, which are accessed through flexible gloves and kept under negative air pressure to prevent any release of contaminant.

- **Fume cupboards** – partial enclosures, again often used in laboratories, which are accessed through a vertical sliding sash, with the enclosure again being kept under negative pressure so that the air flow is through the sash into the hood to prevent any release of contaminant.

- **Captor hoods** – movable ventilators which can be positioned as near as possible to the hazard and capture contaminants by a negative air flow into the hood before they reach the operator, as are used to extract woodworking dust.

- **Receptor hoods** – large structures designed to capture contaminants which have been directed into the hood by thermal draughts, directional movement, or by local generation. An example of a receptor hood is a chimney in an incinerator.

To be effective the LEV must be properly designed and located close to the source of contamination so that the system can extract all or at least sufficient of the contaminant to prevent exposure above the WEL. Capture and extraction may be through engineered natural air flows, such as pressurised systems, or by the use of fans or pumps to suck the air away. Some systems are very noisy and this in itself may represent a hazard.

The contaminant must be carried away by secure ducting to an exhaust outlet. There will usually be some form of filter fitted between the capture hood and the outlet to remove as much of the contaminant as possible before venting.

The positioning of the outlet itself is important. The exhausted air must exit from the system to a safe place. This will usually be into the atmosphere and care must be taken to ensure that this

does not create an atmospheric pollution problem; factors such as chimney height and prevailing wind direction and speed must be considered to ensure adequate dispersal. The efficiency of the exhaust outlet must not be impaired by variations in wind direction or by weather cowls (which should be sited well away from the end of the duct). Exhausted air must also be directed away from any air inlets, otherwise a **cyclic pollution system** is produced.

Factors that Reduce Effectiveness

- If extra hoods and ducting have to be added on to the original design, care must be taken to keep the flow of air as straight as possible

- Filters may become blocked

- Changes in air currents will affect the operation, such as opened doors and windows

- The contaminants may be made up of different particle sizes and larger particles will require a stronger airflow to capture them.

Inspection and Monitoring

The ultimate proof of satisfactory performance of an exhaust ventilation system is that it maintains an acceptable work environment where atmospheric concentrations of airborne contaminants are kept below workplace exposure limits. Periodic air monitoring or even continuous monitoring has to confirm that effective protection is being maintained and to identify signs of deterioration so that remedial action can be taken before harm occurs.

Any new system should be carefully examined and tested as part of the commissioning procedure to ensure it is able to meet the design specification.

There are a range of engineering tests and inspections in current use:

- Regular visual inspections, either as part of daily operations or as a more formal procedure perhaps involving specific checks, are often a first indication that there is a problem. A typical example might be where a local exhaust ventilation system is in place to remove sawdust generated by a circular saw. An excessive build-up of sawdust around the saw might indicate a problem with the system.

- All hoods should be examined in detail to ensure they capture or contain the contaminant effectively. This may be done by using smoke generation to follow the airflows around a hood or by taking airflow measurements.

- Manometers (pressure gauges) or U-tubes can be used to measure static pressures at hoods or enclosures. They can also be used to measure pressure drops across filters or air cleaning plant. The measurements will confirm the suitability of airflow distribution and agreement with the design specification.

- A check should be made on pipe velocity in dust collection systems to ensure that ducts will remain free of dust settlement.

- Air cleaning plant and fans should be checked for continued compliance with the design specification.

Dilution Ventilation

Dilution ventilation operates simply by diluting the contaminant concentration in the general atmosphere to an acceptable level. This is achieved by changing the air efficiently in the workplace over a given period of time; for example, a number of complete changes every hour.

The workplace air will be extracted by the use of fans set in the walls or roof, with fresh air being pumped in.

The system is intended to remove gas contaminants (sometimes fumes) and keep the overall concentration of any contaminant to below the WEL and/or the concentration of a flammable substance to below its lower explosive limit. Where both a harmful and flammable substance is encountered, such as propanone (acetone), then control of the first objective will usually control the second.

Dilution ventilation has fairly limited use as an effective control strategy in occupational hygiene. It can, however, be used with reasonable success provided the contaminants conform, where applicable, to the following descriptions:

- The WEL of the harmful substance is high

- The vapour pressure of a liquid is low, that is it has a low evaporation rate

- The rate of formation of the gas product is slow

- Operators are not in close contact with the contamination generation point

- Any hazardous substance is carried swiftly away from the operator.

Two important criteria have to be considered when contaminants are to be removed from a workplace using dilution ventilation:

- **The rate of contaminant generation.** This conditions the number of air changes per hour required. Relevant factors in respect of the generation of contaminated vapour from liquids include:

  – The vapour pressure and potential to evaporate at the operating temperature of the system

  – The surface area of the liquid in contact with the workplace air, including the potential increase in surface area from spreading; for example, contact adhesives generate vapour at a much greater rate after they have been spread over a surface, and complex metal parts may have quite an extensive covering of solvent after they have been removed from a degreasing bath.

- **The position of the extraction fans**. The important factor which controls the positioning of the extraction fan unit is the density of the contaminant. The density of air is taken as a value of one. The density of many common solvents is greater than one, therefore they tend to layer over the lowest floor area in the workplace. For such conditions, fans should be positioned in the walls at a low level. Where the density is less than one then the contaminant will rise; for this situation the fan must be positioned high on the workplace walls or in the roof.

A major problem in setting up an efficient dilution ventilation system is the formation of **dead areas**. These are areas in the workplace which, owing to the airflow pattern produced by the extraction fan and the inlet of make-up air, remain motionless and so the air is not changed. Dead areas can be detected by the use of smoke tracer tubes. A high density of smoke will remain in the unventilated areas.

A second problem with dead areas is that they can move from one position in the workplace to another. Such moves can be produced by changing the inlet for the make-up air; for example, in cold weather the inlet may be spread over the workplace via the cracks in windows and doors. In hot weather, opening doors and windows will produce a quite different flow pattern. Moving the

position of machinery or workbenches can also cause the same problem. To help reduce the problem, controlled air make-up inlets can be constructed.

Where large quantities of air are being used to carry out the dilution process then consideration must be given to recycling heat losses from the workplace. It can be achieved by using heat exchange systems whereby make-up air is heated by the exhausted air.

Respiratory Protective Equipment

Personal protection involves the use of systems designed to be worn by individuals to help reduce the possibility of harm from the hostile environment in which they are working. This is called a **safe person strategy**. Ideally, the safe person strategy is a second line of defence against a potential hazard, because control at source or a **safe place strategy** should be the first aim.

However, there are situations where personal protection is the only, or the most appropriate, method to deal with a particular hazard; for example when the cost of controlling the hazard at source is high and the time required for protection is low. Classic situations which typify these conditions are:

- Work involving planned maintenance; for example, during plant shutdowns or deluging (damping with water) asbestos-covered boilers

- Failure of primary safety systems or emergency situations; for example, a chemical leak from a totally enclosed plant, or exposure to a smoke-filled building during a fire

As a generalisation, the need for personal protection during normal working should be avoided. However, there will always be some exceptions to this rule and protective footwear, headgear, hand protection and special clothing are worn during most, if not all, of the working time in some cases.

Types of Respiratory Protective Equipment

An important point to note about respiratory protection is that there are two basic but different types:

- **Respirators**, which are designed to purify respirable air by inhaling it through a filter which removes the contaminants. There are five types of respirators and choice depends on the nature of the hazardous substance, the purifying medium (such as filtration for dust particles, or absorption for gases and vapours), how well it purifies the air (efficiency, protection factor) and leakage of contaminant into the respirator (face fit, seals, etc.).

- **Breathing apparatus**, which supplies pure respirable air from an uncontaminated source by means of a hose supplying uncontaminated air, compressed air from cylinders or a compressor, or as a self-contained unit carried by the user.

Filtering face-piece respirator

This type of respirator consists of a piece of filtering material worn over the nose and mouth and secured by twin elastic headbands. Fit around the chin and face depends upon the tension in the headbands; a flexible metal strip enables the user to bend it over the bridge of the nose to effect a personal fit.

Filtering Face-Piece Respirator

The design is simple and provides a cheap disposable unit. They are generally light and comfortable to wear, permit ease of breathing and speech, do not interfere excessively with vision and can be worn with eye protection. There are various types available, offering protection against nuisance dusts, nuisance odours and certain toxic vapours and corrosive vapours depending on the type of filter fitted.

There are some practical disadvantages in that an adequate face-fit test (see later) cannot be carried out, face seal cannot be fully achieved over beards or a few days' beard growth, and used respirators require a safe disposal procedure. Chemically contaminated respirators may require special treatment.

Half-mask respirator

Half-mask respirators are made with a flexible rubber or plastic face-piece which covers the nose and mouth, to which is fixed a replaceable cartridge capable of removing the airborne contaminant during inhalation of respirable air. Some respirators have a single cartridge, while others have twin cartridges. The respirator is supported in the operating position by flexible headbands. Exhaled air is released through non-return exhaust valves.
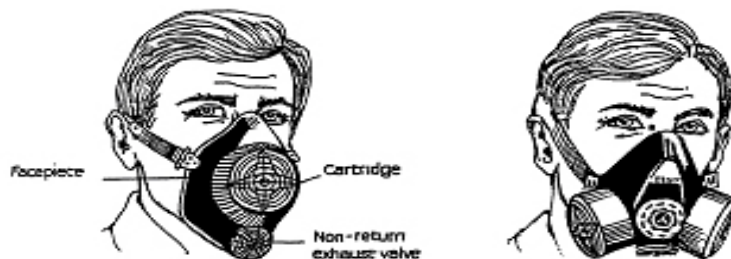
Half-Mask Respirators – Single and Twin Cartridge Types

Face seal is achieved in good quality respirators by the use of a pneumatic cushion around the outer edge. As with disposable respirators, beards and unshaven faces reduce face-fit efficiency.

Half-mask respirators can be used for protection against dusts, fumes, gases and vapours. Cartridges can be obtained for dust/gaseous state protection either together or separately. There are specific types of cartridge for specific hazards and they are often colour coded to help reduce the possibility of incorrect use.

Owing to their sturdy structure, breathing is often not easy (especially as the filter becomes clogged), speech communication is reduced and vision is slightly impaired, especially in twin-cartridge types.

A serious problem which arises with the use of cartridge filters is knowing when their working life has ended. They have to be tested under working conditions to find out when they have lost their ability to provide protection.

Full-face or canister respirator

Full-face respirators, as the name suggests, are designed to cover the mouth, nose and eyes. They are made of a flexible rubber or plastic face-piece which seals under the chin, around the cheeks and across the forehead. They have replaceable gas-absorbent canisters which are either fitted directly to the face-piece, like a single cartridge half-mask, or connected via a flexible corrugated rubber breathing tube. The canister in this case is supported in a harness. The face-piece is secured to the head by a set of flexible adjustable headbands. Wide vision is provided in most modern face-masks by a large tough Perspex visor.

Canister Respirators – Attached Directly to Face-Piece and by Flexible Tube

The canister filling is able to absorb, or convert by chemical means, the harmful contaminant so the respirable air is safe to inhale. As with cartridges, the canister fillings are designed to deal with specific hazards and it is important to use the correct one for the hazard encountered. Again, colour coding is generally used to help reduce incorrect use.

The working life of the canister depends upon the concentration of the contaminant and the time of use. Manufacturers' instructions specify minimum canister life for given conditions and the maximum contaminant concentration in which the canister should be used. Respiration rate is also important; high work rates during use will soon reduce the capacity of the protective filling. Once canisters have been unsealed their capacity declines. Canisters also have a shelf life, so maintenance, storage and issue are important in their safe use, as are training of users and their supervision.

Canister respirators are useful as a respiratory protection system, provided the conditions under which they are to be used are known within fairly close limits. To guard against possible over-exposure, some form of alarm system should be used to support their safe use. Doubts must be raised about the use of canister respirators for rescue or escape in gassing accidents. Their use could **increase** the casualty list, not reduce it; breathing apparatus sets would be more appropriate for both rescue and escape.

Powered clean-air respirator

This type of respirator may be considered as one step up in terms of efficiency on half- or full-face respirators in that the respirator air is pumped into the face-piece.

The main **advantage** of this system is that the pump provides a positive air pressure during breathing, which reduces user fatigue, allows longer work periods between rests and reduces the risk from ingress of contaminants through leaks in the system.

The systems are mainly designed for protection against dusts, claiming 95% removal of respirable range particles, but filters giving protection from vapours are also available.

Powered clean-air respirators cannot be used in oxygen-deficient atmospheres. The units require special planned maintenance with the increase in operating components, as well as fully trained users. Supervision is of course required for effective use.

Powered visor respirator

This is a recent development of the powered clean-air respirator. Purified air is blown down over the user's face behind a protective visor. The technique frees the user from a "sealed" unit, allowing a more comfortable fit and is less restrictive to movement. In addition, the helmet and visor gives added protection to the head, eyes and face.
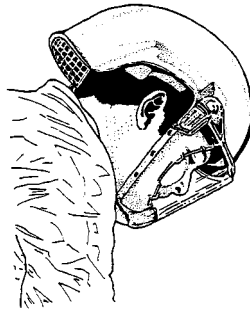
Airstream Anti-Dust Helmet

In principle, the helmet's operation is similar to a household vacuum cleaner. Contaminated air is drawn by a motorised fan into the air intake at the back and passes through an elongated filter bag in the crown of the helmet. The decontaminated air is then directed over the face into the breathing zone where inhalation can take place without any undue effort. Such helmets are highly efficient in removing dusts, but cannot be used for dust immediately hazardous to health or gaseous contaminants, or in oxygen-deficient atmospheres.

Breathing apparatus

Breathing apparatus can be classified under three general headings.

*   **Fresh air hose apparatus**

    Fresh air hose apparatus can be described as a breathing apparatus which provides a supply of unpressurised fresh air from an uncontaminated source to give respiratory protection independent of the atmosphere which surrounds the user. It can therefore be used in toxic and oxygen-deficient atmospheres.

    The user is connected to a fresh air supply by an air hose of up to 20 metres and draws air through simply by breathing. The system is not self-contained, so it enables work to be carried out over an indefinite period, provided it is only a short distance from fresh air.

    The apparatus usually consists of a full-face mask with a short length of hose secured to the user and to which is connected the main air hose. This is securely fixed in the ground or tied to a permanent structure so the free end is kept clear of the ground and is not pulled into the contaminated atmosphere.

    Note that air flow can be affected by "pressure drop" as it flows through a pipe and this is increased by any kinks or bends in the hose. Thus, an operator may breathe quite easily

when the air hose is laid out straight, but after having trailed around obstructions in a real situation, breathing may be impaired and work rates considerably reduced.

- **Compressed airline apparatus**

  Compressed airline breathing apparatus is similar in design to fresh air systems but the respirable air comes from a compressed air source. The compressed air supply may be from a cylinder or from a compressor, with the cylinders providing a mobile supply unit. Compressors are more usual in static situations, such as at the top of coke oven furnaces.

  As the supply uses higher pressures than fresh air systems, much smaller and longer supply hoses can be used, up to 80 m for some units. The airline can be connected via a pressure-reducing valve to full or half face-piece respirators, hoods, coverall suits or protective visors. Positive pressure helps to reduce work rate fatigue and the ingress through leaks of harmful airborne contaminants.

  Compressed airline systems give complete respiratory protection in dusty, toxic and oxygen-deficient atmospheres.

- **Self-contained apparatus**

  Self-contained breathing apparatus provides air or oxygen to the user from cylinders or some other form of container which is carried in a harness on the user's chest or back. The system provides respiratory protection in toxic, corrosive, dusty and oxygen-deficient atmospheres.

  There are three main types of self-contained breathing apparatus, classified mainly on the basis of duration and use:

  – Escape breathing apparatus, used for disaster situations and having only a limited supply of oxygen.

  – General breathing apparatus, using compressed air cylinders and designed for work in hazardous atmospheres for up to 45-60 minutes at normal working rates.

Selection, Use and Maintenance

The selection of appropriate respiratory protection is based on three main criteria:

- Type of hazard – whether the hazard is dust, corrosive or toxic substances, or oxygen deficiency, etc.

- Contaminant concentration – the extent to which filters can reduce the concentration to a safe level, or complete protection is required.

- Wearer acceptability – the extent to which users are able to use the system in comfort whilst undertaking the work. To give full protection, respiratory protection systems must be worn during all of the time the hazard is encountered. Poor wearer acceptability may result from misting visors, unbalanced strain upon the head and neck muscles, a feeling of head discomfort (possible headaches) from headbands, difficulty with breathing and conversation, overheating of the area around and covered by the face-piece, excessive sweating and possible dermatitic response, to name but a few. There is a high probability that the equipment will be removed during use by a wearer to gain some relief from such discomfort.

All PPE must be maintained in efficient working order by defined maintenance at a specified frequency or, where appropriate, by a programme of regular replacement. It must also be stored safely when not in use.

Other Protective Equipment and Clothing

PPE must also be provided where there is a risk of contamination through routes of entry other than inhalation.

Gloves

Gloves and gauntlets are designed to protect the user from harm caused by external agents. There are specific types of protection for use with different types of hazards, and it should never be assumed that one type will offer protection against others.

Protective gloves and gauntlets are available for:

- Chemical agents – such as acids, alkalis and solvents

- Biological agents – such as viruses, fungi and bacteria

- Physical agents – such as asbestos fibres, lead dust, radioactive dust and dust contaminated by other agents, as well as where there is a risk of contamination in the use of syringes and knife blades (for example, sewage workers cleaning filters or abattoir workers).

Overalls

The same basic principles apply for overalls as for gloves. Specialised overalls, aprons and other forms of clothing, such as leggings, are available to offer protection from a similar range of hazards.

Eye Protection

Protection is required from hazards which can cause damage to the eyes, as in handling or coming into contact with acids, alkalis and corrosive or irritant substances, using any gas or vapour under pressure, or working in contaminated dusts. The protection should be extended to all people who may be at risk, not just to those operating the particular processes.

Various forms of eye protection are available, depending on the type of hazard encountered:

- **Spectacles**

    These provide limited protection against liquids and sprays, and may be used where the potential risks are low; for example, in general chemical laboratories. Side pieces extend the protection offered. They are not effective against dusts and vapours.

    Spectacles provide the least of the problems associated with eye protection, that is reduction in visual field, misting and becoming dirty or scratched. Also, where safety spectacles provide adequate protection, the use of sight-corrected or prescription lenses is possible.

- **Goggles**

    These provide full eye enclosure and offers almost complete protection for the eyes from all the potential hazards which occur from dusts, vapours and liquids.

The basic design of goggles consists of a one-piece, clear visual section in front of the eyes surrounded by a safe, flexible frame which seals across the forehead, around the temple and the cheekbone and over the bridge of the nose. The effectiveness of the protection usually depends upon the fit under the eyes and over the bridge of the nose.

It also allows operators to wear their own prescription spectacles under the goggles. This does cause a small problem in that the side seal over the temples may be reduced.

Vision is more restricted than with spectacles and misting over of the eyepiece becomes a problem.

- **Face visors**

  These provide both eye and face protection and will be used where the risk arises from splashes of liquid which may be harmful to the skin. They are secured by an adjustable head frame or may be fixed to a safety helmet.

It is important that users of eye protection have access to lens cleaning and demisting facilities – either of their own or at cleaning stations. Self-maintenance by users has been found to improve the wearer acceptability of eye protection.

Personal Hygiene and Protection

Good welfare facilities must be provided. Hot running water, soap and a means for drying must be provided. With more serious hazards, showers and nail brushes may be required. Barrier creams may also have to be provided if required. Not preparing or eating food in workrooms will help control the hazard of ingestion.

If warranted by the risk assessment, vaccinations may also be required.

Health Surveillance

The objectives of health surveillance where workers are exposed to substances hazardous to health in the course of their work are:

- The protection of the health of individual workers by detection as soon as possible of any adverse changes which may be attributed to exposure to substances hazardous to health

- To assist in the evaluation of measures taken to control exposure

- The collection, maintenance and use of data for the detection and evaluation of hazards to health

- To assess, in relation to specific work activities involving micro-organisms hazardous to health, the immunological status of workers.

Thus, the purpose of routine health surveillance is to identify, at as early a stage as possible, any variations in the health of workers which may be related to working conditions.

Where hazards are low and the likelihood of occupational disease remote there may be no necessity for a system of regular health checks. Nevertheless, it is recommended that basic personal records should be kept for all workers, including a historical record of jobs performed, details of periods of exposure to harmful agents, absence due to sickness or injury, and cause or duration of absence. Where hazards are low but there is known to be the possibility of occupational disease leading to easily recognisable symptoms, self-checks may be acceptable.

For medium range hazards checks by a responsible person, such as a supervisor, first-aider or nurse, may be required.

Where there appears to be a higher level of risk, an assessment of the level of surveillance required should be made with the assistance of an occupational physician. These "higher-level" checks may include:

- Biological effect monitoring – the measurement and assessment of early biological effects in exposed workers (see below)

- Medical surveillance – clinical examinations and measurements of physiological and psychological effects of exposure to hazardous substances in the workplace, as indicated by any symptoms

- Enquiries about symptoms – inspection or examination by a suitably qualified person

- Review of records and occupational history during and after exposure, to check correctness of the assessment of risks to health and to indicate if the assessment requires a review.

Examples of the substances and processes which may give rise to identifiable health effects and for which health surveillance measures might have to be carried out include:

- Substances of recognised systemic toxicity (poisons which affect the entire body rather than a single organ) – monitored by appropriate clinical or laboratory investigations

- Substances known to cause occupational asthma – monitored by enquiries seeking evidence of respiratory symptoms related to work

- Substances known to cause severe dermatitis – monitored by skin inspection by a responsible person

- Contact with chrome solutions in electrolytic plating or oxidation of metal articles by use of an electrolyte, in dyeing processes, or in processes of liming and tanning of raw hides and skins – monitored by skin inspection by a responsible person

Pre-employment Health Screening

In certain circumstances, pre-employment health screening may be appropriate to ensure that workers are fully fit at the outset and able to perform their work efficiently:

- For new workers, or those being transferred from one type of work to another, if it is considered that the work is hazardous to health.

- Where the worker has to enter a hazardous environment to which he or she has not been exposed previously.

- Where there is a high risk of accidents to themselves or others, such as in transport.

- Where there is a risk of endangering others through transmission of infection.

- Where the work entails high standards of physical or mental fitness.

Tests and procedures for pre-employment health screening should relate to the demands of the work and the potential hazards it presents and may include vision, hearing and lung function.

Records of pre-employment health screening provide a base-line measurement of an individual's health and can be used as a comparison for any subsequent health testing.

Biological Monitoring

Biological tests are used in a number of circumstances for the early detection of occupational disease and its precursors. Tests include:

- Blood sampling in which red and white cell counts are measured by automatic analysis techniques and which enables early detection of anaemias and leukaemias.

- Urine tests measure concentrations of certain metals such as lead, cadmium and mercury, and also the metabolites (products of chemical changes within the body) of certain organic compounds, which can be used to assess exposure and absorption of those substances.

- Chest X-rays to screen people in dusty occupations where there is a risk of pneumoconiosis, and establish accurate classification of the stages of the disease.

- Renal (kidney) function tests to identify damage to the liver cells themselves or to the transport mechanisms to and from the liver, from occupational hepatotoxins (toxins which can damage the liver), including organic compounds, antimony, arsenic and yellow phosphorus; and infective agents such as serum hepatitis.

- Assessment of nerve conditions. Toxic damage to the nervous system may affect motor and sensory function or brain function and cause impairment of consciousness. There is a range of neurotoxins (arsenic, lead and mercury, carbon disulphide, methylene chloride, toluene) which require environmental control and regular biological monitoring of people who work with them. Tests include visual testing, nerve transmission tests (electromyography, neuromuscular transmissions) and assessment of any changes in intelligence or personality.

Biological monitoring takes into account routes of absorption, effects of workload, and exposure outside the workplace. It can sometimes be a more reliable indication of health risks than environmental measurements.

BASIC ENVIRONMENTAL ISSUES

Pollution refers to contamination or damage to the environment caused by human activity. We can identify three broad classes of pollution:

- **Atmospheric pollution** – fumes, smoke and dust discharged into the air from incinerators, traffic exhausts or other by-products of industrial processes.

- **Water pollution** – liquid waste (effluent) comprising toxic substances such as detergents discharged into ground water, rivers or seawater directly from sewers, factories or surrounding land (such as fertilisers being washed away from farm land by the rain).

- **Land pollution** – solid waste from industrial processes deposited on land.

Control of Atmospheric Pollution

Control of atmospheric pollution is usually achieved by a system of permits/consents from local government agencies. This is backed up with regular atmospheric monitoring of the stack. To be within permitted emission limits usually requires some form of abatement technology, such as scrubbers. The available techniques usually need to be balanced against the cost involved. What is appropriate is considered in the light of the nature of the industry and the desired level of environmental protection.

Disposal of Waste and Effluent

The general approach to waste disposal should take account of a hierarchy of waste management options:

- Waste reduction – the primary emphasis should be on not producing waste in the first place, by process change and optimising process efficiency.

- Re-use – for example, returnable glass bottles.

- Recovery of waste – including recycling (such as glass, metal and paper), composting and incineration with energy recovery.

- Disposal – generally to landfill.

The keeping, treatment or disposal of solid waste is regulated throughout the world. It usually requires the waste operator to be licensed or otherwise given permission to operate.

Control over water pollution is based on a system of water discharge permits/consents, obtained from the local government agency. These apply in respect of any discharge of trade effluent or sewerage effluent into controlled waters. Controlled waters cover, essentially, all moving water, including inland and underground waters and estuaries, as well as the actual river bed and, in certain circumstances, territorial and coastal waters. Again, regular monitoring may be required to ensure that the discharge consent is not exceeded. It is common for regulators to set limits on such things as metals (e.g. lead) and pH.

REVISION QUESTION 3

(1) What principles of control are illustrated by the following measures?

    (i) Using granulated pottery glazes instead of powders

    (ii) Vacuum cleaning rather than sweeping up with a broom

    (iii) Job rotation

    (iv) Using water-based adhesives rather than solvent-based ones.

(2) What is the difference between local exhaust ventilation and dilution ventilation?

(3) What are dead areas and why are they a problem for dilution ventilation systems?

(4) List the five main types of respirator and the three main types of breathing apparatus

(5) What are the key criteria in the selection of the appropriate respirator to use?

(6) What is the main purpose of routine health surveillance?

The suggested answers are given at the end of the unit.

UNIT SUMMARY

Chemical hazards arise from the presence of substances or preparations in the form of liquids, gases, vapours, mists, fumes and dusts in the workplace. Biological hazards are micro-organisms which are directly connected with the work or are associated with the environment in which it is conducted.

Substances and preparations which are hazardous to health must be classified by the category of danger and risk that they present and when supplied they must be appropriately labelled and accompanied by a safety data sheet. Ill-health effects may be acute or chronic depending on how quickly the body reacts to exposure to the substance and the time over which exposure takes place.

Absorption of hazardous substances into the body may take place by a number of routes: inhalation, ingestion, absorption, aspiration and injection. The route of entry will depend upon the form of the chemical or biological agent to which exposure takes place, and controls the type of control measure which is appropriate.

Workplace exposure limits, expressed as either long-term or short-term, define the acceptable levels of concentration of airborne contamination to which workers may be exposed. Control measures are based on reducing exposure levels even where that is below the WEL for airborne contaminants. Monitoring of airborne contamination levels is required to ensure that this is achieved and there are a variety of means of doing this; for example, stain tube detectors and diffusion samplers. In addition, routine and special health checks may be necessary to monitor workers' exposure to contaminants and ensure that any ill-health effects are identified at the earliest stage.

Control measures for limiting exposure to harmful substances are based on the hierarchy of control; elimination or substitution, process and engineering controls to reduce exposure and segregate workers from the hazards (particularly using local exhaust or dilution ventilation systems) and finally PPE. The main types of PPE required are respirators and breathing apparatus, and protective clothing. All forms of physical control measures, including PPE, must be subject to a programme of routine inspection, testing and maintenance.

SUGGESTED ANSWERS TO REVISION QUESTIONS

Revision Question 1

(1) Liquids, gases, vapours, mists, fumes and dusts.

(2) The classification of hazardous substances is split into three basic groups: Physico-chemical, Health and Environmental.

(3) Acute ill-health effects arise where the quantity of a toxic or harmful substance absorbed into the body produces harmful effects very quickly, that is within seconds, minutes or hours. Chronic ill-health effects arise where the harmful effects of a substance absorbed into the body take a very long time to appear, perhaps months or even years.

(4) Inhalation, ingestion, absorption, aspiration and injection.

(5) The Legionella bacterium thrives in:

   – Water temperatures in the range of 20-45°C.

   – The presence of sediment, sludge, scale and/or organic material in the water which act as a source of nutrients.

   – Slime on the surface of water.

(6) Both carbon dioxide and carbon monoxide are asphyxiants, that is when inhaled they do not cause direct injury to the respiratory tract, but reduce the oxygen available to the body. CO_2 is a simple asphyxiant which displaces air, whereas CO is a chemical asphyxiant which combines with haemoglobin to form a compound which prevents oxygen transport by the blood.

(7) Inhalable substances are capable of entering the mouth, nose and upper reaches of the respiratory tract during breathing. Respirable substances are capable of deeper penetration to the lung itself. It is the size of the individual particle which determines whether a substance such as a dust is inhalable or respirable.

(8) Pneumoconiosis is the general term for an accumulation of dust in the lungs and the tissue reaction to its presence.

Revision Question 2

(1) Workplace Exposure Limits (WELs) are expressed as time-weighted averages, meaning that measurements are taken over a particular time period (15 minutes for short-term limits or 8 hours for long-term limits) and then averaged out. The concept of time-weighted averages allows concentrations levels to exceed the limit, provided that there are equivalent exposures below it to compensate.

(2) The limitation of WELs are:

   – They are designed only to control absorption into the body following inhalation

   – They take no account of human sensitivity or susceptibility (especially in relation to allergic response)

   – They do not take account of the synergistic effects of mixtures of substances

- They do not provide a clear distinction between "safe" and "dangerous" conditions

- They cannot be applied directly to working periods which exceed eight hours

- They may be invalidated by changes in temperature, humidity or pressure.

(3) The label on a preparation which is dangerous for supply must give the following information:

- The name(s) of the hazardous constituents

- The indication(s) of danger and the corresponding symbols

- The risk phrases

- The safety phrases

- Name, address and telephone number of the supplier.

(4) Safety data sheets are intended to provide users with sufficient information about the hazards of the substance or preparation for them to take appropriate steps to ensure health and safety in the workplace in relation to all aspects of their use, including their transport and disposal.

(5) In passive sampling devices the air sample passes through/into the device by means of natural air currents and diffuses into a chamber containing an absorbent material which can be removed for later analysis. In active sampling devices the air sample is forced through the instrument by means of a pump.

(6) The limitations of stain tube detectors are:

- The volume of air sampled may not be accurate due to incorrect assembly interfering with the air flow (through leaks, etc.) or incorrect operation

- There may be the possibility of cross-sensitivity of tube reagents to substances other than the one being analysed

- There may be problems caused by variations in temperature and pressure

- The indicating reagent in the tubes may deteriorate over time

- There may be variations in the precise reagent make-up between tubes

- Hand-operated detectors are capable of only a single "point in time" spot sample.

(7) Smoke tubes are used to test the effectiveness of ventilation or air conditioning systems and chimneys, to detect leaks in industrial equipment, to assess relative air pressures used in certain types of local ventilation systems, and to provide general information about air movements in a work area.

Revision Question 3

(1) (i)   Substitution

(ii) Work process change

(iii) Reduced time exposure

(iv) Elimination

(2)   Local exhaust ventilation (LEV) is a control measure for dealing with contaminants generated from a point source. Dilution ventilation deals with contamination in the general atmosphere of a workplace area.

(3)   Dead areas are areas in the workplace which, owing to the airflow pattern produced by the positioning of extraction fans and the inlets for make-up air used in the ventilation system, remain motionless and so the air is not changed. They can move from one position in the workplace to another as a result of changing the positions of fans and inlets, by draughts of air through windows and doors or moving the position of machinery or workbenches.

(4)   The main types of respirator are filtering face-piece respirators, half-mask respirators, full-face or canister respirators, powered clean-air respirators and powered visor respirators. For breathing apparatus the three main types are fresh air hoses, compressed airlines and self-contained systems.

(5)   The type of hazard (dust, gas, vapour, etc.) and the category of danger, contaminant concentration levels and wearer acceptability.

(6)   The main purpose of routine health surveillance is to identify at as early a stage as possible any variations in the health of workers which may be related to working conditions.

NEBOSH International General Certificate

Unit 13 | Physical and Psychological Health Hazards and Control

Contents

INTRODUCTION

In this unit we consider a range of general issues relating to the design of tasks, the immediate working environment and the general environment of the workplace. These are concerned not just with the physical health and safety of workers, but also their psychological welfare and we will deal with the issue of work-related stress. We also pay particular attention to noise at work and to the hazards of radiation, although this is limited to specialised workplaces.

The unit is designed to meet the following aims and learning outcomes as specified by NEBOSH for this part of the syllabus for the International General Certificate.

Overall Aims

On completion of this unit, you will have knowledge and understanding of:

* Ill-health effects of the physical process of work and of the working environment

* The available control options to combat these risks in the workplace.

Specific Intended Learning Outcomes

When you have worked through this unit, you will be able to:

* Explain the term 'ergonomics' and the contribution that ergonomic design can make to health, safety and efficiency at work

* Identify work processes and practices which may give rise to musculoskeletal health problems (in particular work related upper limb disorders (WRULDs) and hand/arm vibration syndrome (HAVS))

* Illustrate the nature and extent of musculoskeletal effects with reference to the use of display screen equipment (DSE)

* Identify common welfare and work environment requirements in the workplace

* Describe the health effects associated with exposure to noise and suggest appropriate control measures

* Describe the principal health effects associated with ionising and non-ionising radiation and outline basic protection techniques

* Explain the causes and effects of stress at work and suggest appropriate control actions

* Describe the situations that present a risk of violent assault to workers and suggest ways of minimising such risk.

TASK AND WORKSTATION DESIGN

The design of tasks and workstations has been given a high priority in recent years by the introduction of display screen equipment (DSE) in virtually all areas of work. However, whilst much of the discussion which follows relates to the use of DSE in general and of keyboard-based workstations in particular, the principles apply to all manual activities where the worker is essentially in one position for most of the time.

It is important to be clear about some of the terminology we shall be using:

- Display screen equipment covers all equipment used in the workplace to display information with which the user interacts in some way, usually by inputting or out-putting information by use of a keyboard or other device as part of his/her work. Thus it covers computers and their associated control devices, as well as certain other types of equipment such as microfiche or radar (air traffic control) terminals. It specifically excludes displays and instrumentation in drivers' cabs or machinery which are purely to supply information.

- Users of DSE are those for whom working with the equipment forms a major part of their work. Because the risks associated with the use of DSE are related mainly to prolonged use, this excludes those who only occasionally make use of such equipment. Users will be those who use the equipment on a regular basis for periods of over one hour at a time.

- Workstations comprise all the equipment used at a fixed point by an individual user, including any display screen equipment, tables and chairs, storage facilities and other plant and equipment used as part of the work activities.

Principles of Ergonomics

Ergonomics is the study of the way in which people interact with equipment in their working environment with the objective of improving their comfort, safety and productivity. It involves the application of anatomical, physiological and psychological knowledge to the practical aspects of work, so that tasks may be fitted to the needs of the person.

This involves putting the person at the heart of both task and workstation design, and building the working environment around his/her needs, rather than fitting the person into a pre-designed working environment built around the needs of the task.

The starting point for this is to see the work setting as being made up of three elements:

- A worker with a range of physical and mental characteristics, including size, strength, range of motion, intellect, expectations, etc.

- Physical objects comprising the furniture, working equipment (DSE, tools, etc.), working surfaces and parts used in the task.

- The local environment created by physical conditions such as lighting, temperature, noise, vibration, etc., as well as the organisational culture and management which determines interpersonal relationships, attitudes towards work, etc., in the workplace.

The interaction of these elements determines the manner in which the task may be performed, and it is this interaction which must be optimised in order to ensure maximum comfort, safety and productivity.

The key principles of ergonomic task and workstation design centre on:

- The effective layout of physical objects in relation to the worker and to each other, so that the worker is not put under any undue stress in terms of posture or manual dexterity in using those objects. This relates principally to reaching and/or manipulating equipment and parts on the working surfaces, also to reaching additional equipment and resources necessary on a regular basis (such as printers).

- The positioning and design of display screens and other equipment in relation to the worker and to the lighting in the immediate environment, so that the worker is not put under any undue visual stress in using the equipment.

- The organisation of task activities over time and the design of the local physical environment so that the worker is not put under any undue physical stress resulting in fatigue or injury to particular parts of the body. This includes damage caused by noise and vibration in both the immediate and general environment.

- The organisation of task activities, including their control and supervision; and the design of the local environment, so that the worker is not put under any undue mental stress.

III-Health Effects of Poorly Designed Tasks and Workstations

The main risks to health in the design of tasks and workstations relate to:

- Physical stress, resulting in injury or general fatigue – principally through poor posture and excessive demands on manual dexterity, but also through exposure to excessive noise and vibration.

- Visual problems – principally through excessive brightness or prolonged concentrated work on small objects, either on the display screen itself or with components used in a work process, such as in the manufacture of electronic equipment.

- Mental stress – principally through excessive demands of task performance and lack of control over working processes, but it may also be brought about by adverse organisational and physical environmental conditions.

These effects are generally all chronic effects, brought about by prolonged exposure to the activity or conditions.

We consider below a number of specific ill-health problems arising from the above risks. (Note that we shall deal with the effects of noise and with mental stress as individual subjects elsewhere in the unit.)

MusculoSkeletal Disorders

These are injuries and disorders of the muscles, nerves, tendons, ligaments, and joints, cartilage and spinal column. Typical problems include:

- Work related upper limb disorders (WRULDs) or cumulative trauma disorders (CTDs) such as:

  – Tendonitis – a swelling or irritation of a tendon which induces pain, tenderness, and occasionally restricted movement of the muscle attached to the affected tendon.

  – Tendosynovitis – an inflammation of the sheath surrounding the tendon causing pain, tenderness and swelling over the tendon.

  – Ulna neuritis – an inflammation of the ulna nerve which runs down the full length of the arm to the hand and controls muscles that move the thumb and fingers, and which

causes a "pins and needles" feeling and pain in the forearm and in the fourth and fifth fingers.

    – Carpal tunnel syndrome – which is characterised by a numbness, tingling and pain in the thumb, index and middle fingers, resulting from the compression of the median nerve which transmits sensory and motor signals to and from the thumb and first three fingers.

    – Thoracic outlet syndrome - a compression disorder of the nerve and blood vessel between the neck and the shoulder.

- Back disorders, including slipped discs and strains in the lumbar, sacro-iliac or the pelvic region at the base of the spine.

Hand-Arm Vibration Syndrome (HAVS)

This condition is produced at work by exposure to vibrations from hand-held tools in processes such as pneumatic-riveting, hammering and drilling, the use of chainsaws and chipping hammers, etc.

The vibration affects blood flow to the fingers and arms and microscopic examination of affected tissues shows small arteries blocked and inner walls thickened with enlargement of muscle cell structure.

Early symptoms involve the blanching or whitening of the fingers (hence the term "white finger") and tingling of muscles, but more serious conditions can occur where the hand extremities become blue or cyanosed and may ulcerate or even develop gangrene. There is little evidence to show that recovery from HAVS occurs when exposure to vibration ceases; any recovery is only slight and very slow.

Fatigue Related Disorders

The cardiovascular (blood) system provides oxygen and nutrients to muscle tissue. Some tasks require long-term/repetitive muscle contraction, such as walking great distances, heavy carrying and repeat lifting. As physical activity increases, muscles demand more oxygen and metabolites. The body responds by increasing the breathing rate and heart rate, but where muscle demand for nutrients cannot be met (metabolic energy expenditure rate exceeds the body's energy producing and lactic acid removal rate) physical fatigue occurs.

When this happens in a specific area of the body (for example, in the shoulder muscles from repeated or long term arm lifting), it is termed localised fatigue and is characterised by tired/sore muscles.

When it happens to the body in general (for example, from long-term heavy carrying/lifting/ climbing stairs), it is termed whole body fatigue and may produce a cardiovascular accident (heart attack).

Also, high heat from the environment can cause an increase in heart rate through body cooling mechanisms. Therefore, for a given task, metabolic stress can be influenced by environmental heat.

Eye Problems

Visual fatigue (or eye strain) is brought about by the eyes having to work at the limit of their capabilities for long periods. This is most commonly caused by prolonged looking at bright light or concentration on small objects.

Symptoms of visual fatigue include irritation of the eyes (inflammation itchiness), breakdown of vision (blurred or double vision) and headaches, giddiness, fatigue. Strain injuries such as neck and backache can also happen as the person bends to get closer to the object being viewed. Longer term effects may include impaired vision over short distances.

Problems Arising from the Use of Display Screens

Over the years there have been a number of concerns raised about potential health problems associated with the use of display screens. In some instances improvement of equipment has minimised the risk, but in general extensive research has failed to show that the complaints could be attributed to the use of such equipment. The issues raised include:

- Facial dermatitis – a small number of complaints related to the supposed effect of VDUs on facial skin, ranging from occasional itching and prickling of the skin to reddening and more substantial rashes. Evidence suggests that these problems are usually associated with low humidity in the working area and static electricity resulting from a poor choice of carpet materials linked to a dry atmosphere.

- Photosensitive epilepsy – VDUs do not cause epilepsy but it is possible that they could trigger photosensitive epilepsy amongst individuals who already suffer from certain kinds of epilepsy. This is a very rare occurrence which has only been noted in relation to the rapid screen movement and lighting effects associated with certain computer games.

- Radiation effects – concern has been expressed over electro-magnetic radiation emitted from VDUs. However, extensive studies by various bodies throughout the world have concluded that emission levels are well below national and international limits for occupational exposure.

- Effects on pregnant women – there has been some concern that higher levels of miscarriage and birth defect have been experienced among VDU users. However, reliable studies have been unable to demonstrate any link and it has been suggested that the problem may be caused by worry and anxiety rather than through actual VDU use. Women who are pregnant or planning children and are worried about working with VDUs are advised to talk to their doctors.

Risk Factors and Risk Activities

The ill-health effects outlined above are related to the way in which work is performed. These characteristics are the risk factors and we can investigate them under three headings:

- Physical requirements of the task – the way in which the worker interacts with the physical objects in the work setting in undertaking the particular activities required by the task.

- Environmental context – the way in which the worker is affected by the environment when undertaking the task activities.

- Equipment – the way in which the worker is affected by the physical characteristics of work equipment itself.

Physical Requirements of the Task

The key risk factors and the activities which cause them are as follows:

- **Posture and physical action**

    This is the position of the body and the way in which it has to move in order to perform particular actions involved in the task. Problems here involve stress on particular parts of the body caused by awkward posture and movements in undertaking activities required by:

    – Work methods – the need to bend or twist to pick up a box, flex the wrist to assemble a part or to move a mouse, or move fingers and wrists to operate a keyboard.

    – Workplace dimensions – the layout of equipment and items which are required in the performance of the task, such as having to extend one's reach to obtain a part from a high location, having to kneel to stow away articles in a cupboard or having to get up and walk over to a printer to get a print-out.

    Specific areas of injury are associated with awkward postures and movements:

    – Fingers, wrists and hands – from twisting and bending to operate a keyboard or mouse, gripping very small parts or squeezing the trigger of a drill.

    – Upper arms and shoulders – from working with arms outstretched, especially with them at or above shoulder height, as when stretching to put away materials or twisting and bending to reach and manipulate a control lever.

    – Neck and upper spine – from bending and twisting to hold a telephone receiver on the shoulder, or raising, lowering and turning the head to switch focus from a document to a computer screen.

    – Lower back – from bending and twisting at the waist to pick up objects from the floor, or even leaning over to wash dishes in a kitchen.

- **Forces involved**

    This relates to how strenuous a particular activity is. The greater the forces involved, the greater the stress placed on the body and the greater the risk of injury.

    Forces can be exerted in two ways:

    – The speed and degree of movement required, such as turning a lever through 180° as opposed to only 90°, and how quickly it has to be done.

    – The physical characteristics of the object being manipulated or used, such as its size (how easy it is to grip), its resistance (how tight it is to squeeze or press) or its weight (how heavy it is to lift).

- **Repetition**

    This is concerned with how often the particular physical action – lifting, twisting, bending, squeezing, etc. – has to be performed during a task. The greater number of repetitions over a short period of time, the greater becomes the risk of injury.

- **Duration and recovery time**

    This relates to the amount of time a worker is exposed to physical stress in undertaking a task in relation to his/her position and movement, and the amount of time the body has to recover from any such stress. Recovery time may be simply time spent undertaking other activities which do not involve similar stresses, or it may be time specially set aside to allow the body to recover from being under physical stress.

It is important to remember that these factors interact with each other to either increase or modify the risks associated with a particular task, for example:

- The stress on fingers, hands and wrists from continually firing a rivet gun will be increased by the gun having a tight trigger.

- The stress on the lower back caused by lifting a heavy object may be modified by correct posture.

Environmental Factors

The key risk factor here is the lighting conditions, as they affect the ability of the worker to perform the task safely or may cause visual problems for the worker. The lighting level must be sufficient to enable him/her to see clearly in as much detail as is necessary all the physical objects involved in the task, including objects on a display screen.

Problems may come from:

- **Illumination** – the lighting level, which must be appropriate to the type of work being carried out. So, for example, the finer the detail of the work, the higher the illumination required. Variations in lighting level throughout the day with shadows moving across the workplace may cause difficulties.

- **Contrast** – significant variations in lighting levels between different parts of the field of vision or different areas of the workplace, which can temporarily blind the worker or interfere with vision as the eye adjusts to the different levels. (Note that the eye needs contrast to pick things out quickly, and a lack of contrast in, say, the colours of control buttons or instructions on a display screen can cause problems.)

- **Flickering** – the pulsing of light as a result of a malfunctioning device (such as a strip lamp and display screen), which can cause problems for the eyes and induce headaches, etc. A more serious hazard of a similar nature may be caused where the natural frequency of light waves synchronises with the frequency of a rotating or vibrating part so that the part appears stationary. (To reduce this potentially dangerous illusion, it is customary to use "out of phase" light bulbs and minimal-flicker fluorescent lighting tubes in machine shops.)

- **Glare** – which occurs where the eye looks directly into a bright light or receives a sudden input of direct bright light. This may be as a result of a light source being directly in vision (such as the setting sun coming in through a window, or a badly positioned lamp) or from the reflection of light off a polished surface, such as a mirror or the screen itself.

Equipment

The characteristics of the equipment used in the performance of work activities can themselves increase the risk of harm by putting extra strain on the body in two main ways:

- The physical characteristics of the equipment itself, for example:

    - By being difficult to manipulate, such as handles being too small or too large to grip easily, or drawers being too tight to move easily

    - By encouraging poor posture, such as non-adjustable seats or connecting cables being too short and restricting the position in which, say, a soldering iron can be used.

- The position of the equipment in relation to the worker in the position he/she normally occupies, for example:

    - Requiring the worker to work bent over in order to handle items on a conveyor belt

–   Continually having to reach down to pick up items from a low position, particularly when sitting

–   Continually having to get up from a sitting position to reach equipment.

Risk Activities: Analysis of a DSE Workstation

We can illustrate the way in which the above risk factors may come into play by considering the design of a DSE workstation, firstly in relation to the environment and the equipment used and then in relation to the interaction between the user and the equipment.

Environment and Equipment

The key areas for consideration are shown in the following diagram (reproduced from the UK's guidance on its regulations relating to DSE).
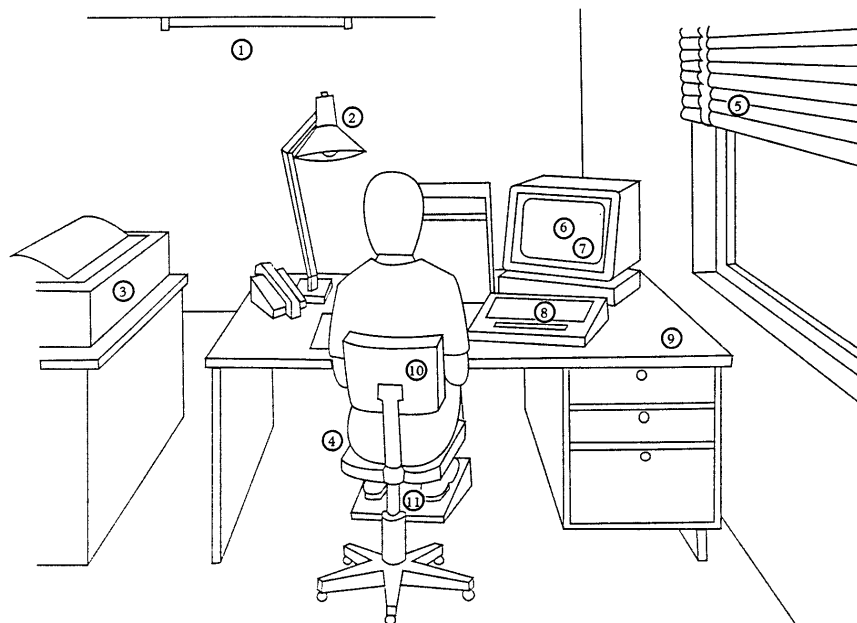
DSE Workstation

The numbered items represent issues to be addressed for comfortable and safe use of DSE. These issues are outlined below:

1   General lighting and heating – the general level of lighting in the area should be adequate for the tasks, with no excessive contrast or shadows in the immediate work area, and the heating maintained at a comfortable level with no draughts.

2   Local lighting – additional lighting may be necessary to provide sufficient illumination of the immediate work area to suit the needs of the task, with no glare or distracting reflections.

3   Distracting noise should be minimised – illustrated above by a shielded printer.

4   Sufficient legroom and clearance should be provided to allow for changes of posture and other general movement to suit the individual, and without being cramped.

5   Windows should allow plenty of natural light wherever possible, but coverings must be provided to prevent glare and excessive heat.

6   Software or information displayed on the screen must be appropriate for the task and be capable of adaptation to the needs of the user (for example, by allowing adjustment of the size of the work area displayed), provide feedback on the systems status and there should be no undisclosed monitoring.

7   The screen itself should provide a stable image, be of sufficient size to allow the information to be read easily and be free of glare or reflections. The screen should also be adjustable (see below).

8   The keyboard should be of appropriate design to be usable with comfort, with the keys being of sufficient size and clarity to suit the demands of the task. Again, it should be fully adjustable to suit the individual user (see below).

9   Work surface – this should be large enough to accommodate all necessary equipment and other items used from time to time, and to allow them to be arranged to suit the individual.

10   Work chair – this should be fully adjustable to suit the user (again, see below).

11   Footrest – provided to assist posture if required.

Interaction Between the User and the Equipment

The key consideration here is that wherever possible equipment should be adjustable to suit the individual user and where of necessity equipment is in a fixed position, it should be positioned so that the user is able to reach and use it in comfort.

- Workstations, including seating and access, should be suitable for any special needs of the individual worker, including workers with disabilities.

- The worker should be at a suitable height in relation to the work surface.

- Work materials and frequently used equipment or controls should be within easy reach, without undue bending or stretching.

- There should be sufficient clear and unobstructed space at each workstation to enable the work to be done safely, allowing for the manoeuvring and positioning of materials. This should also provide for adequate freedom of movement and the ability to stand upright. Spells of work which unavoidably have to be carried out in cramped conditions should be kept as short as possible and there should be sufficient space nearby to relieve discomfort.

Thus, in relation to the workstation shown above, the telephone should be capable of being moved to the preferred position of the user (left or right hand side of the desk and not requiring a stretch to reach it) and the drawers should be at a comfortable height and position to provide easy access and sufficient immediate storage. The chair should be easily movable to allow for adjustment of position and access. The document holder can also be positioned at a height and location to minimise head and neck movement.

The following diagram (also from the same UK guidance document) highlights the need to consider posture in the arrangement of equipment.
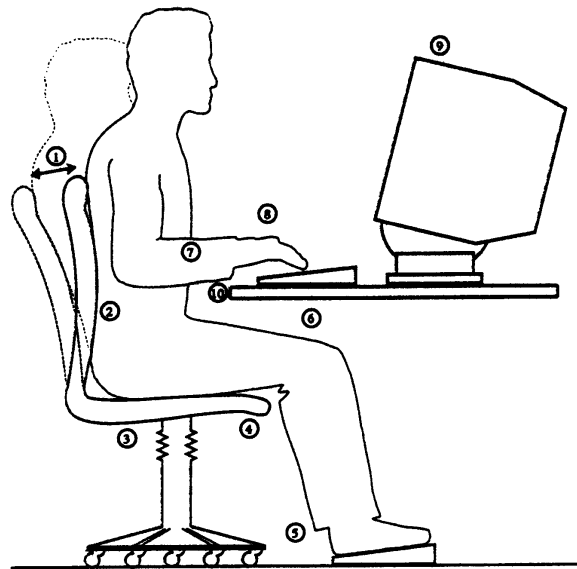
DSE Workstation Posture

The numbered issues are as follows:

1   Seat back adjustability

2   Good lumbar support

3   Seat height adjustability

4   No excess pressure on underside of thighs and backs of knees

5   Foot support if needed

6   Space for postural change, no obstacles under desk

7   Forearms approximately horizontal

8   Minimal extension, flexion or deviation of wrists

9   Screen height and angle should allow comfortable head position

10 Space in front of keyboard to support hands/wrists during pauses in keying.

Additional specific guidance on the positioning of equipment and posture includes the following:

- For tasks consisting of prolonged and consistent use of a display screen (such as data entry), the keyboard height should be such that when the user's fingers are resting comfortably on the home-row keys, the angle of the elbow should be 90 degrees.

- The keyboard should be able to be tilted and separated from the screen, so the operator can find a comfortable position, thereby avoiding fatigue in the arms or hands. A wrist rest can reduce stress on the lower arm both when typing or if work relies on much use of the mouse.

- For displays with tilted screens, the imaginary line joining the centre of the screen to the user's eye should be about 15 degrees below the horizontal, in the operating position.

- The VDU should be viewed from a distance of about 350 to 600 mm. The desk or table should be deep enough to accommodate the display unit for viewing at these distances without cramping the work surface in front of it.

Preventive and Precautionary Measures

The main measure to control risks involves the engineering controls we have considered above, that is altering the physical items in the workplace and ensuring the equipment is suitable for the task, does not present risks in itself, is adjustable to suit the needs of the user where appropriate, and is positioned to allow ease and comfort of access and movement.

Additional measures to reduce risks are in the form of developing safe systems of work and providing appropriate support for the individual.

Systems of Work

The organisation of tasks within jobs and over time acts to reduce the duration of activities which may put a worker under physical stress and/or allow for recovery. Examples include:

- Providing for regular breaks – short, frequently occurring rest breaks appear to be more satisfactory than longer ones taken occasionally, and they should be arranged so that they are taken prior to the onset of fatigue and not as a recovery period from it.

- Job or task rotation

- Assigning a second worker to assist in performing particular tasks

- Enlarging job responsibilities so that the same task is not performed repeatedly

- Limiting overtime work.

Individual Measures

The provision of information and training is important and should cover correct posture, including the adjustment of work equipment to suit the individual, and correct use of that equipment, including the software used on a computer.

In addition, eyesight tests and eye examinations should be carried out at regular intervals to identify any problems and to provide effective and remedial action; for example, providing spectacles for use when working with a VDU. The test, as well as the provision of spectacles if not normally required, should be at the cost of the employer.

REVISION QUESTION 1

(1) Sum up the aims of ergonomics in a simple phrase.

(2) What are the categories of health risks arising from poor task and workstation design?

(3) What is HAVS and how is it caused?

(4) State the risk factors involved in the physical requirements of the task.

(5) What aspects of lighting are risk factors?

(6) Summarise the requirements relating to the following elements of workstations.

  (i) Work surface/desk

  (ii) Keyboard

  (iii) Chair

  (iv) Space.

The suggested answers are given at the end of the unit.

WELFARE AND WORK ENVIRONMENT ISSUES

In this section we will consider a number of general issues related to the environment of the workplace and the welfare of workers, rather than the health and safety aspects of specific activities.

Supply of Drinking Water

It may seem obvious but an adequate supply of wholesome drinking water must be provided for everyone at work. Not all taps supply clean water, and any that do not should be clearly labelled so as to distinguish them from a wholesome supply.

Washing Facilities and Sanitary Conveniences

Toilets/rest rooms and washing stations should be provided in a workplace. The number required should be based on the number of people on the site. There should normally be separate facilities for men and women and all such facilities must be adequately lit and ventilated and kept in a clean and tidy state. Where possible they should be inside a building and protected from the weather. Special facilities should be provided for disabled people.

For hygiene reasons, washing facilities should be provided in the immediate vicinity of toilets and changing rooms. They should have a clean supply of hot and cold water, which should preferably be running water. Soap or other cleaning materials must be provided along with the means for drying, such as towels or a hot air blower.

Showers or baths should also be provided where the nature of the work is particularly strenuous or dirty, or there is a risk of contamination of the skin from harmful or offensive substances. Showers are often provided in industries such as mining or chemical manufacture, and health care.

Lockers and Changing Rooms

If the workforce are required to change into special work clothing (such as overalls, uniforms etc.) the employer should provide changing rooms and also lockers (or other secure means) to store the worker's normal clothing whilst at work.

Rest and Eating Facilities

Where applicable, employers should provide facilities for workers to rest and to eat meals. Rest facilities would normally include:

- The provision of seating.

- The provision of rest areas, with seating, for workers to use during breaks. These should normally be away from the normal work location, in a location where PPE does not have to be worn and where workers will not be subject to excessive disturbance (for example, by contact with the public).

- Rest areas or rooms should be large enough and have sufficient seats with backrests and tables for the number of workers likely to use them at any one time.

Where workers normally eat meals at work, eating facilities would normally be provided and include the following:

- Some means of preparing or obtaining a hot drink; for example, by providing an electric kettle or a vending machine where there is not a canteen. Seats in working areas could be used as eating facilities if there are suitable surfaces to place food on and the area is sufficiently clean.

- Where workers cannot get hot food in, or near, the workplace, some means of heating their own food should be provided (e.g. a microwave oven).

- Eating facilities must of course be kept clean and measures must be taken (including providing nearby washing and changing facilities) to prevent contamination by substances brought in on footwear or clothing.

These requirements should be adapted to the local climate.

Seating

Seating provided for workers at workstations should, where possible, meet the following specifications:

- Chairs should be stable and capable of full adjustment to suit the operator, that is be adjustable in height and the seat back be adjustable in both height and tilt

- The backrest must provide adequate support for the lower back

- A footrest should be provided on request for any worker who cannot comfortably place his or her feet flat on the floor.

Ventilation

Enclosed workplaces should be ventilated with sufficient fresh or purified air. This may be by fresh air from windows, etc. or via mechanical ventilation systems.

The following points should be borne in mind regarding ventilation:

- The means of ventilation must ensure that stale air, and hot or humid air generated as a result of work processes, is replaced at a reasonable rate

- The fresh or purified air must be free of impurities, so air from outside must not be drawn from near a source of contaminated or noxious odours, etc.

- The means of ventilation should not cause any uncomfortable draughts

- If working conditions involve close, humid atmospheres, workers should be allowed adequate breaks in well-ventilated areas, otherwise they may suffer heat stress

- Mechanical ventilation systems should be regularly cleaned, tested and maintained.

Temperature

The temperature in a workroom should be reasonable, not too cold and not too hot. In general, the workroom should be above 15 or 16°C, but this really depends on the nature of the work. So some form of heating may be required along with cooling (air conditioning) to maintain the temperature at a comfortable level.

Lighting

- Lighting should be provided in the workplace. Where practical, natural daylight through windows is best. However, this may not be enough at all times during the day and certainly isn't at night. Different tasks require different levels of light; fine, detailed work or work with a high degree of danger often requires more intense lighting than say, that needed to safely walk down a set of stairs. In certain circumstances, emergency lighting must also be provided in case the main lighting fails.

Where necessary, local lighting (called "task lighting") should be provided at individual workstations and at places of particular risk such as pedestrian crossing points on vehicle traffic routes. Outdoor traffic routes used by pedestrians should be adequately lit after dark.

Natural daylight should be utilised wherever possible. To this end, windows should be cleaned regularly and should be free of obstructions which may obscure the light.

A major objective is that only reflected light rather than light directly from a light source should reach the eyes at the working position. Light arriving at the eyes directly from light sources should not cause glare or discomfort. Thus, ideally, an operator's position at a workstation should not directly face a window where this may cause glare or excessive heat. Similarly, display screens should also not be positioned where conditions create reflections on the screen. If these conditions are not possible, appropriate shading of the window must be provided.

NOISE AT WORK

We are surrounded by sound all the time, we use it as a means of communication and as a source of entertainment (music), and we also use it as a source of information about our environment. Without it we may become disorientated. However, in certain circumstances it can be an intense irritation and a considerable hazard at work. In such circumstances unwanted sound is usually referred to as noise. The major problem of noise is hearing damage, but it can also cause disturbance which can impair efficiency, interference with communication which increase the risk of accidents, and stress.

Effect on Hearing of Exposure to Noise

In moderation noise is harmless, but if it is too loud it can permanently damage hearing. The danger depends on how loud the noise is and how long people are exposed to it.

The effects may be acute or chronic:

- Acute effects are where the peak pressure of the sound wave may be so great that there is a risk of instant damage to the mechanisms of the ear. This is most likely when explosive sources are involved such as cartridge-operated tools or guns. The effects of such trauma to the hearing senses may be permanent or temporary.

- Chronic effects are where constant exposure to excessive noise over a period of time gradually produces damage to the hearing sense. This form of damage may not be noticed until it has become permanent, although some effects may recede with time.

Although permanent damage to hearing is irreversible, surgery may reduce the damage in the case of acute injury to the eardrum, but there is no cure for hearing impairment.

The effects of damage to the hearing mechanisms of the ear may take a number of forms:

- Sounds become muffled so that it is hard to tell similar sounding words apart, or to pick out a voice in a crowd and it is difficult to distinguish speech from background noise. This effect is known as "threshold shift", indicating that the level at which sounds can be clearly distinguished has reduced. The condition may be permanent or temporary.

- Noise induced hearing loss occurs where the ear is unable to respond fully to sound within the speech range. The person does not necessarily lose the ability to hear sound, but is not able to distinguish the spoken word clearly even if it is presented with a raised voice.

- Tinnitus is a subjective condition where "noises in the head" or "ringing in the ear" are the descriptive symptoms. There are no observable external symptoms. This may be an acute condition which recedes with time, although the recovery period could be twelve or more hours where very high exposure levels occur. It may also occur with people who have a chronic noise-induced hearing impairment, in which case it is usually permanent.

Where conditions in the workplace are such that it is necessary to shout in order to be understood, or there is a difficulty being understood by someone about two metres away, there is likely to be a problem and the noise level will have to be assessed by a competent person.

Measurement of Sound

Sound is transmitted by the production of waves in the air (or whatever medium it is travelling through, such as water) as shown in the diagram below.
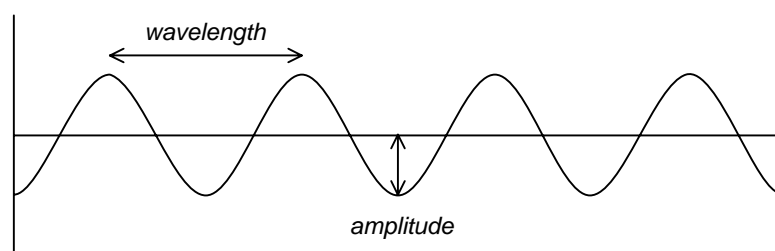
Pressure Variation in Sound Waves

There are two basic ways in which sound may be measured:

• Frequency – which is related to the wavelength of the sound and determines the pitch of the sound. The shorter the wavelength, the higher the frequency and the higher the pitch. Frequency is measured in cycles per second or hertz (Hz).

• Pressure – which is related to the amplitude (size of the wave produced) and determines the loudness of the sound that is heard. Sound pressure (or loudness) is measured in decibels (dB) which is essentially the ratio of the pressure produced by the sound waves to the normal air pressure. Because of the way in which decibels are calculated, the dB scale is what is known as "logarithmic". All we have to know about this idea is that 3 dB means twice as much sound pressure, and an increase of 10 dB means ten times as much. However, the way in which we perceive loudness is not directly proportional to the decibel level; for example, a sound 10 dB greater than another is not perceived as being ten times as loud, but only about three times as loud.

Because the human ear hears both loudness and frequency, we must take account of both in measuring the intensity of sound. Thus, decibels are usually measured with a filter which emphasises sounds in certain frequencies. The "A" filter (dB(A)) is the one most frequently used, producing a scale which mimics the response of the human ear to sound.

The following diagram gives an indication of different sounds along the dB(A) scale.
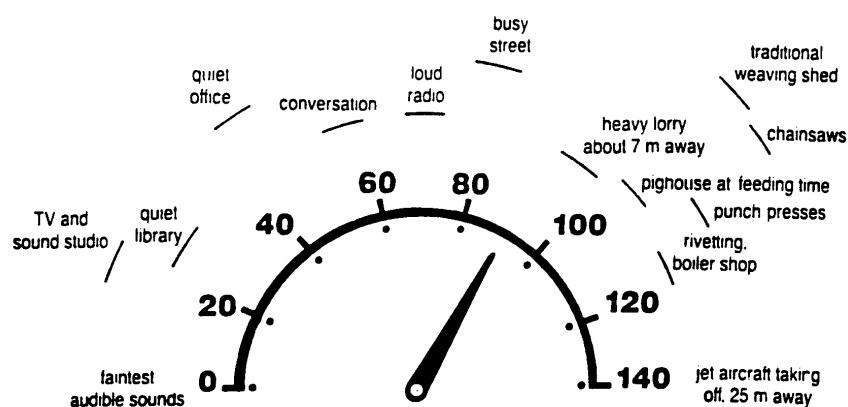
Typical dB(A) Levels (Source: HSE)

Note that in identifying and controlling specific noise sources the dB(A) scale may not be sufficient to provide all the information necessary. For example, for machines emitting noise at just one or two frequencies (as is often the case with circular saws), the most efficient method of noise reduction would be to absorb sound at those frequencies. So we want to know about the

frequency levels as well, and most sound level meters are equipped with filters which enable an analysis in these terms.

Exposure Levels

The damaging effects of noise are related to the total amount of energy or "dose" which the ear receives. The dose/energy depends on two factors – the level of noise and duration of exposure. It is commonly accepted that equal amounts of noise energy entering the ear causes the same effect to exposed workers irrespective of the noise or exposure profiles. Thus a short exposure to a high level of noise is considered to cause comparable hearing damage to a long exposure to a low level of noise. This is illustrated in the following table by reference to an exposure equivalent to 90 dB(A) for eight hours (a working day).

Exposure Equivalents

Sound Level in dB(A)	Exposure Equivalent
90	8 hours
93	4 hours
96	2 hours
99	1 hour
102	30 mins
105	15 mins
108	7.5 mins

Each exposure represents 100% of exposure equivalent to 90 dB(A). Note that if the sound level is doubled (represented by a 3 dB(A) increase on the logarithmic scale) then the duration of exposure has to be halved for the total dose to remain the same. A person's daily personal exposure to noise (abbreviated to $L_{EP,d}$) is the measurable quantity most often used in this regard.

Personal exposure to noise is what counts rather than the background noise in a room. If a person never enters a very noisy environment then he is never exposed to that noise. In practice, a worker may be exposed to various levels and frequencies of noise throughout the day. As explained above, it is the personal dose that is important.

An employer should always take positive steps to reduce noise where possible, whatever the level. Machinery manufacturers often provide noise output information in their operating manuals. An individual machine may not be particularly noisy, but added to all the rest of the equipment in a room, the noise can build up to unacceptable levels.

Based on the idea of personal dose, the control trigger of "Action Levels" has developed. "Action Levels" are personal doses at which an employer would be expected to take certain actions to control the noise. In general (though legislation varies from country to country) if a person is exposed to an $L_{EP,d}$ of at least 85 db (called the "First Action Level"), an employer may be expected to take specific actions to control noise in the workplace. This might include:

- Carrying out noise assessments

- Informing workers about the risks to hearing and what they should do to minimise those risks, including the use of hearing protection

- Making hearing protectors freely available (these should only be used as supplementary protection, not as a substitute for tackling noise at source).

At $L_{EP,d}$ of 90dB(A) and above (the "Second Action Level"), an employer would be expected to take the following actions over and above those already required for the first action level:

- Enforce the use of hearing protection and identify these areas as hearing protection zones with appropriate signage.

- Reduce exposure to noise as far as possible other than by the use of hearing protection (i.e. tackle noise at source rather than reliance on PPE).

The "Second Action Level" actions are also required in operations which involve an instantaneous peak sound pressure of 200 Pascals (equivalent to 140 dB instantaneous). Typical scenarios would be the use of drop forge hammers and cartridge operated tools. By referring to the previous exposure equivalents table it can be calculated that 140 dB(A) exposure for less than about 100 milliseconds is equivalent to the 90 dB(A) for 8 hours. Remember it is the total noise dose that does the damage, not just the duration of exposure.

Simple Noise Measurement Techniques

Personal noise exposure can be calculated from measurements obtained from a simple sound level meter when an individual works in a single location and the noise level is fairly constant. However, where noise levels are more variable or workers' movements are irregular, the measurement of noise exposure becomes more difficult.

A simple noise level survey at a fixed position may be carried out as follows:

- Measurements should be taken with the process or equipment under operating conditions but without operators in position (thus preventing stray reflections). They should be taken at a height of about 1.5 m from the floor where work is carried out in a standing position, and about 1.2 m if operators are seated.

- The first measurements should be made at a horizontal distance from the noise source of about 1 m. Further readings should be taken at about 2 m intervals around the noise source to provide a general plan of the noise distribution.

- Having identified the general noise pattern, the area may be re-measured with operators in position. Measure at points of highest noise, at the operator's ear and other convenient positions.

Noise dosimeters provide a simple means of measuring personal exposure where workers are exposed to complex and variable noise fields. These small personal monitoring devices are worn by workers throughout a representative part of the working day. The dosimeter incorporates a small microphone which picks up and integrates the noise level continuously so that at the end of the sampling time a direct reading of personal exposure is displayed.

Basic Noise Control Techniques

Wherever noise is a problem there are three orders of priority for dealing with it:

- Noise reduction at source – by elimination or substitution of the process or equipment producing the noise

- Attenuation in transmission – by engineering controls which limit the amount of noise transmitted

- Personal protection – use of ear protection, only if neither of the first two approaches results in a satisfactory solution.

Elimination and Substitution

Noise can often be eliminated or reduced by replacing the noisy equipment or process with different, quieter equipment or process, for example:

- Diesel/petrol engines replaced by electric motors

- Pneumatic tools replaced by electric tools

- Solid wheels replaced by pneumatic rubber tyres

- Metal chutes, buckets, boxes replaced by rubber or plastic ones.

Many machines are noisy because of worn parts, poor maintenance, inadequate lubrication, or because they are "out of balance". Planned maintenance, replacement of worn parts and regular oiling will reduce noise and increase efficiency.

Instead of replacing a complete machine or process it may be possible to carry out a simple modification; for example, plastic or rubber-coated rollers and guides on a conveyor belt may be used for handling glass or metal components.

Isolation

In many cases the best method of noise control is to enclose the noise source. Machinery enclosures should have a heavy noise-reflecting outer skin and a noise-absorbent lining such as mineral fibre. They should be mounted so that they do not transmit noise and vibrations to the floor.

To be effective, enclosures must be airtight as the smallest gap allows sound to escape and reduces the attenuation of the noise inside the enclosure. This is a particular problem with, for example, woodworking machines such as saws and planes, where timber is fed in at one end and comes out at the other. Such equipment can, however, be fitted with noise-reducing feed and delivery tunnels which should be lined with noise absorption materials and fitted with windows to allow clear viewing and with adequate lighting.

Absorption and Insulation

Machines are often situated in large acoustically reverberant (echoing) areas which reflect sound and build up noise levels within the room. Noise levels in adjacent rooms can be reduced significantly by using sound-absorbing materials on walls and other large surfaces. The absorptive surfaces reduce the echoing component of the overall sound and consequently the level of noise in general.

As well as possessing absorbent properties, noise screens or enclosures and havens must be acoustically insulating. This means that they must transmit very little noise and thus they tend to be heavy. The superficial density of the barrier must be high.

The positioning of barriers is important. They should be near the noise source or the noise receiver. Generally speaking, the least effective place to position a barrier is at an equal distance

from the source and receiver. Barriers can reflect noise away from the receiver as well as absorbing it.

Damping

Vibration is one of the main causes of noise. The vibrations can be transmitted from the source via a rigid connection to a variety of sites such as the panels of a machine, floors, walls and tables. These large surfaces act as sounding boards and increase the level of noise.

Simply by isolating the machine on anti-vibration dampers or rubber mountings may reduce noise levels considerably; for example, putting rubber feet around the legs of machines. Other damping techniques include construction methods using bolts rather than welds and surface coatings or bonding applied to sheet metal.

Silencing

Certain types of equipment involving the intake or discharge of air or other gases may be fitted with acoustic silencers, similar to the way in which gunshot sounds or the noise from car exhausts may be suppressed. These work by absorbing the sound pressure generated by the process at its source.

Personal Hearing Protection

Where people have to work in noise-hazardous areas ear protectors (ear muffs or ear plugs) must be made available. However, they should not be regarded as a substitute for noise reduction at source. Hearing protection should be chosen to reduce the sound level at the user's ear to below the limit for unprotected exposure. It most be worn all the time to give the protection it is designed to achieve and should not be removed since even a short exposure in a high noise environment represents a significant noise dose.

Types and Selection of Ear Protection

There are two basic types of protection:

- **Ear muffs or ear defenders**

    These are normally hard plastic cups which fit over and surround the ears, fitted to the head by cushion seals filled with a soft plastic foam or a viscous liquid. A simple padded band over the head holds the cups comfortably in position and allows the muffs to be slipped off easily when not required. However, this prevents use of a hat or helmet. Hats can be worn more easily if the band runs behind the wearer's neck or under the chin and the muffs are supported by a thin strap under the hat, although it is then difficult to slip them off. Other types are attached to safety helmets and can be swung out of the way when not wanted.

    Ear muffs are easily seen, making the enforcement of their use easier.

- **Ear plugs**

    These are small pieces of sound absorbing material which are placed directly into the ear. They can be supplied with a cord or a neck band to prevent loss, useful in the food industry for example.

    There are three types:

– Permanent, intended for use for an indefinite time

– Re-usable, which can be used a few times

– Disposable, which are thrown away after one use.

Ear plugs are not easily visible, making their enforcement more difficult. Because they fit into the ear canal they are not always suitable for workers suffering from an ear disorder.

In choosing the most appropriate form of protection, consideration should be given as to how suited they are both to the individual and to the working environment. This includes whether they are compatible with other protective equipment or special clothing, how well they fit (they must be a perfect fit to be effective) and how comfortable they are to wear. This last point is an important point since they must be worn all the time. All protectors are likely to cause some discomfort, especially in hot sweaty conditions.

If possible a selection of ear muffs and ear plugs should be on offer and people should be encouraged to take one type to try out for a few days and report back. They should be allowed to take another type if the first does not suit them.

Limitations of Protection

Generally speaking, the cheaper ear defenders can be expected to give 8 to 15 dB(A) attenuation (reduction) at low frequencies, and up to 35 to 40 dB(A) in high frequencies. The more expensive heavy duty hearing protectors designed for very high noise levels give attenuation of 20 to 25 dB(A) at low frequencies, and up to 45 dB(A) at high frequencies. No form of hearing protection will give attenuation of more than 45 to 50 dB(A) because noise leaks through the bones of the skull, sealing may imperfect and so on.

Protection will be reduced by various factors which lower the effectiveness of the seal between the ear and the ear muff or plug, for example:

- As a result of long hair, thick spectacle frames and jewellery

- The wearing of helmets or face shields which prevent ear muffs fitting correctly; ear plugs are often better in such circumstances

- Ear plugs not being properly inserted into the ear.

Note also that much of the protection ear muffs or plugs are designed to offer is lost when they are removed, even if only for a short time; removing the protection for only 15 minutes in an 8 hour shift can lose the wearer 80% or more of the protection. Not many users are aware of this fact.

One manufacturer recommends buying ear defenders giving 5 dB(A) higher protection (greater sound attenuation or noise reduction) than is apparently needed, to allow for such factors as intermittent wearing, loose fittings and so on.

HEAT AND RADIATION

In this section we consider two hazards which occur only in certain types of workplace.

Exposure to Extremes of Temperature

We have seen that the temperature of workrooms should be reasonable (normally at least 16°C but not uncomfortably hot). However, there will always be situations where, due to the nature of the work, workers will be exposed to temperatures far above or below what could be considered comfortable. Examples include:

- Extreme heat – working with molten metals and in foundries

- Extreme cold – working in cold-stores.

Effects of Exposure

Prolonged exposure to excess heat or cold can lead to fatigue, a general slowing of reactions and a loss of dexterity, affecting both work efficiency and the possibility of making mistakes which can lead to accidents.

Apart from the risk of burns from contact with hot materials, surfaces and equipment, working in very hot environments can cause heat exhaustion, dehydration, heat cramps and heat stroke.

Exposure to extreme cold can lower the body's deep core temperature, either locally (for example, in the fingers or toes) where it may cause frostbite or more generally where it can cause hypothermia. These conditions are extremely unlikely in an occupational setting, but lesser effects include shivering, loss of awareness, pain in the extremities of the body and reduced grip strength and co-ordination. Contact with very cold materials, surfaces and equipment can also cause burns.

Preventive Measures

The general requirement on employers to take all reasonable steps to achieve a reasonably comfortable working temperature still applies in situations where extremes of temperature are inevitable. The first aim of measures to prevent the ill-effects of exposure to extremes of temperature should be engineering and process controls. They include:

- Providing as much ventilation as is reasonably practicable in hot environments.

- Providing insulating floor coverings where workers have to stand for long periods on cold floors.

- The provision of adequate rest facilities, away from the extreme temperatures, with appropriate facilities to counter the effects of exposure, such as hot or cold drinks.

- Where practical there should be systems of work (for example, task rotation) to ensure that the length of time for which individual workers are exposed to uncomfortable temperatures is limited.

It is quite likely that suitable protective clothing will have to be provided. For workers in hot environments this will include face shields and heat/flame resistant footwear, gloves and clothing. In cold environments, insulated footwear, gloves and clothing will be required.

Ionising and Non-ionising Radiation

Radiation is a general term for the processes by which energy is transmitted from a source without physical contact. The energy transmitted is capable of causing considerable harm, depending on its form and the length of exposure.

There are two forms of radiation: ionising and non-ionising.

Ionising Radiation

This includes both the streams of particles emitted by the decay of radioactive substances (alpha- and beta-particles and gamma rays) and X-rays. The energy transmitted is powerful enough to ionise atoms in living tissue, causing chemical changes at the cellular level. At high doses this can result in massive cell destruction, damage to organs and possibly death. At low doses it can result in the formation of cancers. If these form in the reproductive organs it can cause hereditary effects in future generations.

Non-Ionising Radiation

This form consists of lower energy electromagnetic waves whose energy decreases with increasing wavelength. There is a spectrum of types of non-ionising radiation based upon the wavelength of the energy transmitted. This spectrum, together with the effects on the body, is as follows:

- *Ultra-violet radiation* – this has low penetrating power and its effects are confined mainly to the skin and the eyes. Acute effects on the skin are similar to sunburn, whereas chronic effects include premature aging of the skin and skin cancer, although this is highly unlikely to be contracted from occupational sources. The most common effect on the eyes is conjunctivis, an inflammation of the eye often associated with welding where it is commonly known as "arc eye".

- *Visible radiation* – most particularly from high intensity beams such as lasers, which can cause serious burns to exposed skin tissue and is particularly dangerous to the eyes.

- *Infra-red radiation* – which is emitted from any hot material and can cause reddening of the skin, burns and cataracts in the eyes.

- *Micro-wave radiation* – which generates heat by causing the vibration of liquid molecules within tissues and exposure can produce deep-seated burns, particularly to the eyes.

- *Radio frequency radiation* – which can cause excessive heating of exposed tissues.

Controlling Exposure to Radiation and Protection Strategies

Protection from ionising radiation is based upon following strictly the three forms of control which limit exposure to the absolute minimum:

- Administrative controls to restrict the use of radioactive materials to designated areas and particular workers, provide for safe systems of work and ensure monitoring of exposure levels.

- Engineering controls – the use of shields to form a physical barrier which prevents the transmission of radiation.

- Personal protective equipment – the provision of appropriate clothing to protect the individual worker where there remains a risk of exposure despite the full application of other forms of control.

Protection from the effects of non-ionising radiation is principally in the form of shields and PPE, although where UV sources are powerful enough to constitute a hazard, administrative controls may also be necessary.

Ionising Radiation

Ionising radiation is subject to special controls throughout the world. Whilst the details vary, the general principles remain common. Below we outline the key aspects of control of exposure to ionising radiation.

Appointment of Worker with Specific Responsibility for Radiation Protection – advising and enforcement of rules

Such workers (one or more) must have particular experience of the type of work the employer undertakes and be able to provide advice and guidance on the following matters:

- Compliance with current legislation and local rules

- Local rules and systems of work (which may be site or room specific)

- Personnel monitoring, dosimetry and record keeping

- Room design, layout and shielding

- Siting of equipment emitting ionising radiation

- Siting and transport of radioactive materials

- Leakage testing of sealed sources

- Investigation of incidents, including spillages or losses.

Designated Areas

The key method of controlling exposure to radiation is by defining areas where there is a radiation hazard and restricting access in order to reduce the radiation dose.

Radiation work should only be permitted in areas which have been approved for that purpose. At the entrance to each area a sign must be posted indicating the designation of the area, the nature of the source and any restriction of activities. Also listed are the names of authorised workers and those responsible for supervision of work in the area. Within the area all sources of radiation must be clearly marked with the radiation hazard symbol.

Areas for radiation work are usually described by the likely radiation dose of those working in those areas. The foreseeable radiation dose will determine the measures needed to control exposure.   Areas where radioactive materials are stored and dispensed are where likely exposures will be highest. Working in radiation areas will be restricted to those who have been authorised, having received all the appropriate information about the hazards and training in the use of specific precautions and safe systems of work. The safe system of work will, depending on the nature of the worker's duties, include rules for handling radioactive source material, action in the event of accidents or other incidents and procedures on leaving a radiation area.

Dosimetry and medical surveillance

The International Commission on Radiological Protection (ICRP) has set the following limits on exposure to ionising radiation:

- The general public shall not be exposed to more than 1 mSv per year

- Occupational exposure shall not exceed 20 mSv per year.

These limits exclude exposure due to background and medical radiation.

To give you an idea of what these figures mean, the total natural radiation to which people are likely to be exposed is about 1.5 mSv per year, a chest X-ray involves an exposure of 0.04 mSv, nuclear fallout from atmospheric tests in the 1950s and 1960s was 0.02 mSv per year and for people living in control zones near Chernobyl (the scene of a major nuclear power plant disaster in 1986) exposure is 10 mSv per year.

Monitoring to ensure that these limits are strictly adhered to takes three forms:

- Personal monitoring – the exposure of workers in controlled and supervised areas should be assessed by the use of personal dosimeters. These may measure the whole body dose or the dose to a part of the body such as the fingers.

- Medical examination – routine examinations for workers should be conducted before employment and every 12 months, with an immediate special examination after an overexposure.

- Area monitoring – levels of radiation in areas must be regularly assessed, and the equipment used to carry this out must be properly maintained, examined and tested.

Records of all forms of monitoring should be kept.

Control of radioactive substances

Radioactive substances used as a source of ionising radiation should be in the form of a sealed source whenever possible. This should be designed, constructed and maintained to prevent leakage. Records of the quantity and location of radioactive substances must be kept.

Non-ionising Radiation

Control of exposure to non-ionising radiation is generally solely through the use of engineering controls and PPE. However, where there is the possibility of prolonged exposure to UV radiation, administrative controls may be necessary; for example, the use of warning signs, limitation of access and exposure time, and the provision of information on the nature of the hazard and the precautions to be taken.

Engineering Controls

Access to controlled and supervised areas and also to areas where there is a high risk from non-ionising sources may be restricted by forms of enclosure such as interlocked doors. Within areas where UV or visible radiation may be generated, reflective surfaces should be avoided and surfaces painted in a dark matt colour.

Segregation and containment of unsealed radioactive material prevents its dispersal and ingestion or inhalation by workers. Ventilated glove boxes or fume hoods under negative pressure serve to contain radioactive contamination and prevent its escape.

Where there is a risk of exposure to radiation, shielding is the best method of protection. It depends upon the absorption of radiation energy by the interaction with a dense medium, such

as lead or concrete. Particulate radiation can be completely stopped by interaction with solid material, while electromagnetic radiation can be sufficiently absorbed, so that the emergent radiation has a very reduced risk level.

There should be no unnecessary metal objects near any radiating RF device, as localised high field strengths may result around such items. Care should therefore be taken to remove rings, watches or bracelets when working close to radiating sources.

Personal Protective Equipment

Gloves and overalls prevent exposure from low energy beta emitters and prevent skin contact. High density materials are used to provide shielded body protection for persons at risk from penetrating radiation, such as radiographers.

Eye protection, possibly using high-density lenses, may be used to protect the eyes if the head is at risk from exposure to beams of radiation. Respiratory protective equipment may be needed as an additional precaution to prevent inhalation of radioactive contamination.

Occupational Sources of Radiation

The use of ionising radiation in the workplace is a specialist activity subject to strict controls, and it is highly unlikely that you will encounter direct experience of this particular occupational health hazard. However, non-ionising radiation is relatively common in the workplace.

Ionising Radiation

The most familiar example of ionising radiation is the use of X-ray equipment for radiography in hospitals and dentistry. You will also be aware of the use of radioactive materials in the nuclear power industry. In addition, X-ray and gamma radiography is commonly used for non-destructive testing of welds where it is essential that the weld cannot fail; for example, in stainless steel pipelines carrying dangerous liquids; and radiochemical isotopes are regularly used for a range of purposes in medicine, including tracer or diagnostic work.

Most other uses of radioactive materials are confined to laboratory research.

Non-Ionising Radiation

Typical sources of the different types of non-ionising radiation include:

- Ultra-violet – electric-arc welding, plasma torches, curing of inks and resins, sunbeds, some lasers and a variety of high intensity lamps such as mercury and arc lamps. Operators using any of this equipment are at risk, as are others nearby who may be exposed to the source.

- Visible radiation – lasers and other high intensity lights, which are increasingly found in common machinery and equipment such as photocopiers and printers. Again operators and others nearby may be at risk from exposure.

- Infra-red radiation – any hot body gives of this type of radiation, as well as specialist infra-red heaters. There is a risk to anyone working close to sources of high temperatures, such as foundry workers, catering staff, etc.

- Microwaves – drying and heating equipment, as used in catering and laundries, etc.

- Radio frequency – heating units, plastic welding, overhead power lines and high-powered transmitters used for TV/radio broadcasting and mobile phone base stations. These are relatively low risk sources (and there is considerable debate about the status of mobile

phone base stations), but it is known that acute effects can occur where a person short circuits transmitter aerials.

REVISION QUESTION 2

(1)   Do employers have to provide each of the following at all times, and if not, are there circumstances in which they must?

    (i)   Soap and a towel or air drier in washing facilities

    (ii)   Baths or showers

    (iii) Changing rooms

    (iv) Eating facilities

    (v)   Natural light for workstations

    (vi) A temperature of 16 degrees centigrade

    (vii) Footrests for seated workers

    (viii) Ear protection

(2)   What does an $L_{EP,d}$ of 85 dB(A) mean and what is significant about this figure?

(3)   What are the limitations of ear defenders and earplugs?

(4)   Identify the protective measures to be used for working in conditions of extreme heat.

(5)   What type of non-ionising radiation is given off by the following pieces of equipment?

    (i)   Radio transmitter

    (ii)   Hot plate in a kitchen

    (ii)   Arc welder in operation

    (iv) Laser

(6)   What are the health risks of visible radiation?

The suggested answers are given at the end of the unit.

STRESS AT WORK

In recent years, work-related stress has become recognised as a significant concern.

Causes

Work-related stress has been defined as "the adverse reaction people have to excessive pressures or other types of demand placed on them". To be set challenging targets at work can be motivating, but if demands are placed on workers which they feel they cannot cope with, they will experience stress, which in turn affects morale and performance. Work-related stress is a complex subject because it results from the interaction of organisational factors and factors which are personal to the individual worker.

There are nine broad categories of causes of work-related stress: culture, demands, control, relationships, change, role, training, support and factors unique to the individual.

Culture

We have already seen that organisational culture is the mixture of formal and informal rules, relationships, values and customs which describe the distinctive "feel" of an organisation. The culture is often very strong, rooted in history and difficult to change. It is a key factor in determining the incidence of work-related stress.

Examples of cultural factors which make it more likely that workers will experience work-related stress include working long hours (also known as "presenteeism"), taking work home, inflexible working patterns and an autocratic management style, with little communication and consultation. The attitude of the organisation towards stress is also important; if mental health problems carry a stigma and feeling under pressure is seen as a sign of weakness, workers will not feel able to express their concerns.

Demands

Demands on the individual worker are often regarded as the main cause of work-related stress. Stress can arise either if a worker is allocated too much work to do with insufficient resources (for example, where it is not possible to complete a task within the time available) or if the work is too difficult and the worker has not received appropriate training or the task is beyond their capability.

The physical and psycho-social environment in which work is carried out can also be a source of stress. Aspects of the physical environment which affect workers include temperature, noise, vibration, light, ventilation and workstation design. A significant factor in the psycho-social environment is the risk of violence (which we will look at in more detail in the next section); for example, for workers who have to deal face-to-face with angry members of the public.

Work underload, when a worker does not have enough to do, or feels insufficiently challenged by the work, can also result in stress.

Control

Stress used to be regarded as something which primarily affected senior managers in highly responsible positions, but research has shown that lack of control over work is a more significant cause and this is more likely to be found in jobs lower down the organisation. Senior managers often have considerable discretion in deciding which tasks they will undertake and when, whereas subordinates are likely to be subject to greater control and to work to more rigid

timescales. Lack of control is particularly acute in jobs where the pace of work is set externally to the worker – for example by a production line or the demands of customers.

Relationships

There is a wide variety of different people with whom we interact at work, including managers, colleagues, subordinates, customers, suppliers and members of the public. Often such relationships can be an important source of support, but they can also cause stress; for example if there is interpersonal conflict. Harassment and bullying are particularly important causes of stress and if they are not tackled they can lead to stress-related illness.

Harassment and bullying is defined as offensive behaviour involving an abuse of power by one person over another. This may arise from prejudice based on factors such as gender, ethnic origin, religion or disability, or from other sources of power, such as a person's hierarchical position in the organisation, age, length of experience, educational background, social class, etc. Harassment and bullying can take place at all levels in the organisation and may be carried out by a manager towards a subordinate, between colleagues or by a subordinate towards his manager. Obvious examples of harassment and bullying include racial abuse, requests for sexual favours, spying and pestering, but it can also take more subtle forms, such as persistent belittling in front of others, excessive supervision, withholding information or social isolation.

Change

Organisations are constantly adapting to changing external and internal conditions, such as new technology, political regulation and competition. Their response may include restructuring, downsizing and new ways of working. Such changes can have a beneficial impact for individual workers by making their work more interesting and enabling greater job satisfaction, but change can also cause worry, anxiety and feelings of insecurity, particularly if there is a threat of job losses.

Role

If a worker's role in the organisation is unclear, because they are unsure of the scope, responsibilities and requirements of the job, or they are subject to conflicting demands, this is a significant source of stress.

Support

A worker receives support formally from management and informally from colleagues and others with whom they interact at work. If the worker feels unsupported because, for example, they feel that the problems they face are not appreciated by management or there is a lack of social support from colleagues, then they are more likely to experience work-related stress.

Training

A worker must receive sufficient training to be able to undertake the main functions of their job. If a worker is not given basic induction training when they start a new job or additional training when changes are made, such as the introduction of new working methods or a new piece of equipment, they will struggle to carry out their duties effectively, inducing feelings of worry and anxiety.

Factors Unique to the Individual

The personality of workers is an important factor in how they respond to the different pressures facing them at work; for example, some people thrive on change whereas others are frightened by it; some people are motivated by working to tight deadlines, whereas others panic. A worker

may also be more vulnerable to work-related stress because of factors outside work; for example, if they are experiencing a domestic crisis or bereavement or have previously suffered from a depressive illness.

Effects

Work-related stress has adverse effects on the individual worker and the organisation. For the worker, the symptoms of stress may be physical or psychological, including headaches, dizziness, panic attacks, skin rashes, stomach problems, poor concentration, difficulty sleeping and increased alcohol consumption. If stress is intense or prolonged it can lead to the onset of serious physical and mental health conditions such as high blood pressure, heart disease, gastro-intestinal disturbances, anxiety and depression.

Because stress is a major cause of sickness absence among workers it represents a significant cost to employers. Losing even one worker because of a stress-related illness can also have a dramatic effect on output and result in additional costs if a replacement has to be brought in to cover their job. Work-related stress also affects morale and motivation which can result in lower productivity, reduced performance, tensions between colleagues and increased incidence of industrial relations problems. In the long term it may cause workers to leave, with the consequential costs of recruiting and training replacements.

Prevention Strategies

As with all control measures, strategies to tackle work-related stress must be based on a risk assessment and apply the basic risk control principles:

- Avoiding the risks – for example, by establishing a positive organisational culture where working long hours or taking work home is not encouraged.

- Combating the risks at source – for example, by using effective recruitment and selection procedures to ensure that recruits have the necessary skills and experience to undertake the job.

- Adapting the work to the individual – for example, by giving workers freedom to plan their work to meet the deadlines required and catering for individual differences in a team.

- Developing collective measures – for example, by dealing with such factors as working conditions, the organisation of work and relationships.

Even after implementing such measures there may be some sources of stress which are unavoidable and efforts should therefore be directed towards helping the individual worker to cope; for example, by means of increased supervision, workplace counselling and stress management training.

Many of the actions which an employer can take to address work-related stress can simply be described as good management practice. They do not require significant expenditure, but sound people management skills. The types of action which can be taken are outlined below.

Culture

An organisation has a positive culture when there is open communication and trust between employer and workers. Workers should be encouraged to raise any problems, knowing that they will be recognised and dealt with promptly. There should be recognition of the importance of

striking the right work-life balance. Work-related stress should be treated seriously, with the employer responding positively to any concerns.

Demands

The employer should ensure that there are sufficient resources available to do the work allocated; for example, tasks may have to be re-prioritised or deadlines renegotiated to ensure that resources are directed to where they are most needed. Risk assessments should be undertaken to control physical and psychosocial hazards.

Control

Workers should be encouraged to have more say in how their work is carried out; for example, in planning their work, making decisions about how it is completed and how problems will be tackled.

Relationships

Clear standards of conduct should be explained to workers, with managers leading by example. The organisation should have policies in place to tackle misconduct and harassment and bullying.

Change

If change has to take place the workers should be consulted about what the organisation wants to achieve and given the opportunity to comment, ask questions and get involved. Workers should be supported before, during and after the change.

Role

A worker's role in the organisation should be defined by means of an up-to-date job description and clear work objectives and reporting responsibilities. If workers are uncertain about their job or the nature of the task to be undertaken they should be encouraged to ask at any early stage.

Support

Feedback to workers is an important way of improving performance and maintaining motivation. All feedback should be positive, with the aim of bringing about improvement, even if it is challenging. Feedback should focus on behaviour, not on personality. Managers should ensure that feedback is given for tasks which have been performed well, not only when there are problems.

Training

Workers have to be competent and feel comfortable about doing their jobs. Induction training should be provided to new workers and the training needs of all workers be regularly assessed to ensure that they are equipped to deal with new challenges. There are a range of ways in which training can be provided, both on and off the job.

Factors Unique to the Individual

The employer should take into account that people's skills and the way they approach their work will differ and try as far as possible to cater for individual differences when allocating and managing work.

VIOLENCE AT WORK

Violence at work has become an issue which has attracted increasing attention in recent years. High profile incidents of violence at work have been reported in the press and have raised awareness of the issue among the public, employers and government bodies alike. Definitions of what constitutes violence at work vary and can range from physical assaults to verbal, emotional and psychological abuse. The definition of violence at work adopted here is as follows:

Any incident in which an individual suffers verbal abuse, physical abuse or threats in circumstances relating to their work.

Risk Factors

Specific acts of violence are generally unpredictable but the situations in which violence may occur are not. It is possible to identify a number of such situations:

- The handling of high value goods – for example, cash, drugs or other costly items. Here the risk of violence is associated with robbery.

- Contact with customers or clients where the outcome will be to refuse the person what they want; for example, a loan, a benefit or some other product (such as another drink) or service, access to another person, general redress of a grievance, etc.

- Contact with customers/clients where the outcome is to censure them in some way; for example asking someone to leave the premises, etc.

- Contact with customers/clients who are under stress (perhaps as a result of frustrations or delays in obtaining the necessary contact), under the influence of alcohol or drugs, or with a history of violence. Any of these factors may serve to aggravate the risk situation or may be the cause of the risk itself.

Note that we refer to customers and clients, that is people from outside the organisation. This forms the greatest risk but there are situations where workers may be at risk from other workers in their own organisation.

These risk situations imply that there are certain occupational groups who are at much higher risk of violence than others; for example, security staff, cashiers, chemists, nurses and healthcare workers, social workers, teachers, transport staff, restaurant and bar staff, police officers, etc. It is noticeable that violence has spread in recent years from situations involving robberies and excessive drinking to situations in which social authority is challenged, particularly in the public services.

Other risk factors include:

- Staff handling situations alone

- The time of day, where late evening/night workers are more vulnerable

- The geographical area; work in urban areas is generally more risky and within cities particular areas have more social problems and higher crime rates which may indicate a higher risk for workers in those areas.

Prevention Strategies

As with all control measures, strategies should follow the hierarchy of controls.

Elimination/Substitution

Avoidance of the risk at source is the first strategy and may be achieved by changing working practices.

- **Minimisation of cash handling**

  Examples include paying wages into a bank account, encouraging the use of credit and debit card transactions, regular removal of cash from tills, etc., to safe storage (and advertising the practice).

- **Minimisation of customer/client frustration**

  This will include measures to enable quick access to the point at which a person's problem or issue is properly dealt with; for example:

  – Providing sufficient staff to deal with the expected numbers of customers/clients

  – Opening hours tailored to suit customers/clients

  – Queue management and shortening arrangements, including preliminary screening to ensure customers are routed to the correct contact person, information about waiting times, use of appointment times which are kept to, etc.

  – Improved reception and waiting facilities, including attention to room decoration and seating, etc.

  – Improved information, both at the point of contact and prior to it, such as the provision of clearly written instructions, information and explanations, easy access to contacting the right staff by telephone, etc.

- **Refusing access to potentially violent customers and clients**

  This enables the risk to be contained to security staff specially employed to perform such work.

Engineering Controls

There is a range of physical security measures both to protect cash and valuables, and to protect staff themselves. Examples include:

- Secure doors with entry locks to prevent unauthorised access

- Surveillance and alarm systems, including closed circuit video, observation panels in interview room doors, panic alarm buttons, etc.

- Elimination of all out of sight and vacant areas in premises, particularly those from where there is no exit

- Improved lighting

- Removing or securing loose objects which could serve as missiles or weapons

- High or wide counters, or the use of security screens, to provide a physical separation between staff and customers/clients.

Procedural Measures

Systems of work may also be reviewed to ensure greater security of staff, particularly in accompanying staff where necessary and avoiding lone work (or having arrangements to keep in touch with lone workers).

Individual Measures

Measures at the personal level to protect staff include training and information; for example on how to recognise the early signs of aggression and strategies for managing difficult customers/clients.

Staff may also be issued with personal protection in the form of personal alarms and communication devices (including mobile phones).

Investigation

Finally, violent incidents must always be properly investigated and support offered to the victim. The outcome of investigations should not be solely to allocate blame, but also to decide if procedures were adequate and whether further measures, including the provision of information and changed working practices, should be developed.

ALCOHOL- AND DRUG-RELATED PROBLEMS IN THE WORKPLACE

Alcohol or drug abuse in the workplace can cause significant problems both socially and in regard to health. An intoxicated worker can be a danger both to himself and to others – for example, a drunk driver may endanger the lives of all of his passengers as well as his own. Alcohol is, in reality, just another type of drug. However, historically, society has often viewed alcohol differently.

"Abuse" has been defined[1] as "persistent or sporadic excessive...use inconsistent with or unrelated to acceptable medical practice". In regard to drugs, such abuse would mean not only the use of controlled (i.e. illegal) drugs but also the misuse of medically prescribed drugs.

Symptoms and Signs

Signs of alcohol or drug misuse are not unique. They may also be caused by other factors such as stress. That said, these are common signs: sudden mood changes, unusual irritability/aggression, confusion, deterioration in relationships with others, theft (to fuel an expensive habit) and dishonesty, loss of productivity, increased short-term absenteeism.

Effect on the Organisation

There are several major effects on a business

- Increased absenteeism

- Increased staff turnover (persistent abusers may be dismissed from their employment)

- Reduced productivity (even when not absent)

- Increased risk of accidents - alcohol and drugs affect judgement and physical coordination and so can increase the risk of accident (particularly in safety critical tasks).

Benefits to the Organisation of Tackling Misuse

Successful implementation of an alcohol/drug policy in the workplace can bring benefits to an employer. Benefits include:

- Reduced absenteeism

- Increased productivity

- Reduced staff turnover

- Reduced risk of accidents.

Tackling the problem

Establish whether there is a Problem

Examining data you have on absenteeism, productivity, accidents and disciplinary records may indicate a problem. Useful also is any data on local cultural attitude to drinking/drugs and

typical local consumption rates (this may come from national or local surveys or from surveys carried out in similar companies). All of this data may indicate whether there is a problem and, if so, the scale of it and any particular groups that may be a priority.

Develop and Implement an Alcohol/Drugs Policy

A written policy should be developed in consultation with the workforce. Consultation with medical personnel is also desirable.

This may be included in the company health and safety policy or be a stand-alone document. The basic elements are a statement of aims and objectives, defining the responsibilities (who does what) and describing the arrangements (the rules). Arrangements might include:

- Measures to reduce alcohol/drug-related problems through:
    - improved working conditions (poor conditions can contribute to such problems)
    - proper management and supervision (not encouraging behaviour which incites misuse of alcohol/drugs)
    - proper arrangement of work (not placing a rehabilitated worker in a situation which may have contributed to the problem)
    - consultation between management and workers.
- Prohibition/Restriction of the availability of alcohol/drugs on the premises (e.g. no alcohol allowed to be brought on site) and making alternative soft drinks available.
- Education programmes (information, instruction, training) on e.g.
    - effects of alcohol/drugs on health
    - training for supervisors/managers on identification/confidential referral of individuals with alcohol/drugs issues
    - Rules to be followed and consequences of non-compliance.
- Identification, assessment and referral of individuals with alcohol/drug issues. This may also include alcohol/drugs testing of individuals – particularly in safety critical jobs. However, this subject needs to be handled delicately since it is an emotive issue with moral, legal and ethical consequences.
- Treatment and Rehabilitation programs – treatment and re-integration into the workforce.
- Rules governing conduct and disciplinary measures for their infringement (including dismissal). Employers have the right to discipline workers for employment related misconduct related to drug/alcohol misuse. However, treatments should be preferred unless a worker refuses to cooperate in the treatment programme.
- Equal opportunities – the worker should not be discriminated against.
- Confidentiality – the employer should maintain confidentiality when alcohol/drug misuse is identified or declared.

REVISION QUESTION 3

(1)   State the nine categories of cause of work-related stress and, for each, give one example of a preventive measure.

(2)   State the main risk factors for violence at work.

(3)   What strategies are available to avoid the risk of violence?

The suggested answers are given at the end of the unit.

UNIT SUMMARY

The principles of ergonomics, which means fitting the task to the worker, underpin task and workstation design. The key risk factors to be addressed are those of the physical requirements of task activities (posture and movement, forces involved, repetition and duration/recovery), the environmental context and the layout and design of work equipment. Poor task and workstation design can lead to physical, visual and mental stress. To avoid these risks work methods, lighting and the layout of equipment and other physical objects should be based around the needs of the worker.

Specific requirements have been developed to reflect these principles in the layout and design of DSE workstations, including ensuring that the equipment (the display screen itself, keyboard, lighting, desk and chair) is suitable for the task, does not present risks in itself, is adjustable to suit the needs of the user and is positioned to allow ease and comfort of access and movement.

In addition to specific safety requirements in relation to particular risks, employers have to provide a range of facilities and environmental factors to ensure the general welfare of workers at work. The facilities required cover the supply of drinking water, washing facilities, sanitary conveniences and accommodation for clothing, changing, rest and eating. General environmental considerations include ventilation, heating and lighting.

Control of noise at work is based on particular measures being taken when specified noise dose levels are reached, based on daily personal exposure ($L_{EP,d}$). The measures required may include personal hearing protection and informing workers of the risks to their hearing. Various engineering controls, such as substituting or isolating equipment and processes, and sound insulation, damping and silencing may be used to reduce noise from work equipment.

Ionising radiation is potentially life-threatening and requires safe methods of using, storing and transporting radioactive materials and of using X-ray equipment. These are based on strict separation of workers from the harmful rays by restricting use to designated areas, shielding, safe systems of work and PPE. Whilst ionising radiation is only encountered in very few workplaces, non-ionising radiation is far more widespread. It is capable of causing severe injury, principally by burns to the skin and eyes, but may be effectively controlled by adequate shielding.

Stress at work is defined as the adverse reaction people have to excessive pressures and other types of demand placed on them. There are nine broad categories of cause: the culture of the organisation, demands of the whole job or of particular tasks, degree of personal control over activities, relationships in the workplace (particularly where these involve bullying or harassment), organisational change, role conflict or uncertainties, degree of training, individual support offered by management and factors unique to the individual. Preventive measures essentially involve good management practice in the organisation and control of work and relationships, particularly basing them on the needs of the individual.

Violence at work is an increasing problem, particularly for public service workers. High risk situations occur where cash and high-value goods are handled, and where there is personal contact with customers and clients which may result in adverse outcomes for those customers/clients. Such contact may be aggravated where the customer/client is under stress or the influence of alcohol or drugs, although these may be trigger causes of violence in themselves. Preventive measures involve avoiding the risk by changing work practices to minimise cash handling and customer/client frustration, refusing access to potentially violent

customers/clients, physical controls to segregate workers and increase visibility of potentially risky encounters, safe systems of work which provide support for lone workers and training in handling difficult situations.

SUGGESTED ANSWERS TO REVISION QUESTIONS

Revision Question 1

(1) Fitting the task to the worker.

(2) Physical stress, resulting in injury or general fatigue, visual problems and mental stress.

(3) Hand-Arm Vibration Syndrome (HAVS) is a condition produced at work by exposure to vibrations from hand-held tools. The vibration affects blood flow to the fingers and arms causing blanching of the fingers (white finger) and tingling of muscles, and may cause blocking and restriction of blood flow in small arteries and even gangrene.

(4) Posture and physical action, forces involved, repetition, and duration and recovery time.

(5) Illumination, contrast, flickering and glare.

(6) (i) The work surface or desk should be large enough to hold all necessary equipment and other items used from time to time, and to allow them to be arranged to suit the individual's needs. If necessary, it should also be deep enough to accommodate a VDU for viewing at a distance of about 350 to 600 mm without cramping the work surface in front of it.

(ii) The keyboard should be of appropriate design to be usable in comfort, with keys of sufficient size and clarity to suit the demands of the task. It should be able to be tilted and separated from the screen so the operator can find a comfortable position.

(iii) A work chair must have an adjustable seat back, good lumbar support and be adjustable in height to suit the user.

(iv) There should be sufficient clear and unobstructed space at each workstation to enable the work to be done safely, allowing for the manoeuvring and positioning of materials. This should also provide for adequate freedom of movement and the ability to stand upright.

Revision Question 2

(1) This refers to a daily personal exposure to noise ($L_{EP,d}$) at a level of 85 dB(A) over the course of a working day (eight hours), or an equivalent exposure over a shorter period.

(2) There is a general limitation on the level of noise reduction that can be achieved, depending on the quality and type of ear protection. Taking off the protection reduces its effectiveness. In addition, the seal between the ear and the protective device may be less than perfect due to long hair, thick spectacle frames and jewellery, incorrect fitting of plugs or the wearing of helmets or face shields.

(3) Providing as much ventilation as is reasonable, ensuring that the length of time for which individual workers are exposed is limited, there are adequate rest facilities, away from the heat, with appropriate facilities to counter the effects of exposure, including cold drinks. Where there is a direct source of heat, protective clothing will have to be provided, such as face shields and heat/flame resistant footwear, gloves and clothing.

(4) (i) Radio frequency

(ii) Infra-red radiation

     (iii)   Ultra-violet

     (iv)   Visible radiation

(5)   Visible radiation can cause serious burns to exposed skin tissue and is particularly dangerous to the eyes.

Revision Question 3

(1)   (i)   Culture – Preventive measures include taking stress seriously, with encouragement to raise any problems, knowing that they will be recognised and dealt with promptly, and a recognition of the importance of the work-life balance.

     (ii)   Work demands – Preventive measures include ensuring that there are sufficient resources available and support is offered to re-negotiate priorities and deadlines.

     (iii)   Control over work – Preventive measures include encouraging workers to plan their work, and make decisions about how it is completed and how problems will be tackled.

     (iv)   Relationships between staff – Preventive measures include clear standards of conduct and policies to tackle harassment and bullying.

     (v)   Organisational change – Preventive measures include consultation and involvement of staff in determining processes.

     (vi)   Role conflicts and uncertainties– Preventive measures include clear work objectives, job descriptions and reporting responsibilities.

     (vii)   Support by management – Preventive measures include providing positive feedback, focusing on performance, not on personality.

     (viii)   Training – Preventive measures include training needs assessments and the provision of appropriate training programmes where necessary.

     (ix)   Factors unique to the individual – Preventive measures include taking account of individual differences in skills and approaches in allocating and managing work.

(2)   The risk factors reside in particular situations such as:

–   The handling of high value goods

–   Contact with customers or clients where the outcome will be to refuse the person what they want

–   Contact with customers/clients where the outcome is to censure them in some way

–   Contact with customers/clients who are under stress (perhaps as a result of frustrations or delays in obtaining the necessary contact), under the influence of alcohol or drugs, or with a history of violence.

(3)   Minimisation of cash handling, minimisation of customer/client frustration and refusing access to potentially violent customers and clients.

NEBOSH International General Certificate

Unit 14 | Construction Activities - Hazards and Control

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INTRODUCTION

Construction is a high-risk activity because it involves using a lot of large dangerous machinery and equipment, often in exposed situations below or above ground level. The site itself is in a state of continual change due to the range of people involved who may be concentrating on their own work without necessarily considering what other workers may be doing; many of them will be subcontractors.

A very high proportion of all fatal accidents at work take place on construction sites and most of them are directly attributable to failures in managing site operations effectively.

This unit starts by considering the general nature and hazards of construction work. We then go on to look at the particular risks and control measures of working above and below ground level. In doing so, the unit is designed to meet the following aims and learning outcomes as specified by NEBOSH for this part of the syllabus for the International General Certificate.

Overall Aims

When you have worked through this unit, you will have knowledge and understanding of:

- The basic hazards and risks encountered in construction activities
- The measures to be taken to minimise the risks

Specific Intended Learning Outcomes

On completion of this unit, you will be able to:

- Identify the main hazards of construction and demolition work and outline the general principles necessary to control them
- Identify the hazards of work above ground level and outline the general requirements necessary to control them
- Describe the safe working practices for common forms of access equipment
- Identify the hazards of excavations and outline the general requirements necessary to control them
- Identify the hazards to health commonly encountered in small construction activities and explain how risks might be reduced.

GENERAL PRINCIPLES OF CONSTRUCTION

Scope

Construction includes all work on any structure from the beginning to the end of its life – building, maintenance and demolition. Such work is generally recognised as being dangerous and many countries have detailed legislation which deals specifically with this industry sector. The International Labour Organisation (ILO) has produced international standards on the regulation of safety in the construction industry. These are the Safety and Health in Construction Convention 1988 (C167), supported by Safety and Health in Construction Recommendation 1988 (R175) and its associated code of practice. This is in addition to the general principles of the Occupational Safety and Health Convention 1981 (C155) discussed in Unit 1.

Stacking and Storage

The following discussion relates to the general storage of materials used in construction work. For certain substances (such as radioactive materials and explosives), specific legal requirements as to storage precautions may apply in your country.

Safe stacking and storage of materials and substances used in construction activities contributes to a safe place of work in respect of both the good order of the construction site (and consequent keeping of pedestrian routes free of obstruction) and any inherent hazards presented by the materials themselves.

Stacked Goods

The following points represent good practice:

- Stacks should be kept as small as is practical, adequate space should be provided around them and they should be vertical with no excessive leaning

- They should be kept away from walls and off the floor by using pallets, with the pallets being in good repair

- They should not be placed in a position where they could block light (either natural or artificial) necessary for working areas, obstruct fire detection or control equipment (such as alarm points, fire-fighting equipment, or sprinklers) or block drains or scuppers

- Different types of containers (such as packets, drums, cylinders, etc.) should be separately stacked.

Storage – General

The details of storage necessarily depend on the nature of the materials to be stored and how they are packed. We consider the particular requirements in respect of flammable substances below, but the following points relate to safe stores for all types of materials.

- Storage areas should not be used for other work activities, such as mixing, processing or cutting, etc.

- The design and layout of storage areas should ensure there is adequate space for the movement and stacking/removal of the types of materials involved, including the movement of vehicles and people within the store and access and egress from the storage area.

- The area should be kept clean and tidy to ensure unobstructed access and movement, there should be the means to deal with any spillages and any waste or scrap materials should be safely disposed of.

- Where mixed storage areas are used, different goods and materials should be separated in different areas to allow for easy location and access. Where hazardous substances are involved, incompatible materials should not be stored together in mixed stores.

- Warning signs should be provided where necessary to inform people about any special dangers associated with the materials stored and any special precautions to be taken, including restrictions on entry and the wearing of PPE.

- There should be adequate fire precautions including the provision of fire-fighting equipment, safe electrical systems and restrictions on smoking.

- The storage area should not permit public access, be secure and vandal resistant.

Storage of Flammable and Combustible Substances

Construction work often involves the use of combustible materials such as wood and also flammable liquids (i.e. those with a low flash point), including LPG (liquefied petroleum gas) such as butane or propane. These will be supplied in large, fixed storage tanks, smaller cylinders and bottles of varying sizes or aerosol cans.

In addition to the general requirements as to safe stores noted above, flammable or combustible substances will require special storage arrangements due to the greatly increased risk of fire. Additional requirements would generally include:

- Stores containing flammable materials should not be used to store other materials and flammable liquids, solids and gases should each be kept in separate stores. Oxygen cylinders should always be stored separately from other cylinders of flammable gases.

- External open-air stores should be at least three metres away from the nearest building's boundaries, drains or excavations. If this is not possible there should be a fire-resistant partition separating the store from the building and drains and excavations should be sealed. There should be a security fence surrounding the store.

- Internal stores should be constructed of fire-resistant materials and provide a good level of ventilation to stop dangerous levels of gases accumulating. Completely separate buildings may be required for storing volatile flammable materials (although this need not be made of fire-resisting materials if it is located in a safe place).

- Stores containing large quantities of flammables should have at least two egress (or exit) points to allow a means of escape in the event of fire. Doors and gates (solid or mesh) should be shut whenever they are not required to allow the passage of goods and be locked when they are not in use.

- Stores should be marked with suitable information about the hazards and precautions to be taken.
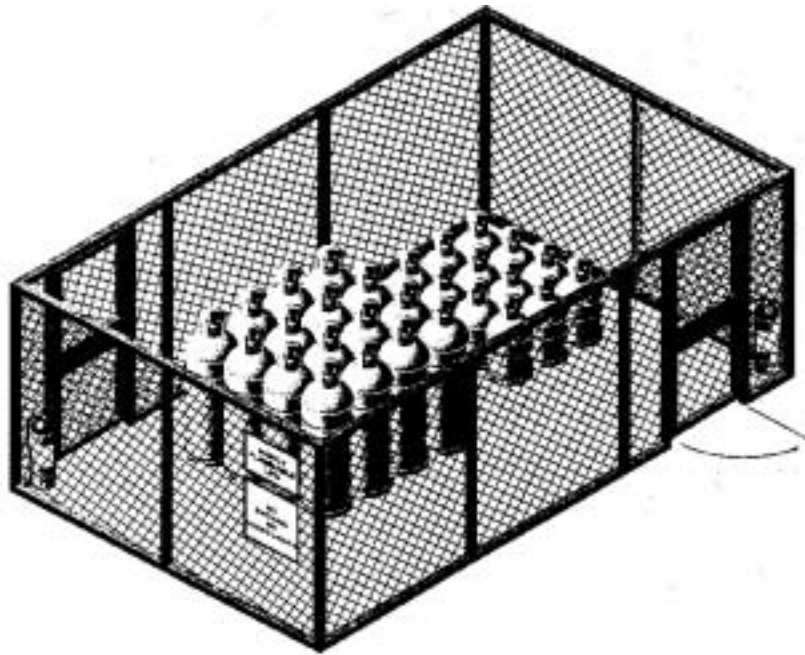
Purpose-Built, Secure Accommodation for LPG Cylinders

- Activities which may represent a source of ignition and lead to a fire or explosion should not be carried out close to the storage area unless suitable protection is provided; for example, shielding from sparks when welding.

- All electrical equipment within the area should be of a standard related to the risk, with internal stores being equipped with heating systems that are not a potential source of ignition of the materials stored.

- Fire-fighting equipment must be provided and kept in good condition. Consideration should be given to use of fire detection systems.

- Stores should be inspected regularly and there should be a planned programme of maintenance, including cleaning and the removal of waste and debris to prevent accumulations.

Main Hazards and Controls

As with all workplaces there is a general requirement to ensure a safe place of work which applies to all construction work. Apart from the hazards associated with working at a height (above ground) and in excavations (below ground) which we deal with elsewhere in the unit, the main hazards and control measures are as follows.

Machinery and Vehicles

Fixed construction plant, machinery and equipment can be large, heavy and inherently dangerous. Portable equipment and tools may be quite small but may also be very dangerous. The hazards include the range of injuries caused by people coming into contact with the moving parts of machinery or equipment, as well as dust, noise and vibration caused by their use.

All machinery, etc., must be properly maintained and used in the manner and for the purpose for which it is intended. There should be appropriate warning signs about particular risks and precautions to be taken. Moving parts should be fitted with suitable guards and measures taken to reduce noise and vibration. Work which is particularly dangerous or produces large amounts of dust or excessive noise should be conducted in specially segregated areas. Appropriate PPE should be worn, including ear defenders, goggles, masks, gloves and special footwear.

The movement of plant and vehicles presents particular problems on construction sites. The vehicles themselves may be very large and difficult to manoeuvre and the terrain may be uneven and muddy. Space may also be limited and congestion can be a problem. The hazards include plant and vehicles toppling over, collisions with pedestrians or other vehicles and collisions with plant and structures which may cause them to collapse.

Sites must be organised to allow the safe movement of both vehicles and pedestrians. It is always a good idea to aim to keep people and vehicles separate as far as possible, especially near site and building entrances/exits. Traffic routes should be suitable and sufficient for the people or vehicles using them. There should be sufficient space for vehicles to manoeuvre and where visibility may be restricted, arrangements should be made to direct such movement e.g. by use of a banksman giving hand signals to the driver. When vehicles are stationary, measures should be taken to ensure that there is no unintended movement; for example, ensuring moveable plant and machinery is in a horizontal position and properly secured, brakes are always applied, etc.

Site Security

A member of the public could easily enter an unfenced construction site, especially if the site is in a busy high street. In addition, construction sites commonly attract children, vandals and thieves. This could place the public at risk as well as workers (if an intruder tampers with equipment). Construction sites should deny casual access by the general public and be protected from vandalism. The type of security will depend upon the location and the nature and duration of the work being carried out.

Perimeter security should ensure that it is not possible to gain access to the site except through designated entrances, which should be lockable. Generally this will be by means of fencing which may be solid or mesh and should be two metres high. Fencing may not always be necessary; for example, the refurbishment of domestic premises may be secured by the boarding of doorways and lower windows.

Other protection measures include:

- Not leaving ladders lying around

- Disabling equipment – for example, by removing keys and spark plugs from vehicles

- Covering excavations

- Securely locking tools, explosives, flammable liquids and other hazardous substances away at night

- Providing security staff, CCTV (surveillance television camera system), lighting and alarms if necessary.

In the case of children, who are naturally curious but do not realise the potential dangers of such curiosity, extra measures may be needed. Thus, for example, panels should be fixed around the

base of the scaffolding to prevent children from using the scaffolding as a climbing frame and ladders at ground level removed.

Electricity

The principle hazard of electricity on construction sites is the trailing of electrical cables across open ground. They may be from portable powered tools or may be mains or generator supply cables in the process of installation or powering fixed plant and equipment. Where leads are damaged or cables are cut by vehicles running over them, live wires may be exposed. Other hazards include the use of unsafe equipment and contact with overhead power lines and buried cables.

Most of these risks can be prevented by appropriate site and project management which identifies the positioning of buried cables, controls where and when other cables may be laid, provides guards and segregated areas where unprotected cables may be a particular risk and ensures that all equipment is properly maintained. Other means of reducing the risk of shocks include the incorporation of circuit breakers on equipment, use of low voltage circuits and substitution of other forms of power where appropriate (particularly compressed air, though this has its own set of hazards too).

Slips, Trips and Falls – Working at Height and Excavations

Working at ground level with the surface likely to be uneven and muddy with possibly trailing equipment leads, presents many risks of workers slipping, tripping and falling. Care must be taken, particularly where materials are being carried.

In addition, there are risks of falling into holes and excavations and of being hit by falling items. Controls to prevent these occurrences are dealt with later in the unit. To protect against falling items, head protection should be worn.

Management Controls

Due to the nature of both the risks involved and the practice of using multiple contractors and subcontractors in construction work, the basis of safety lies very much with management control.

At a fundamental level, projects of any size will involve most if not all of the following roles:

- Client (the person requiring the job to be done)
- Designer/Architect (he will design the building according to the design brief of the client)
- Co-ordinator (someone to supervise and co-ordinate all the Health & Safety aspects)
- Main contractor
- Subcontractors

In practice one person or organisation may take on several of these roles. From a health and safety perspective, some basic steps should form part of any large construction project before it even gets off the ground: planning for health and safety; documentation to be left with the client regarding the construction; selecting suitable contractors to do the job. These items are not unique to health and safety; they are simply an extension of good management practice to control risks in the workplace. We will explore each of these in turn.

Planning for Health and Safety

Health and safety plans provide the health and safety focus for the construction phase of the project.

Planning will normally be done in at least two stages. The first stage is done before a contractor is engaged. This "pre-tender" plan puts together some basic information that a contractor would need to assess the nature of the job. This should generally contain the following information, where relevant:

- The nature of the project

- Details of the environment – for example, ground conditions, services (gas, electric), surrounding area (schools, factories) and traffic

- Details of the construction plan, including plans and drawings, and any significant hazards already identified by the client and/or the designer

- Details of the site – for example, access, egress, traffic/pedestrian routes, etc.

- Site rules, including procedures for liaison.

Once appointed, the main contractor would then develop the health and safety plan with more detail, updating it and monitoring its implementation. Again, this would be before construction work actually begins. This would contain the following information:

- Arrangements for ensuring the health and safety of all who may be involved in the construction work, including a description of standards to be achieved and project rules, risk assessments, method statements, details of other control measures, common arrangements and emergency procedures.

- Arrangements for managing health and safety during the construction work and for monitoring compliance with legal requirements, including organisation and responsibilities, communication routes, arrangements for information and training and how compliance with the plan and legal requirements will be monitored.

- Information about welfare arrangements on site.

For many projects, not all information relevant to the project may be available to develop the health and safety plan fully before the construction phase starts; for example, not all the design work may have been completed or many of the subcontractors who will be carrying out the work have yet to be appointed. However, the plan should be sufficiently developed so that the general framework for dealing with the management organisation, emergency procedures, arrangements for monitoring, communications, and welfare is in place, and that it addresses the key tasks of the early work packages.

The degree of detail in the plan should be in proportion to the nature, size and level of health and safety risks involved in the project. Projects involving minimal risks will call for simple straightforward plans, whereas large projects or those involving significant risks will require further detail.

Documentation

It is important to make a record of information which tells the client/end user (or others who might be responsible for the structure in the future) about the key health and safety risks that have to be managed during maintenance, repair or renovation. This will usually be a set of files for a large project which are left with the client at the end of the job. The actual content of the

information will be agreed between the various parties. What is important is that it records enough information to be of use for anyone who works on any future design, building, maintenance or demolition of the structure.

The file should include drawings, construction method details, equipment and maintenance facilities, maintenance procedures and requirements for the structure, operation and maintenance manuals and details of utilities, services, emergency and fire-fighting systems.

Selection of Contractors

The way in which contractors are selected will vary with the type of work they are required to do and the level of risk involved. Potential bidders for a contract should be given information on all the hazards they would be likely to encounter in the course of the proposed work. The details should be included in the tender specification. Once made, the bid should be checked against the details to ensure that all health and safety issues have been considered by the contractor.

A shortlist of suitable contractors should be compiled, where "suitable" means in relation to health and safety, rather than being the lowest bid tendered. Safety policies should be vetted and verified by the client in respect of the contractor's knowledge, ability and resources to do the job. The specific requirements to be addressed would include:

- Contractor's arrangements for implementing the health and safety plan, including specific procedures to be put in place by the contractor to manage health and safety (including fire safety) and intentions for dealing with the high risk areas identified by the designers and the planning supervisor.

- Arrangements for monitoring health and safety legislation compliance, skills and training of those who will be managing the work, and the way people are to be employed to ensure compliance with health and safety law.

- The time allotted to complete the various stages of work.

- The reputation of the contractor, including any membership of professional bodies.

Control of Contractors on Site

Once the construction phase of the project starts, the main contractor is in charge of the site and all other contractors are under his control. The main contractor sets site rules. If site rules are set then subcontractors must obey. The main contractor must monitor compliance with and enforce agreed site rules.

Contractors should provide written method statements before their work commences when significant risks to health and/or safety may be involved; for example, work with asbestos or demolition. If a contractor departs from the method statement, operations should cease until a new method of working has been agreed in writing with the principal contractor.

REVISION QUESTION 1

(1)   What are the requirements for a mixed store?

(2)   What are the requirements for the internal storage of flammable materials?

The suggested answers are given at the end of the unit.

WORKING ABOVE GROUND LEVEL

One of the major hazards in construction is that a large part of the work is done at heights and there is an ever-present risk of falling. This is the main cause of accidents and of major injuries, and falls are the largest cause of accidental death in the construction industry. The danger of people and materials falling affects not only those working at heights but also those underneath.

Accidents involving falls could be prevented if the work is planned properly, safe systems of work are followed and the right equipment is used.

Work Activities Over Two Metres

Many activities require working at height, which means working two or more metres above the surrounding ground. A distinction can be drawn between those activities which always involve working at a height and those which may be undertaken at a height:

- The first category includes roof construction, repair and demolition, steel erection, erecting and dismantling scaffolding, window construction and cleaning, etc.

- Activities which may be undertaken at a height may themselves be divided into work that is often carried out above ground (such as bricklaying or painting and decorating) and that which only rarely involves heights, such as welding, machinery maintenance or inspection of overhead pipework.

The distinction is useful in that it draws attention to the fact that it is quite possible for people with little or no experience of working at a height to be required to carry out such work. Proper planning, instruction, training and supervision are essential.

Basic Hazards

As we noted above, the main hazards in working above ground level are falls and falling objects, with the risk being both to people working at a height and to others below. The risk situations are as follows.

Roofs

Roofwork includes construction and maintenance of roofs, such as replacing tiles, gutter cleaning, chimney repairs and repointing. Most accidents occur mainly during small routine jobs and maintenance work. The reasons given for this are that care and forethought for small jobs tend to be overlooked and accidents commonly result from not having sufficient equipment to work safely. In addition, maintenance work is often undertaken in a hurry; for example, storm damage repairs.

Note that roofs are not a normal working area and should be included in a risk assessment for construction work.

Particular dangers arise with two types of roof.

- **Fragile roofs**

    Any roofing structure which is not specifically designed to carry loads and only has sufficient strength to withstand the forces produced by the weather (i.e. wind and snow) must be considered a fragile roof. Roofing materials such as cement, asbestos, glass,

reinforced plastics and light tongued and grooved wood covered with roofing felt are all liable to collapse under the weight of a worker.

All fragile roofs except glass should have a large warning notice displayed on them. However, we must remember that with a multinational workforce a sign worded in English does not necessarily provide sufficient warning and it must be backed up by verbal warnings or multi-language signs.

The accepted safe method of working on fragile roofs is by the use of roof ladders (or crawling boards). These are laid across the roof surface, supported by the underlying load bearing roof members and distribute the load of the worker over a wide area, enabling the roof structure to sustain the load safely. Roof ladders also provide a good foot and handhold for the worker.

When a worker has to move around over a roof, then two ladders or boards should be used so that one can be moved while the other provides support. This can be risky and falls have occurred as a worker has moved off a ladder or board in order to move it.

- **Sloping roofs**

  These are roofs with a pitch greater than 10 degrees. Falls from the edges of sloping roofs generally cause serious injury even when the eaves are low, as on a single storey building. If the person has slipped down the roof from the ridge, considerable acceleration can be built up which tends to project the person from the eaves, adding to the force of impact with the ground and hence to the seriousness of the injuries sustained.

Deterioration of Materials

The condition of the structure on which people are working should be sound. However, materials deteriorate over time, particularly when exposed to the effects of the weather (heat as well as cold and water) and attack by insects, etc.

Unsound materials represent a hazard in two ways:

- The danger of the material breaking when a person puts his/her weight on it and causing a fall through the surface.

- The danger of materials breaking off and falling to hit people or structures at lower levels. Where they hit lower structures, this may cause a collapse.

It may not always be evident that deterioration has occurred until it is too late, so care must be taken to ensure that footholds are sound and secure where there is any possibility that the surface may not take the person's weight.

Unprotected Edges

Where the edges of surfaces on which people are working at a height are open, the risk of falls or falling materials is greatly increased. This applies to roofs, elevated walkways, scaffolding and access platforms, etc.

As we shall see, the use of guard rails, fencing and other protective boarding is required to prevent such accidents.

Unstable Access Equipment

Access equipment includes scaffolding, towers, platforms and ladders. There are inbuilt risks in using such equipment, but they are compounded if the equipment is not properly stable and secured in some way.

Scaffolding may collapse or overturn under certain conditions due to incorrect erection, defective components or insufficient secure bracing or failure to tie into the building. The conditions which may cause this include excess weight being placed on the structure as a whole, or the weight being in one place instead of being spread along the length. It may also be caused by high winds, particularly where incorrectly secured protective sheeting gets caught by the wind and acts as a sail.

Ladders and step ladders are the most common means of reaching higher levels and are also the cause of a large number of accidents because their dangers are overlooked. The two most common hazards in their use are as follows.

- Ladders may not be tied or resting on firm ground, causing them to tip when being used, particularly when people use them to work from and subject them to sideways forces.

- Wooden ladders can warp and rot as they are often left out in all weathers to get wet and then dry out. The rungs may then break or become unsafe and loose as the wedges fall out. Also, ladders tend to get covered in paint and plaster which conceals defects.

Particular problems may arise when workers move from the access equipment onto the structure itself if the access equipment moves at all. This applies to scaffolding and ladders and also to lift and hoist platforms.

Failure of any equipment is a potential hazard and procedures must be in place to inspect and maintain it.

Weather

Apart from the weather affecting the material structure of buildings it can present a hazard in itself to workers above ground level in the open air.

Any moisture can make surfaces slippery, including rain, dew and frost, as well as the more obvious dangers of snow and ice. Because footholds at heights are generally not so good as at ground level, balance is more critical and is more likely to be lost in such conditions.

Wind is a particular problem. At ground level the rate of air-flow is often reduced by the protection given by buildings, compared with its effect at roof level where a worker is exposed to its full force. The effects of wind can also be exaggerated by it catching large, relatively light sheets of materials (such as roofing boards or lengths of wide timber) and causing them to blow around, often quite violently. This can be dangerous as such materials can act as projectiles and, where they are being carried, causing a loss of balance. There have even been accidents where workers have been blown off a roof while handling large items of materials.

Exposure to cold weather can reduce manual dexterity, directly via temperature and indirectly via the need to wear protective clothing, such as gloves. This may make it more difficult for workers to hold on to supports or more likely to drop objects.

Falling Materials

It goes without saying that objects falling from a height are capable of causing considerable damage to both people and other materials which they hit. The objects themselves may be loose structural material such as tiles, bricks and timbers, waste materials such as stone chippings or offcuts of wood, or equipment or tools which are dropped.

Circumstances which contribute to the likelihood of falling materials include the following:

- Deterioration of structures causing crumbling brickwork or loose tiles

- Bad storage of materials – for example, at the edges of scaffold platforms, or in unstable stacks

- Poor housekeeping leading to accumulations of waste and loose materials

- Gaps in platform surfaces or between access platforms and walls

- Open unprotected edges

- Incorrect methods of getting materials, equipment or tools from ground level to the working area

- Incorrect methods of getting materials down to ground level; for example, being thrown off instead of being lowered in a bucket or down an "elephant's trunk" waste chute to a skip.

Main Precautions to Prevent Falls and Falling Materials

There is an overlap between the prevention of people falling and materials falling from edges. Some control measures have dual functions, helping to prevent either hazard.

As with control measures used in other circumstances, there is a hierarchy to the precautions taken.

- The first objective is to provide physical safeguards to prevent falls. Where possible, means of access and working places should be of sound construction and capable of safely supporting both people and the materials needed for the work. Guard rails, toeboards or other forms of protection should be provided at any edge from which people could fall.

- Where it is either not possible to provide such safeguards or the work is of such short duration or difficulty that it would not be reasonable to do so, properly installed personnel equipment such as rope access or boatswain's chairs should be used.

- If for the same reasons these methods cannot be used it will be necessary to consider equipment which will arrest falls, such as safety harnesses or nets with associated equipment.

Similarly, in respect of falling materials, the first objective is to prevent such occurrences where they could hit someone. Only where it is not reasonable to do so should other means such as covered walkways be used.

Guard Rails, Fencing and Toeboards

Protection must be provided for all unprotected edges to prevent people and materials from falling. This can be achieved by means of guard rails, toeboards and brickguards on scaffolding and other platforms, as well as using the platform itself. Guard rails are designed to prevent people from falling, whereas toeboards and brickguards are principally designed to stop materials from falling.
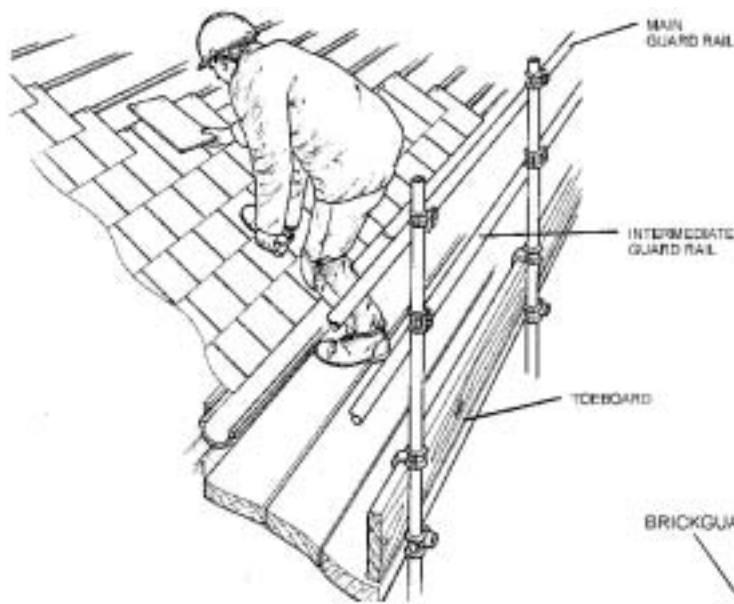
Guard Rails on Scaffold Platform
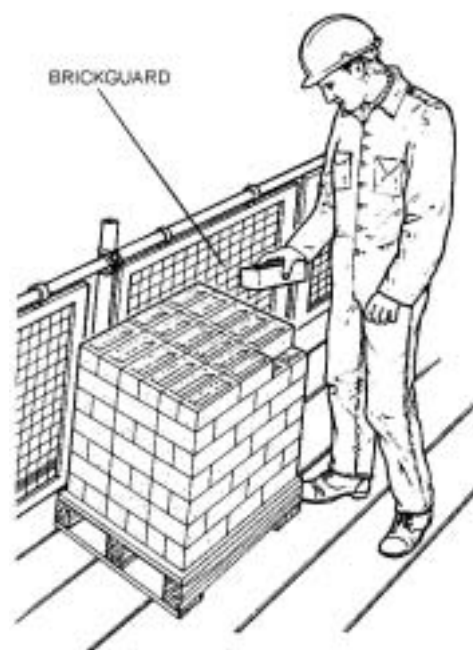
Use of a Brickguard

Toeboards are usually scaffold planks laid on their edge at right angles (90°) to the working platform. They are laid at the outer edges and ends of the working platform, although sometimes the inner edge (the one nearest the building) also requires edge protection. Toeboards prevent small objects, such as rubble and tools, from being casually kicked off the platform. Brickguards prevent a more substantial amount of material from falling and have a secondary function of helping prevent people from falling as well.

The same arrangements apply to flat roofs and also to other forms of edge protection such as mobile tower scaffolds, mobile elevated working platforms and elevated walkways.

Gaps are allowed in edge protection provided they are the minimum required for reasonable access. Barriers or fencing can also be erected around roof edges using scaffolding tubes and boards.

Working Platforms

The following are some basic obvious requirements of work platforms (e.g. on a scaffold tower):

- They should be sufficiently wide to allow the free passage of people and safe use of equipment and materials

- They should be capable of bearing the loads imposed upon them, whether that be people, equipment or materials, and must not be overloaded. The boards must be free from significant defects such as rotted timber, large cracks, split ends or large or many notches cut into the wood.

- The supporting framework should be strong enough for its purpose and be stable. Strength and stability should be decided at the design stage and monitored by periodic inspection. Supporting scaffolds are made stronger and more stable by tying and bracing (see later).

- The surface should be closely boarded to prevent gaps that could present tripping hazards and allow materials to fall through. Tripping hazards in general should be avoided and account taken of weather conditions so that the surfaces do not become unduly slippery.

Usually the platform is made up of scaffold boards resting upon the scaffold framework. Toeboards and endboards (boards placed at the ends of the platform rather than across the front) help secure them and sometimes a scaffold tube can be fixed across the top of the boards to provide added stability. However, such a tube presents a tripping hazard and a balance has to be struck between the need for increased stability (for example in high winds) and the hazards it presents.

Ladder Hoops

Ladder hoops are normally associated with vertical or near vertical ladders. They are metal loops attached to the ladder stiles to form a vertical "tunnel" containing the ladder and any persons climbing it. They are designed to prevent people falling away from the ladder at great heights, but do not prevent sliding down the ladder.

Fall Arrest and Suspended Access Equipment

Suspended access equipment should only be used when it is not practicable to work from a platform with proper edge protection. The two main types are the boatswain's chair and safety harness.
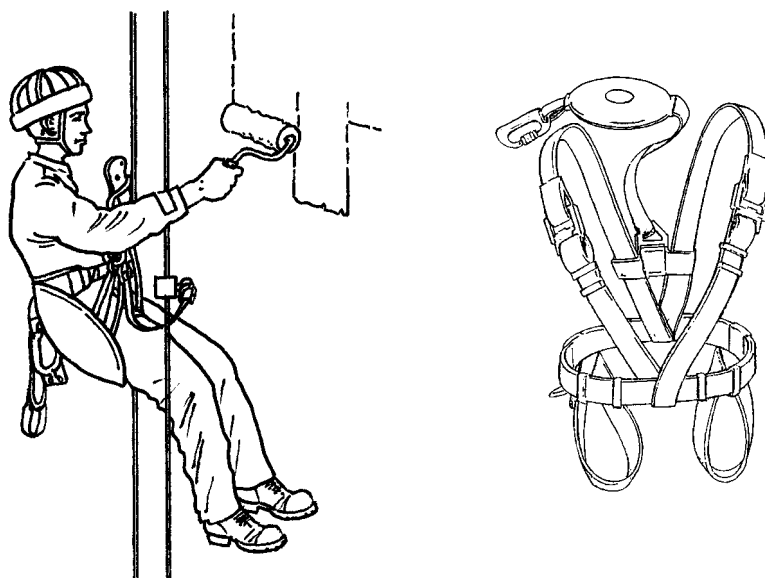
Boatswain's Chair and Safety Harness

A boatswain's chair can be used for light short-term work. The chair usually consists of a seat with a back, a suspension point and means for carrying tools. The user should be attached to the chair by a harness to prevent falls. Control of descent is by the user, based on the same techniques as abseiling, although there should not be a single suspension point. Larger suspended working platforms (cradles) may also be constructed and used in a similar way; for example, for window cleaning on high rise buildings.

Safety harnesses are useful when open edges have to be approached; for example, during steel erection. The safety harness itself should not become a hazard during use; for example, falling and then being suddenly jerked to a halt can cause serious injuries. Inertia reel harnesses which allow for some gradual deceleration of the person before the final stop (the same principle as an inertia reel car seat belt) should be used. Consideration should also be given to how a person suspended after a fall will be rescued.

All equipment must be maintained to the highest standards and be strong enough for its purpose. Full training must be given to operators of such equipment.

Protection from Falling Materials

As we have noted, the main objective is to prevent materials from falling in the first place. This may be achieved by:

- Not stacking materials near edges, particularly unprotected edges.

- Close boarding of working platforms – minimising gaps between scaffold boards or placing sheeting over the boards so that material cannot fall through.

- Using hoists to convey materials up to a height rather than carrying them.

- Providing safe means of lowering materials, such as hoists again or chutes, rather than having them carried down or, worse, thrown down.

Where these actions are impractical or cannot be assumed to eliminate the risk, measures to protect people underneath from being hit by falling materials must be introduced; for example:

- The construction of covered walkways – for example, "tunnels" formed by closely boarded scaffold planks or sheeting through which pedestrians can walk.

- Placing sheeting across the face of the scaffold to contain materials from falling outside of the scaffolding area (although remember that sheeting can act like a sail in high winds and reduce the stability of the scaffold).

- Use of netting to catch falling material.

- Designation of exclusion zones to keep people out of the way of falling objects, although these have to be carefully controlled.

Head Protection

Hard hats are PPE. They offer protection against small falling objects such as rubble or hand tools but are not designed to protect against, say, steel girders falling on someone's head. Nor is the issue of hard hats a replacement for other controls designed to prevent objects from falling, such as toeboards or nets, or to protect people from them, such as exclusion zones.

Hard hats must be worn on construction sites whenever work is taking place overhead. A construction site can be designated a hard hat area, in which case hard hats must be worn at all times whether there is a foreseeable risk of injury to the head or not.

Safe Working Practices for Access Equipment

Access equipment covers scaffolding, mobile elevating work platforms, ladders and cradles. The two main types of scaffolding are independent tied scaffolds and mobile towers.

Independent Tied Scaffolds

Scaffolding is made up of the following basic components:

- Standards – the vertical tubes used as a support for transferring a load to the ground or to a base plate. Standards are sometimes called uprights because they stand upright.

- Ledgers – the horizontal tubes tying the scaffold structure longitudinally, usually running parallel to the face of the building. They may also act as guard rails.

- Transoms – the tubes spanning across ledgers to tie a scaffold transversely, positioned at right angles (90°) to the face of the building. They may also be used to support a working platform. Additional ledgers may also be used to support the transoms.
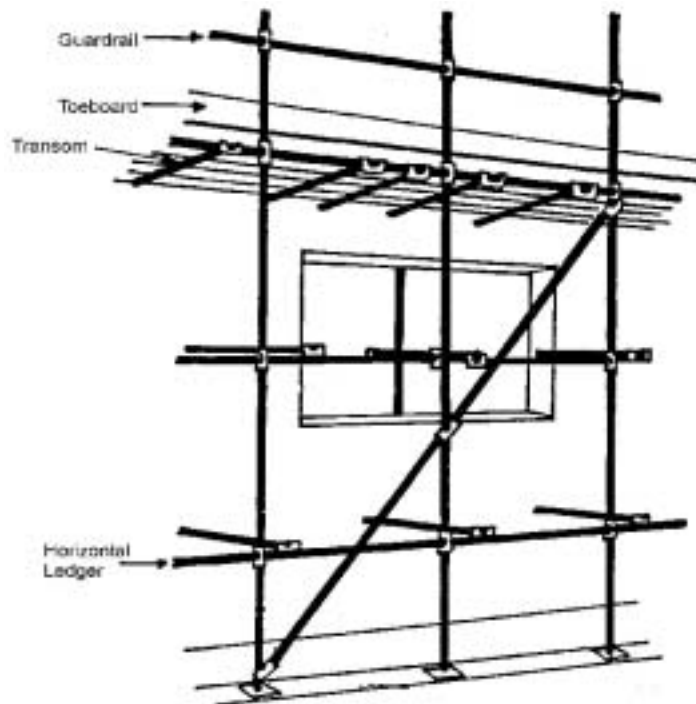
Independent Tied Scaffold

An independent tied scaffold is designed to carry its own mass and the full load of all materials and workers used on the scaffold. The total load is supported by the ground on which the scaffold has been erected. The scaffold is not totally independent and must be tied to the building where it is sited, to give the stability that prevents any possible movement of the scaffolding away from or towards the building.

As the total mass of the structure when in use is supported by the ground it is very important that the ground conditions are suitable to cope with the load. Base plates are used to spread the load at the base of each standard. In addition, where there is a risk of sinking into soft ground, sole boards may be laid. These are larger than base plates, spanning at least two standards, and are more effective at spreading the load.

There are a number of ways in which the structure can be tied to the building to prevent it moving either away from the building or laterally along the building.

- Anchor bolts – where one end of a metal bolt is screwed into the wall of the building and the other end is attached to the scaffold tubing.

- Through ties – where special scaffold tubes extend into the building through an opening (such as a doorway or window frame). The end of the tie which is inside the building opens out so that the walls of the building hold the scaffold in place.
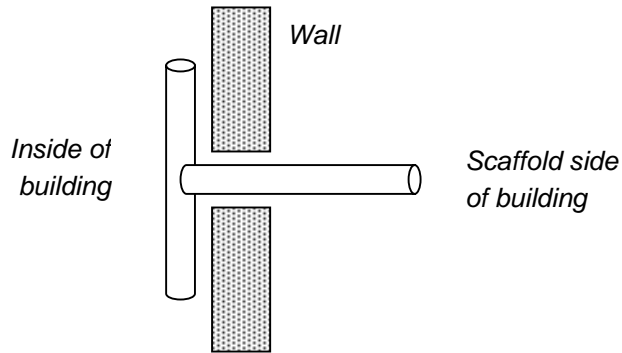
Plan View of a Through Tie (i.e. from above)

- Reveal ties – which rely on friction to achieve strength. They are not as strong as through ties.
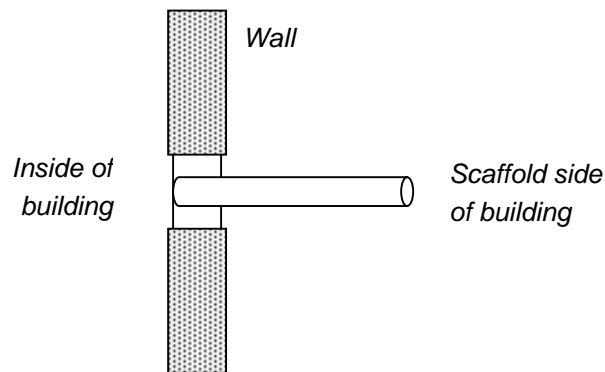
Plan View of a Reveal Tie

- Rakers – which are supports which push the scaffold onto the building. This system takes up space and may not be suitable in urban environments.
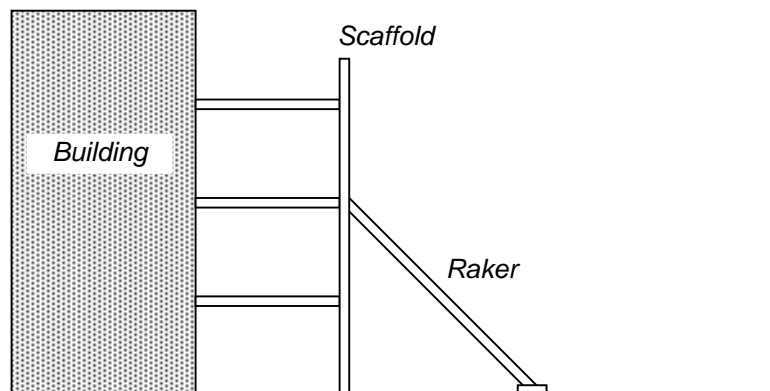
Side Elevation View of the use of Rakers

In addition to tying into the building, bracing can be used to stiffen the scaffold framework (standards, ledgers and transoms) and help to prevent collapse. The basic forms of bracing are:

- Façade bracing – provided by scaffolding tubes running diagonally across the face of the scaffold between the intersections of the standards and ledgers. This is also known as sway and longitudinal bracing.

- Ledger bracing – provided by scaffolding tubes running diagonally within the framework, between the intersection of the standards, ledgers and transoms at the front of the structure and the other end of the next transom up. Alternate pairs of standards should have ledger bracing.

Mobile Towers

Mobile tower scaffolds are often used for painting and simple maintenance jobs on buildings. They are light-duty scaffolds only and their use should be restricted to such work. They have one working platform at the top which is accessible by a ladder fitted internally and may be constructed using normal scaffolding tubes, although they are now mostly proprietary-made structures. The whole structure is mounted on four wheels so it can be moved about with relative ease.

The height of a mobile scaffold is generally limited to 12 metres except for special purposes. For internal use the height should not exceed three and a half times the shortest base dimension. When used externally the factor is reduced to three. When used above 9.8 metres some form of guy rope, ballast or anchoring device must be used to give added stability. Outriggers may also be used to spread the base dimensions and increase stability in the same way as they do on mobile cranes.

Particular safety points in the use of mobile towers include:

- People and materials should not remain on the tower, particularly at the top, when it is moved as they can easily overturn when being moved.

- Towers become very unstable on rough ground – they cannot cope with undulations and potholes in the way independent scaffolds can.

- Care should be taken to avoid obstacles, particularly overhead electrical cables, when the tower is moved.

- The wheels should be locked when the tower is in use.

Mobile Elevating Work Platforms (MEWP)

MEWPs are motorised vehicles or trailers with powered extending arms supporting a work cradle, used to reach lamp-posts, etc.
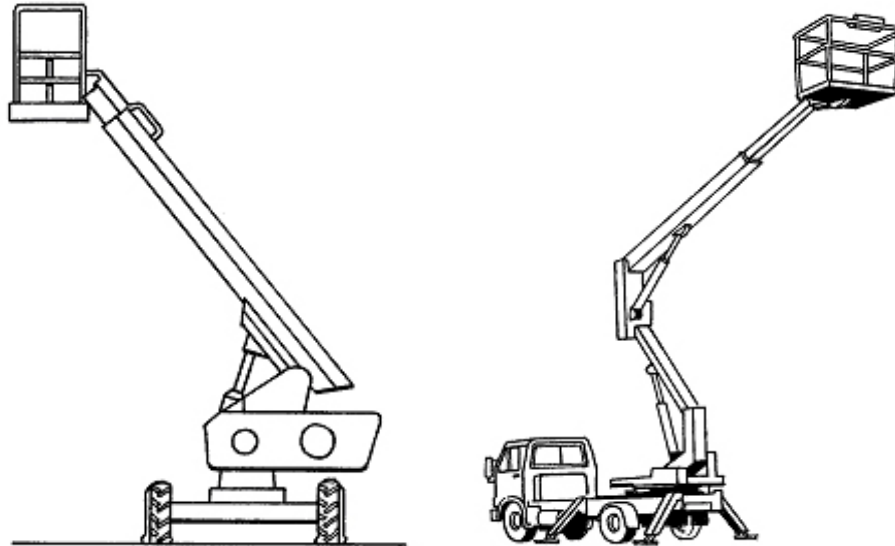
Mobile Elevating Work Platforms

When in use the same safety precautions must be taken as for lifting equipment such as mobile cranes. These precautions will include:

- Firm, sound ground is required for the vehicle to stand on.

- There must be sufficient clearance from any building or obstacle when operating.

- Barriers must be put in place to avoid collision with pedestrians and vehicles, as mobile equipment takes up a considerable amount of space. Such barriers can also act as an exclusion zone to protect people from objects falling from the cradle.

- The usual edge protection for the work platform when working at height is required and must be incorporated into the cradle.

- The controls of the arm should be inside the cradle so that the person actually working at height is in charge of the positioning of the working platform.

In addition to the precautions to be taken when in use there are other precautions when on the move; for example, ensuring the boom is secure since it can swing loose and hit oncoming traffic or buildings.

Ladders

As well as being well maintained, ladders should be of the correct quality for the task. There are generally three grades:

- Grade 1 for light work, as found in DIY stores and used in domestic premises

- Grade 2 for medium use and longer duration work

- Grade 3 for heavy-duty work as found on construction sites.

Metal ladders should not be used near unprotected live electrical circuits such as power lines. This also applies when unloading ladders from vehicles or passing under power lines.

Any ladder must be set up on a solid and flat base so that the feet do not sink into the ground. It may be necessary to place a plank on the ground for the feet to stand on. Ladders should only be supported on the styles, never on the rungs as these are not strong enough to take all the weight.

The angle of the ladder should ideally be 75° to the horizontal or at a ratio of 1:4 distance away from the wall to height.

The top of the ladder must rest against a solid support (and note that plastic guttering does not provide this and may give way). Whenever possible the ladder should be secured at the top. If this is not possible, then guy ropes should be attached and secured to firm supports. As a last resort someone should stand on the bottom rung. These precautions will prevent the ladder from sliding sideways if someone up the ladder reaches too far to one side.
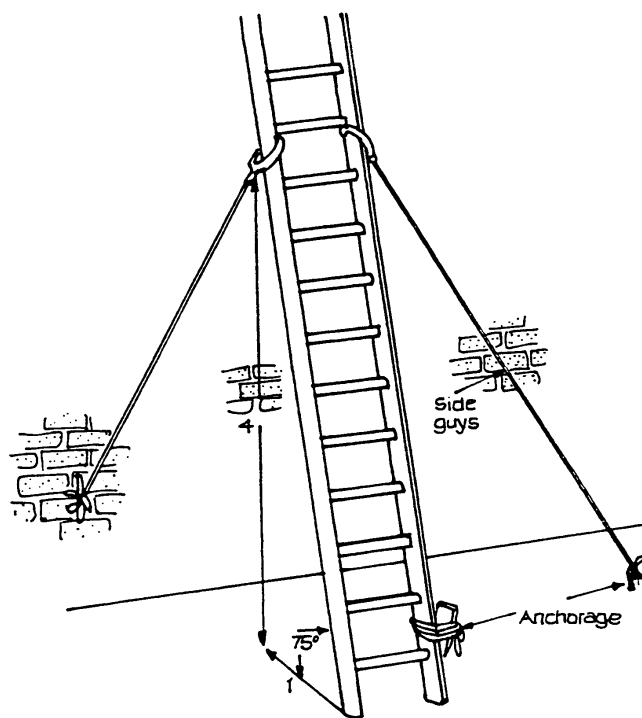
Ladder Siting

The ladder should be long enough for its purpose. The top of the ladder should extend far enough above the level of the working position or the platform onto which it provides access to provide a safe handhold. 1.05 metres is considered a sufficient overhang. This is particularly important when climbing on to roofs and scaffolding and when climbing down into an excavation. The stepping off point should be safe and clear, with guard rails and toeboards etc. if possible.

Only one person should climb on the ladder at any one time as the extra weight could put excess stress on the ladder.

If possible, nothing should be carried in the hands while climbing, so that both hands are free to grasp the styles. Engineers and carpenters often have belts with holsters in which they can keep their tools.

If the ladder is to be to a great height there should be a landing at intervals so that a rest can be taken. The landings should be suitably protected with guard rails and toeboards, etc.

Wooden ladders should not be painted as this can hide defects. Care should be taken that ladders do not warp during storage.

Extension ladders – those that slide up in sections – must have sufficient strength at the overlap. The guide is:

Closed ladder length	Overlap
Less than 5m	1.5 rungs
5m to 6m	2.5 rungs
Over 6m	3.5 rungs

Cradles

Cradles are a common form of access equipment. They are often seen suspended from the roofs of high rise buildings where they are used for window and other cleaning work. They are often referred to as suspended access systems.

The usual rules for edge protection when working at height apply to them. An exclusion zone may need to be established below them, and operatives may need to wear harnesses inside the cradle for extra safety. Weather conditions can pose problems to the use of cradles, particularly wind and lightning.

Inspection of Scaffolds

Because of the possibility of collapse of a poorly constructed working platform (e.g. scaffold), it is good management practice (and usually a legal requirement) to inspect them at regular intervals (typically once per week). They should also be inspected when they are first erected, after any substantial alteration and also if something happens that may affect their stability, e.g. after being struck by a vehicle or after a violent storm or high winds.

Typical things to check for include:

- Tying and bracing
- Edge protection
- Ground conditions
- Access
- Loading

These inspections should be recorded and is particularly important where a defect is noted and remedial action is required.

REVISION QUESTION 2

(1) What is the safe method of working on a fragile roof?

(2) What are the main hazards of using ladders?

(3) What measures should be taken to prevent materials falling from a height?

(4) In respect of scaffolding:

   (i) What is the difference between standards, ledgers and transoms?

   (ii) What is the difference between tying and bracing?

(5) State the safety precautions which need to be taken when mobile elevating work platforms are in use.

(6) What is the angle at which ladders should be positioned?

(7) When should scaffolding be inspected?

Check your answers with those at the end of the unit.

EXCAVATIONS

Excavations involve work below ground level and, whilst perhaps not as common as working above ground level, are a reasonably regular feature of construction. They are particularly associated with the construction of foundations for buildings, drainage work and the installation and maintenance of services. Excavations include any earthwork, trench, well, shaft, tunnel or underground working.

Hazards In and Around Excavations

The two main dangers with what are effectively holes in the ground are that things (and people) may fall into them and that the soil will collapse into the hole.

People, Equipment or Materials Falling In

The dangers here are very similar to those of people or materials falling from a height, creating a risk of injury from the fall or, for those working in the excavation, from being hit by an object.

Particular risk situations include:

- Unprotected edges to the excavation allowing people or vehicles to fall in, often through failing to notice the hole.

- The use of access ladders which are badly sited (both on the floor level of the excavation and in respect of the overhang available to get on to the ladder at ground level) leading to people slipping or falling off.

- Badly constructed ramps used for vehicular access to the excavation causing vehicles to topple over into the site.

- Materials stored or machinery/vehicles working or parked too close to the edge of the excavation, making them liable to fall in if there is any collapse of the ground around the edge. (The vibration caused by machinery and vehicles may contribute to such a collapse.)

Collapse

If an excavation cannot be battered (sloped back), the sides will require support to prevent the possibility of collapse. This is because the soil and earth which form the sides cannot be relied on to support its own weight for any length of time and will eventually slip. The problem is compounded in the following situations:

- There is inadequate shoring of the side walls – for example, supports are placed too far apart, allowing collapse between them, or the materials used for shoring are not strong enough.

- There is additional load on the sides – for example, from heavy plant and materials at ground level close to the edge.

- Where the earth walls are subject to shaking caused by the vibration of nearby machinery or vehicles.

- If the soil structure is loose or is made unstable by waterlogging (as a result of rain or other sources of water such as broken mains or drains). Soils expand when wet and shrink when dry; they are never stable for very long.

The consequences of a collapse are that materials forming the walls of the excavation will fall into the hole. They will also bring with them anything standing on the top, close to the edge.

This can amount to a large quantity of materials and very heavy weights, perhaps moving at considerable speed.

Even a minor collapse can cause serious injury to a person caught underneath. He/she is likely to be knocked over and at least partially buried. This can cause serious (perhaps fatal) crushing even if the arms, head and shoulders are not covered.

In addition, digging too close to or under the foundations which support nearby buildings may undermine that support and make the building liable to collapse. This would be compounded in the event of a collapse of the excavation itself.

Buried Services

Every year many workers digging on building sites and roadworks have narrow escapes when they accidentally hit buried live electricity cables. Others are not so lucky and suffer severe shocks or burns which may prove fatal.

It is not just electricity cables which are a hazard, although they may present the most immediate risk. Fracturing gas pipes, water mains, drains and sewers can all release dangerous substances, with gases presenting a particular problem due to the risk of fire and explosion where there is a possible source of ignition nearby.

Flooding

Flooding may occur as a result of weather conditions (rain or melting snow), of digging into and beyond the natural water table of the land or of disruption to the natural drainage flows within the ground. Changes in the level of the water table (as a result of rainfall) may also cause flooding.

This is unlikely to present a significant risk to people working in the excavation except where a watercourse is breached and there is a massive surge of water into a confined space such as a trench.

Hazardous Substances

There is the possibility that digging will uncover buried materials or contaminants within the ground which are hazardous to health. These may be the result of the decomposition of organic matter or from the dumping or spillage of hazardous substances. Particular problems include:

- Flammable gases such as methane (marsh gas) and carbon monoxide

- Toxic gases such as hydrogen sulphide (many of which are heavier than air and will accumulate in trenches or excavations)

- Chemicals and metal compounds, either in containers or within the soil.

Other hazards include dust from drilling, accumulations of fumes from burning materials (especially in tunnels where there is poor ventilation) and the presence of rats, with the risk of Leptospirosis or other infectious diseases.

Precautions

In common with other construction activities, the control of the risks involved in excavation is based on effective management.

Basic Support Systems

The main function of excavation supports is to prevent the collapse of the side walls of the excavated area and thus allow work to proceed safely and without interruption inside the workings. The type of support structure will vary in design upon the soil conditions and the type of excavation (such as trenches or pits). The two main types are explained below.

Battering

This technique allows almost any excavation to be carried out safely without the need for a support system. It relies upon the properties of the soil and earth into which the excavation is being dug to form a stable sloping pile when allowed to form naturally into heaps. The sloping surfaces of the heap form an angle with the horizontal called the angle of repose. Each material has its own particular angle of repose which will differ with the amount of moisture it contains.

It is very easy to demonstrate the variations of the angle of repose between materials by taking a quantity of material and pouring it into a pile on a flat surface.
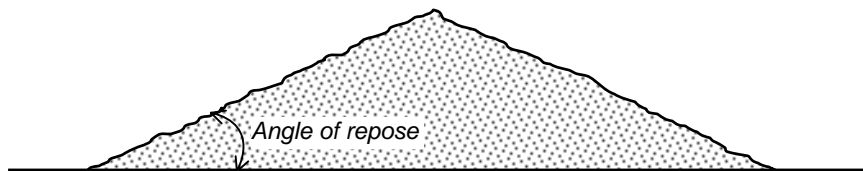
Angle of repose

In an excavation, as the hole is dug out, the sides are sloped back to less than the angle of repose so that the soil will support itself without the need for extra support.

It is important that the angle of repose of the soil materials being excavated is known. It can only be predicted for uniform soils of known water content. Where the soil has several strata with different compositions, a reasonable estimate of the lowest angle of repose for the materials should be used.

The technique has one drawback in that it requires considerable space in which to construct an excavation and is probably impractical in built-up areas, but remember that accidents in correctly battered excavations are very rare.

Shoring

Shoring is artificial support for the side walls of an excavation needed when they are steeper than the angle of repose. This will invariably be at 90° to the base of the excavation since it is virtually impossible to provide the bracing required at lesser angles. The type of shoring required will depend on such factors as the depth and width of the excavation and the material being excavated.

The basis of shoring lies in laying boards across the face of the side wall to provide the support against the soil and earth, and bracing them against a secure surface to withstand the force. The main type comprises vertical wooden boards (poling boards or soldiers) which are held in place by horizontal timbers (walings), and then braced by wooden timber struts against a facing wall, as in a trench or a square pit shaft with two pairs of facing walls. Steel sheets secured together by clamps and braced by expandable steel struts are also common. The struts in these constructions will impede the working space available, particularly in trenches. Where there is no facing wall to brace the supporting sheets against they may be braced against the floor using angled supports similar to rakers in scaffolding.
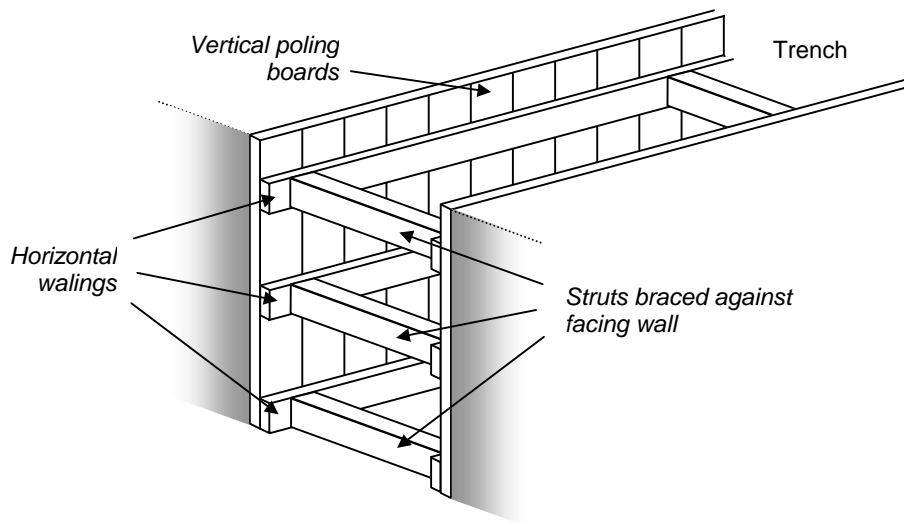
Double-sided Support in a Trench
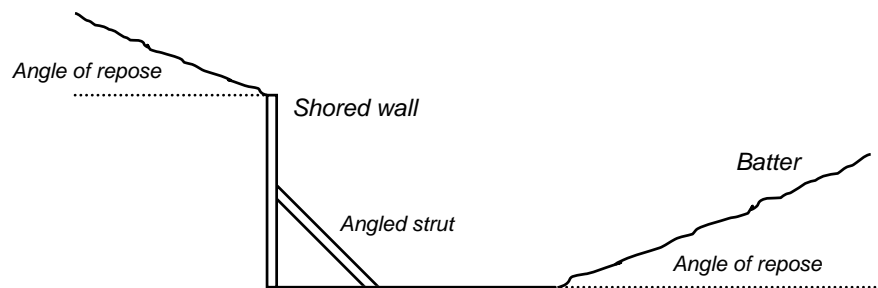
Angled Strut Support

If working near to buildings then it may be necessary to shore up the foundations and brace the walls so that the building does not fall down.

Barriers

Where a person may fall a distance of more than two metres into an excavation, this is equivalent to "working at heights" covered earlier. For the same reasons the edge should be protected by barriers or the excavation covered. However, it is advisable to protect even shallow excavations. Guardrails which meet the same standards as required for working platforms should be provided around every accessible part.

To prevent vehicles from falling in, logs or concrete blocks are laid some distance from the edge, to act as a buffer.

Excavations may have to be covered, particularly at night. Such covers must be capable of bearing a person's weight and held securely in place.

In addition, fencing or hoarding may be required to protect members of the public as well as construction workers. This provision will depend upon making a risk assessment, taking into account such factors as volume of traffic (pedestrian and vehicular) around the workings and the depth of the excavation.

Access Ladders

Ladders provide the main method for access and egress from an excavation. They must be suitably secured to prevent undue movement and extend above the excavation to give the necessary height required for a safe handhold.

To allow for adequate means of escape in emergency it is considered that one ladder every 15 metres is an average to work to, but more may be required depending upon the number of workers and the potential risk; for example where there might be a possibility of flooding from a rising water table.

Care must be taken to ensure that they are kept in good condition.

Crossing Points

Crossing an excavation should only be permitted at designated points. The crossing point should be of sound construction and suitable to support all the types of vehicles and equipment likely to use it. Gangways across excavations should have guard rails and toeboards.
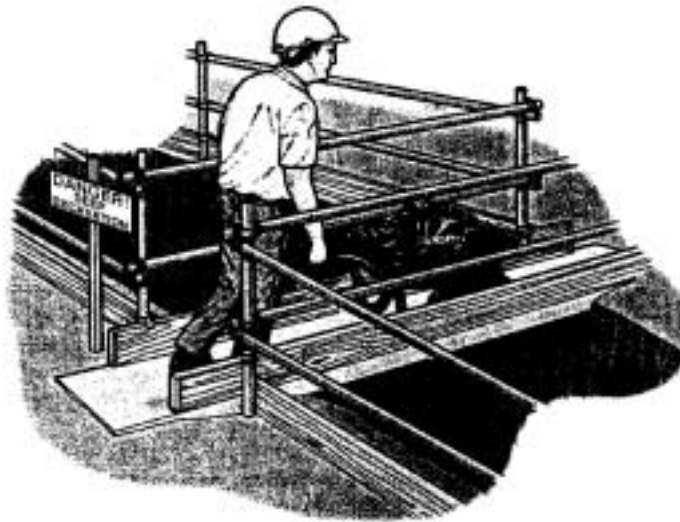
Crossing Point

Lighting and Warning Signs

The use of clear warning signs is an important part of the means used to prevent people falling in to an excavation. Signs should warn of the excavation and any special measures to be taken on entering the site. They should be placed in clearly visible places at all potential access points.

If working on a roadway, the police or the local authority should be consulted about traffic lights or stop/go signs. Appropriate lighting should be installed to ensure that there is an adequate level of illumination without distracting shadows in order to ensure the safety of work activities both within the excavation and on the surface. High powered electric lights or those which operate from liquid petroleum gas (LPG) will be required for general workplace illumination. Consideration may have to be given to smaller personal lights for individual workers, which should be battery operated to avoid the risks associated with trailing electrical leads.

Personal Protective Equipment

Hard hats are a likely requirement at all times. The need for other PPE will be determined by the nature of the work carried out in the excavation; for example:

- Fumes and dust may require the use of masks and respirators

- Excessive noise levels will require the wearing of hearing protection

- Where welding work is carried out, face shields and protective clothing will be necessary

- Breathing apparatus and safety harnesses may be required for working in tunnels and shafts.

Checks for Buried Services

The location and configuration of all cables and services on the site of the excavation should, so far as is possible, be identified prior to work commencing. It may well be possible to avoid cable routes at the planning stage of work.

Before work starts the following action should be taken to establish the nature, routes and depth of any pipes and cables:

- Checking any available plans

- Contacting local services providers and owners such as electricity, gas, water and telecommunications companies

- Surveying the site and surrounding areas to identify indicators of the existence of cables, etc.; for example, street lights or junction boxes

- Using cable locators.

The positions of known services should be marked on plans and also on the ground itself. All workers must receive adequate information and instruction about the nature of the risks.

Where appropriate, arrangements must be made with the services providers to isolate the cables/pipes and ensure that it is safe to work in the vicinity of them.

Safe digging procedures during the process of excavation include the following:

- Regarding all buried cables as live; pot-ended cables cannot be assumed to be dead or disused.

- Excavators and power tools should not be used within 0.5 metres of the indicated line of cable/pipe.

- Hand-digging should be employed when nearing the assumed line of the cable/pipe.

- Exposed cables and pipes should be supported and protected against damage. They should never be used as hand and footholds.

Proximity to Excavators

Excavators can be very large and unwieldy machines and represent a significant hazard in terms of the risk of collision with the moving digging arm and scoop, and from materials falling from the scoop when being lifted and manoeuvred. Apart from site workers, members of the public may be at risk where the work is carried out in or near public roads.

The use of exclusion zones marked out by barriers and with warning signs and lights must be considered.

Excavator cabs must have adequate sight lines and operators must be properly trained.

Position and Routes for Equipment, Materials and Vehicles

To prevent objects falling into excavations the following precautions should be observed:

- Waste or building materials must not be stacked near the edge. This includes ensuring that piles of material dug from the excavation are set well back or removed entirely. Apart from the risk of falling material, the weight of stacks close to the edge may cause the walls of the excavation to collapse.

- Machinery and vehicles should only be operated in specially designated areas which are strong enough to withstand the effects of vibration without causing a collapse. Specially built routes to allow access to the floor of the site for vehicles and plant may have to be constructed.

- Where vehicles have to approach the edges of the excavation (for example, to receive or tip materials) there should be stop blocks to prevent them overrunning.

Filling In

When work in the excavation is completed, support materials should be safely removed by experienced workmen and a competent person should inspect the site to ensure that all dangerous materials and equipment have been removed. Water may have to be pumped out of the excavation before it is filled.

Filling should use only appropriate materials and be conducted in a controlled manner under the direction of a competent person. Uncontrolled tipping might contravene local laws.

Inspection of Excavations

For similar reasons that scaffolds should be inspected, so too should excavations. No-one should be allowed to work in an excavation before it has been competently examined. An excavation may collapse, crushing the workers in it.

Excavations should normally be examined daily as they will be changing as the excavation continues. Deep excavations may require more frequent inspection. Again, like scaffolds, if an event occurs that is likely to affect stability, it must be examined again e.g. after flooding.

CONSTRUCTION-RELATED HEALTH HAZARDS

Construction workers are likely to suffer ill-health as a result of their work in the industry after exposure to both hazardous substances and harsh working conditions. Ill-health can result from exposure to dusts, including asbestos, which causes a range of respiratory diseases and cancer, to solvents which can cause corrosive injuries and skin diseases such as dermatitis, to high noise levels causing hearing loss and to vibration. Lifting heavy and awkward loads may cause back and other injuries.

In many instances the only preventative measure available is the use of personal protective equipment.

Noise and Vibration

The noise levels on construction sites or in particular parts of them can be very high, requiring action such as the wearing of hearing protection.

Apart from the noise generated, compressors, pneumatic drills, heavy plant, vehicles and activities such as pile driving also produce considerable vibration. This can be a severe hazard resulting in HAVS (hand-arm vibration syndrome) or whole body vibration which can cause internal damage after prolonged exposure. Equipment vibration should be damped wherever possible and the time spent working with such equipment or on activities giving rise to these risks should be limited by adequate rest breaks or job rotation.

Dust

Dust is a common hazard on demolition sites. Brick and concrete dusts are a constant problem and can cause physical injuries to the eye and respiratory discomfort. They may also be a hazard to neighbours. In addition, there are specific hazards associated with particular types of site where toxic materials or harmful fungal or bacterial matter may be present, for example:

- Bird droppings in lofts or on roofs

- Demolition of abattoirs

- Excavations of land or demolition of buildings where the processes have involved hazardous materials, such as zinc, cadmium or lead.

To reduce general dust to a minimum, demolition areas should be kept damped down with water.

Asbestos

This is one of the most serious continuing health hazards to demolition work because of its general use in all manner of structural systems over the years. Insulation, fire retardant material, plastics and building cladding materials are some of the more common examples of asbestos use.

Both crocidolite (blue asbestos) and the more common chrysotile (white asbestos) must be treated as carcinogenic. Respirators and breathing apparatus must be worn and precautions must be taken to avoid dispersion of asbestos into the environment.

Cement

Cement is widely used in construction work and forms part of the mix for mortar and concrete. It is abrasive and mildly corrosive and can cause harm by:

- Contact with the skin – resulting in irritant or allergic dermatitis and sometimes serious skin burns and ulcers if it gets trapped inside a worker's boots or gloves.

- Contact with the eye – causing irritation and inflammation.

- Inhalation – causing irritation of the nose and throat, short-term difficulty in breathing and possible long-term lung function effects.

Chemically resistant gloves and dust masks should be worn when working with cement in its powder form.

Solvents

Solvents are corrosive chemicals and are found in many materials used in construction, such as paints, varnishes, adhesives and pesticides. The most common hazardous substances are:

- White spirit – in paints, varnishes and cleaning products

- Xylene – in paints and adhesives

- 1-Butanol – in paints, lacquers, and natural and synthetic resins.

Solvents cause harm in their liquid form (through skin and eye contact and ingestion) and through the vapours given off (where absorption may be by inhalation or through the eyes). This may result in irritation and inflammation of the skin, eyes and lungs, causing dermatitis, burns and breathing difficulties. Exposure to vapours may also cause headaches, nausea and dizziness, and lead to reduced concentration and impaired dexterity (both of which could lead to further accidents). Long-term exposure to high concentrations of vapours, as in unventilated confined spaces, can lead to unconsciousness and even death.

Many solvents are also flammable and the build up of vapours and ignition sources need to be avoided.

The use of dangerous solvents in paints and adhesives is gradually being replaced by other less hazardous substances but their use remains a hazard. Precautions include wearing the correct type of gloves, goggles and masks.

Cleaners

A variety of toxic and corrosive chemicals are used in cleaners, including solvents (as discussed above), acids and alkalis, such as caustic soda. They can cause harm by:

- Direct contact with the skin – resulting in slow healing serious burns and possible permanent scarring

- Inhalation of fumes and mists – resulting in damage to the eyes, respiratory tract and lungs.

REVISION QUESTION 3

(1) Identify the main hazards associated with excavation work.

(2) What is battering?

(3) What are the key elements of shoring?

(4) Identify the requirements for crossing points.

(5) How can the hazards of buried services be avoided?

(6) When must excavations be inspected?

Check your answers with those at the end of the unit.

UNIT SUMMARY

Construction work covers all work below, at or above ground level on any structure built or assembled on land, from the planning of the project to the end of the life of the structure.

Management control over construction work is the basis of safety. Health and safety must be addressed at all stages of, and by all persons working on, the construction project. This includes preparing a health and safety plan for the work, keeping a health and safety file, and ensuring the competence of all personnel through procedures for the selection and control of contractors.

The general hazards encountered in construction include the risk of fire and explosion from flammable materials, collisions and other dangers from the use of machinery and vehicles on site, falling objects, dangers from exposing buried cables and pipes, and general slips, trips and falls. In addition, there are health hazards arising from noise, vibration and dust and the hazardous nature of some of the substances used in building work, and a general need for site security.

These hazards may be addressed by specific rules about the storage of flammable materials, general rules about the stacking and storage of other types of materials, the use of guards to enclose moving parts of machinery, the designation of vehicle traffic routes, barriers and signs to enclose particular working areas and restrict entry, and the use of PPE to provide personal protection for workers.

The additional hazards of working at a height are principally those of falling or of falling materials. These are addressed by strict requirements for edge protection of building surfaces and working platforms, including the use of guard rails and fencing to prevent falls, and brickguards, toeboards and close-fitting flooring on platforms to prevent materials from falling. Where necessary overhead protection must also be supplied for those passing below to protect them from falling materials. Head protection must always be worn.

Attention must be given to the use of access equipment, including scaffolds, ladders and mobile elevating work platforms. Scaffolding must be inspected regularly and be constructed in such a way as to ensure its stability at all times and in all conditions.

The additional hazards of working below ground are principally those of falling in and collapse. These are addressed through the use of barriers and site rules to prevent persons and vehicles approaching or working close to the edges of the excavation, and the use of different techniques (mainly battering and shoring) to prevent the sides of earthworks collapsing. Daily inspection of the support systems used for excavations is necessary before work can commence. In addition, careful planning to locate and avoid buried services is usually essential and there are safe digging methods to be followed when working close to pipes and cables.

SUGGESTED ANSWERS TO REVISION QUESTIONS

Revision Question 1

(1) In mixed stores, different goods and materials should be separated in different areas to allow for easy location and access. Incompatible hazardous materials should not be stored together, nor should flammable materials be mixed with other materials and flammable liquids, solids and gases should be kept separately.

(2) Internal stores for flammable materials must be constructed of fire-resistant materials and provide a good level of ventilation to stop dangerous levels of gases accumulating. The requirement for fire-resistant materials is not necessary if the store is a completely separate building located in a safe place.

Revision Question 2

(1) The use of roof ladders (or crawling boards) laid across the roof surface, supported by the underlying load bearing roof members, in order to distribute the load of the worker over a wide area.

(2) Not being tied or not resting on firm ground, which may cause the ladder to tip. Poor storage and maintenance allowing the ladder to rot or warp, which may cause the rungs to break.

(3) To prevent materials from falling in the first place, the following control measures should be used:

– Not stacking materials near edges and particularly unprotected edges

– Close boarding of working platforms – minimising gaps between scaffold boards or placing sheeting over the boards so that material cannot fall through

– Avoiding carrying materials up or down ladders, etc. by using hoists and chutes to move materials.

(4) (i) Standards are the vertical tubes (the uprights), ledgers are the horizontal tubes running parallel to the face of the building and transoms are the tubes spanning across ledgers to secure a scaffold transversely.

(ii) Tying secures the scaffolding to the building, whereas bracing is used to stiffen the framework.

(5) The precautions for the use of MEWPs are

– That there is firm sound ground for the vehicle to stand on

– That there must be sufficient clearance from any building or obstacle

– Barriers must be put in place to provide an exclusion zone which also prevents collisions with the equipment

– That there is adequate edge protection for the cradle

– That the controls of the arm should be inside the cradle.

(6) 75°

(7)   Before being used for the first time, after any substantial alteration or any event likely to affect its strength or stability, and at regular intervals (usually weekly) days.

Revision Question 3

(1)   The two main hazards are that things (and people) may fall into the excavation and that the ground will collapse into it. Other hazards include buried services, flooding and hazardous substances.

(2)   Battering is the process of allowing the sides of an excavation to lie naturally at an angle to the floor of the excavation which is below the angle of repose for the materials involved.

(3)   The key elements of shoring are the support boards laid against the face of the side wall and the struts which brace those boards against a secure surface.

(4)   The crossing points should be of sound construction and suitable to support all the types of vehicles and equipment likely to use them. They should be fitted with guard rails and toeboards.

(5)   By identifying, as far as possible, the location (routes and depth) and nature of all buried services before work starts, planning work to avoid them, marking their location on working plans and on the surface, and through safe digging practices.

(6)   At least daily and more frequently for deep excavations (exceeding 2 metres). Additional inspections will be required after any event likely to have affected the strength or stability of the excavation, or any part of it.

NEBOSH International General Certificate

Unit 15 | Investigation, Recording and Reporting of Events

Contents

INTRODUCTION

So far we have looked at principles and techniques for preventing or controlling risks. Such measures are very important because they help prevent accidents, and this must be the first concern and duty of an employer. Unfortunately, despite the very best in preventive and control measures, accidents will happen.

The first response to an accident must be to care for the victim. After that, the employer must take steps to find out what happened and act to prevent it from happening again. Accident prevention is based on learning from those accidents and other incidents, so accurate information about them has to be obtained and analysed.

This unit looks at the way in which accidents are investigated and how information about them is used to identify immediate and underlying causes, and used as the basis for taking remedial action. We will also consider the role of such information in actions under civil law, such as negligence, and the requirements for reporting certain types of incident to the enforcement agencies or other government bodies. In doing so, the unit is designed to meet the following aims and learning outcomes as specified by NEBOSH for this part of the syllabus for the International General Certificate.

Overall Aims

On completion of this unit, you will have knowledge and understanding of:

- The need for an organisation to have a system for internally reporting, recording and investigating accidents, cases of work-related ill-health and other occurrences
- Local requirements for notifying certain events to external agencies.

Specific Intended Learning Outcomes

When you have worked through this unit, you will be able to:

- Explain the purpose of and procedures for investigating accidents and other events at work.
- Utilise records of accident and ill-health experience in an organisation.
- Explain the local requirements for notifying events to external agencies.

ROLE AND FUNCTION OF ACCIDENT AND INCIDENT INVESTIGATION

We have seen earlier undesired and unplanned events at work can give rise to incidents, which are any events the outcome of which may (but may not) cause harm to people and/or loss. Accidents are a particular type of incident which may result in loss, personal (minor) injury, serious injury or death. Where no such outcome results, the incident is classified as a near miss. Certain types of incidents, including accidents, may also be reportable to government organisations.

Since any incident could cause a fatality, a serious injury, a minor injury or just a near miss, all incidents should be investigated, not just accidents. The main purpose of an investigation is to find the cause, with the intention of preventing a recurrence, rather than to find somebody to blame.

Each accident or incident should be investigated as an individual event. However, looking at all the incidents which may have taken place at work may indicate that some appear to be linked; for example, the history of a number of similar incidents may indicate a trend of certain types of accident or failures of particular safety devices. So it is important to consider the particulars of the current incident and also to see if it fits a pattern with others. This means that the results of all investigations must be summarised and analysed, usually using statistical methods.

For the organisation, the main purpose of incident investigation and reporting is to prevent them from happening again by dealing with the issues identified as the immediate and underlying causes. This may include introducing new safeguards, procedures, training and information, or any combination of them. However, other people outside of the organisation may have different reasons for investigating incidents; for example:

- Enforcement agencies look for evidence of an offence and to identify those responsible (i.e. to blame)

- Insurance claims assessors look for evidence of liability.

In addition, governments are interested in obtaining general information on where and how certain types of incident and accident happen, to enable them to advise on preventive action and identify priorities for future legislation. As a result, certain types of incident are usually reportable to government agencies.

There are two aspects to the role of investigations:

- The investigation itself – inspecting the scene of the incident, interviewing those involved and other witnesses, drawing conclusions as to the causes and identifying action to prevent a recurrence.

- The reporting of both the incident and the results of the investigation, both within the organisation and to outside agencies such as the enforcing authorities.

BASIC ACCIDENT INVESTIGATION PROCEDURES

An investigation may be carried out by a single person or a team, depending on the nature and severity of the incident and its consequences. So, for example, the investigation of an accident using a machine guard on a grinder may be dealt with quickly by the supervisor on the spot, whereas a train crash will involve a large team of experts working for many weeks. In principle, though, both types of investigation go through the same process:

- Establishing the facts

- Identifying immediate causes

- Identifying any underlying causes; i.e. why were the immediate causes there?

- Identifying remedial action to prevent the causes from happening again.

Who Investigates?

The investigation should be conducted by or under the supervision of a competent person. This would be someone with knowledge and skills of the specific working environment in which the incident occurred, and who understands the nature of the safety requirements. There will be several people who might fill this role, depending on the nature and severity of the incident:

- **The immediate supervisor or foreman**

  Most minor incidents can be investigated and resolved effectively by the supervisor. He/she is on the spot and knows the situation, people and work involved better than anyone else. The supervisor also has an interest in sorting out the causes of accidents because it can have an effect on the efficiency and morale of the workforce.

- **A member of management**

  If the incident has implications wider than the immediate workplace, a more senior manager may have to be brought in to oversee or conduct the investigation. This may be because of the particular nature of the incident (such as involving a bad injury), or perhaps because the causes are more serious or the type of incident seems to fit a pattern.

- **A safety representative and/or an workers' representative**

  The staff representative must normally be told by management where a manager is involved in the investigation and in more serious cases the representative may actually be involved in the investigation itself.

- **A safety officer or one of his staff**

  The safety officer will be involved in more serious incidents where his/her expertise may be necessary. The safety officer will normally be in charge of the investigation, but will have to work through the supervisor and perhaps a number of safety and management personnel.

Establishing the Facts

The first task of the investigation is to find out what happened. The process of gathering evidence should begin as soon as possible.

Someone, usually the immediate supervisor, should assume responsibility for dealing with the consequences of the incident. The first priority should be to treat the victim(s) and secure the

area from further danger. After that, the circumstances should be observed and recorded, and any immediate evidence collected, both physical and from witnesses. In all serious accidents, and in all other cases where practicable, conditions at the accident or incident scene should remain undisturbed until they have been fully investigated. On occasions the site may have to be made safe, but otherwise left undisturbed for investigation by outside agencies; e.g. the police. The investigation should also cover clearing-up operations and reinstatement, as further evidence may emerge.

In the case of fire investigations it is useful if the investigator can safely be present during the fire or as soon as possible after it has been extinguished. The exact area in which the fire started may be more readily apparent, although it may be obscured by smoke, and heat may prevent access to the building. In such cases, it may be possible to gain useful information by watching the activities of the fire-fighters or by photographing the course of the fire.

Interviewing Witnesses

It is best to carry out interviews at the scene of the accident when possible, because it is generally easier for those involved to communicate better with the scene close at hand. It is usually much easier to explain clearly what happened if witnesses can point out specific things and recall their actions on the incident site.

There are three types of witness:

- Primary witnesses – those involved directly in the incident, including any victim(s). When an accident happens where someone is injured, the first priority should be treatment of the victim or victims. However, they and any others directly involved should always be the first to be interviewed. Where a victim's condition is such that immediate questioning is not possible, the interview should be delayed until the person has sufficiently recovered, but the initial stage of the investigation cannot be concluded until this has been done.

- Secondary witnesses – those who saw the incident. Eye-witness statements are best collected as soon as possible after the incident, whilst the details are fresh in mind.

- Tertiary witnesses – those who did not see the incident but can verify certain information about the actions of people or about aspects of the circumstances. This may include providing collaboration of other witness statements.

Witness interviews should be conducted with tact and care. The purpose should be to ascertain as much information about the incident as possible and witnesses should be encouraged to talk freely about all aspects of the particular incident and any other relevant matter. They should be assured that the purpose of the interview is not to blame anyone but to attempt to find out the cause and so reduce the possibility of it happening again.

It is important not to prejudge or assume your conclusions; allow witnesses to explain what happened from their own viewpoint, even where this conflicts with what appear to be the facts or with other witness statements. It may only be possible to find out exactly what happened after looking at all the different opinions and viewpoints. For this reason, in more serious cases it may be necessary to advise witnesses not to discuss the incident amongst themselves as they may influence each other's observations and judgment.

It is best to follow a procedure when interviewing by starting with "what" questions and then working through "where", "when", "how" and "who" before ending with the "why" questions:

- What happened? – What did you see? – What time was it?

- Where were you at the time? – Where was the victim?

- When did you realise something was wrong?

- How did it happen? – How were you involved? – How could it have been prevented?

- Who else was involved? – Who else saw it? – Who reported it?

- Why do you think it happened?

Starting with the "why" questions may seem aggressive and put a witness on the defensive or even antagonise him/her, so they should be lead up to by preliminary questioning about the facts.

When each witness's account of an accident has been heard, the investigator should repeat it back to the witness to make sure that the account has been fully understood before it is officially recorded. This also allows the witness to check and clarify any aspects.

When the investigator and the witness are both satisfied that a true account has been given, the interview should be finished on a positive note. This may be achieved by discussing any ideas the witness might have regarding prevention of a similar occurrence. It will also serve to repeat the purpose of the interview and encourage his/her further co-operation, if necessary.

Plans and Photographs

The physical layout should be recorded graphically through the use of plans, figures and diagrams, and by photographs.

Plans and diagrams should be used to show:

- The location of all the people involved (including all witnesses), together with their actions and movements

- The position and movement of all relevant objects, such as vehicles, machinery and equipment, etc.

- The extent and severity of the damage, both in the immediate and surrounding areas; for example, the main locations and the extent of splashes from a spillage.

The plans should also make clear any environmental conditions which may have had some bearing on the incident, such as temperature, ventilation, humidity and lighting (particularly glare).

All this information may have to be very precise, depending on the nature and severity of the incident. Thus, the plans may have to be marked to show such physical measurements as:

- Noise levels

- Light levels

- Substances involved, from samples analysed in a laboratory if necessary

- Electrical current/voltage flow levels

- Speeds of vehicles or the moving parts of machines

- Distances involved – for example, reach distances, size of openings, etc.

Photographs or video recordings can be very useful. These should show both general and close up views of the area from a range of different vantage points. They should particularly record any irregularities which may have contributed to the incident; for example, destroyed

appliances, overturned containers, absence of machine guards. They should also record any aspects of the clear-up and reinstatement operation, as new evidence may come to light, for example when rubble and fallen equipment is removed.

Relevant Records

If the investigation starts after the incident has happened and the immediate effects have been dealt with, the first record to be consulted should be the entry in the accident book. All organisations should have an accident book in which the basic details of accidents are recorded at the time they happen. This is only the first relevant document and should not be considered to be the definitive statement of what happened.

Any further existing information about the people, plant and machinery involved in the incident, and environment in which it occurred, should also be examined for any light that it can shed on the causes. There is likely to be a wealth of evidence available, including the following types of record:

- Inspection and maintenance records – All plant, machinery and equipment work should be examined and maintained on a regular basis. For those items which are inherently dangerous or which are crucial to maintaining safety, this should be in accordance with a planned programme. The inspection and maintenance records completed after each examination and, where necessary, servicing and repair, should provide a detailed history of the equipment, etc. involved.

- Risk assessments – The latest risk assessments covering the workplace involved should be examined to find out if the circumstances of the incident had been foreseen and whether any actions had been identified for dealing with it.

- Environmental measurements – for example, any measurements of workplace agents, such as noise levels, levels of airborne contaminants, etc., taken before, at the time of and after the incident.

- Medical records – The existing medical history of the victim may be relevant, particularly in relation to any occupational health monitoring undertaken due to workplace risks (such as radiation monitoring).

- General and specific safety reports and analyses which relate to the circumstances; for example, safety audits and formal in-depth inspections undertaken as part of safety sampling programmes.

- Training and other personnel records – These should provide relevant history about the individual workers involved, including their experience, level of training and involvement in any previous incidents, etc.

- Minutes of safety meetings – These may reveal previous discussions about relevant issues.

Checklists

In any organisation it is a requirement that all accidents and many types of incident are reported to management and, as we shall see later, there are usually specific forms for doing this. They will list key points which must be investigated, such as:

- What actually happened
- The nature of any injury or damage
- What inflicted the injury or damage

- What caused the accident, that is the physical conditions and what people did

- Who had control of the cause of the injury or damage.

Depending on the nature of the workplace and the operations undertaken, such checklists of investigatory points may be more or less detailed. For example, the general nature of the above list may be sufficient in low risk workplaces such as an office; but in a machine shop there may be very detailed points to cover, such as the position of machinery controls, floor conditions, lighting levels, etc.

Identifying Immediate Causes

Accident reports tend to concentrate on the cause of the injury, but the purpose of the investigation is identifying the cause of the incident. They are not necessarily the same thing; for example, the cause of an injury may be slipping on a wet floor, but the cause of the accident may be in neglecting to put up a barrier to prevent people walking on the hazardous surface.

The first priority of the investigation is to identify the immediate, direct cause of the incident because there is a risk that the same circumstances may occur again and steps must be taken to ensure that there is no repetition of the problem.

Accidents are caused, at least in the first instance, by unsafe acts on the part of people and/or unsafe conditions in respect of the machinery and equipment used, working practices or the application of control measures. Whilst there might be an underlying reason for these acts or conditions, it is important to establish exactly what has caused the incident.

- **Unsafe acts**

  These are where the actions (or omissions of action) of people in the workplace directly cause, or contribute to, the incident. They include the following types of action or omission (sometimes referred to as active or passive unsafe acts):

  – Operating without permission or in direct contravention of specific rules

  – Operating or working at unsafe speed, for example rushing, either in the use of machinery or in the person's own movements

  – Not using safety devices or rendering them inoperative

  – Knowingly using unsafe equipment

  – Using equipment in an unsafe manner; for example, not for its intended purpose or with reckless regard to safety

  – Using unsafe methods of work; for example, not following established safe systems

  – Adopting an unsafe position or posture; for example, when lifting or carrying objects

  – Failure to wear safe clothing or personal protective devices

  – Acting in a reckless manner; for example talking to or distracting, teasing or startling a colleague

  – Not reporting safety-related incidents, such as inoperative guards or minor accidents

  – Working whilst under the influence of alcohol or drugs, or when unfit due to fatigue or ill-health.

• **Unsafe conditions**

These are where the physical conditions at the workplace, or the methods of work, directly cause or contribute to the incident. They include the following circumstances:

– Unguarded machinery, or the absence of the required guards

– Inadequate guarding; for example, guards of inadequate height, strength, mesh, etc.

– The provision of unsafe equipment, because it is defective or improperly maintained

– Unsafe floors and working surfaces; for example, slippery, decayed or cracked surfaces

– Unsafe systems of work; for example, where the working processes and practices which are required to be followed put workers in danger

– Unsafe PPE; not providing, or providing inadequate, clothing, goggles, gloves or masks, etc.

– Inadequate housekeeping, resulting in accumulations of waste materials or dirt, blocked traffic routes (particularly emergency exits), etc.

– Unsafe layout and design of the workplace; for example, poor lay-out of pedestrian and traffic routes resulting in congestion, or inadequate space at workstations

– Unsafe environmental conditions, including inadequate lighting or excessive glare and reflection, inadequate ventilation, excessive noise, inappropriate working temperatures or humidity, etc.

Identifying the Root or Underlying Causes

This part of the investigation asks why the immediate causes occurred and what brought about the unsafe acts/omissions or the unsafe conditions.

It is not enough simply to establish the immediate cause of the incident and prevent that happening again; for example, a broken guard can be repaired. We have to know if there is a reason for the immediate cause, such as why did the guard break? If there are underlying reasons for the immediate cause, they must also be remedied to prevent the same circumstances occurring again. So, for example, if the guard that broke had not been inspected as required the week before, that may be a contributory reason. Or there may be a suspected defect in its installation. Then we have to explore the reason for these underlying causes, to find out why the inspection programme was not followed or why the installation was not carried out correctly; because if these are not corrected, there is a possibility of the same thing happening. This process of investigating the reason for each underlying cause goes on until the real root of the problem is established.

Consider another example. If a pipe fails and the cause is said to be corrosion, we must follow the trail of underlying causes by asking more questions:

• Was the material of construction specified correctly?

• Was the specified material actually used?

• Were operating conditions the same as those assumed by the designers?

• What corrosion monitoring did they ask for?

- Was it carried out?

- Were the results ignored?

And so on.

When we track back through the underlying causes, what we always find are more unsafe acts (or very often, omissions) by people and/or more unsafe conditions. All of these factors must be addressed, but at the heart of all investigations is a failure in management control.

It is the employer's responsibility to ensure the safety of the workplace, and it is part of management's role to carry it out. If the workplace is unsafe it must be management's responsibility, either for not establishing the appropriate controls or for failing to make sure that the established controls were effective at all times.

In most circumstances it is possible to identify a management failure which requires correcting in order to prevent the same or similar events from happening again. So, in respect of the example of the broken guard from above, the following root causes may be established:

- The failure to inspect may be the result of the supervisor being on holiday and no-one else carrying out the inspection in her absence, which is a failure in management organisation.

- Or it may be the result of a lack of understanding of the importance of inspection by the supervisor concerned, which is a failure in supervisory safety training, a management responsibility, and in the management of the individual supervisor.

- The failure to install the guard properly may be due to a mistake by the installer, which itself may be the result of a failure in training or recruitment processes, which again are management responsibilities.

- Or it may be because the instructions for fitting the guard were incorrect or confusing, which may be the fault of the supplier, which itself should then be investigated and the root cause identified, perhaps as a lack of checking instructions before publishing them.

Note that any of these circumstances may point to a breakdown in the safety culture which must be addressed as a wider issue for the organisation as a whole, or a particular part of it.

Of course, it is possible that the events were triggered by the reckless action of an individual which it was unreasonable for management to foresee. Also, the sequence or combination of underlying causes may have been so unusual that it would not have been reasonably practicable to have foreseen them and taken preventive measures. However, the purpose of the investigation is not to attribute blame, it is to establish all the reasons for the incident and to see if there are any lessons that can be learned for the future.

Identifying Remedial Actions

This is the final stage in the investigation. Having established the immediate and underlying causes of the incident, we have to determine what should be done to prevent the incident, or others with the same underlying causes, from happening again. If an underlying cause is remedied it should not only prevent the particular incident recurring, but also other similar incidents which may arise for the same reason.

Immediate causes are usually quite easy to deal with; for example, replacing a missing guard or telling a worker to use hearing protection. As a response to the immediate cause, it may be necessary to stop the activity or machine, etc., involved until remedial action has been carried out.

Underlying and root causes require management action at different levels, such as:

- Changing working practices; for example, to introduce checking of installers' work before passing it fit for use, or checking the effectiveness of assembly instructions before sending them out

- Improving safety or skills training

- Improving management and supervisory control

- Building a more positive safety culture.

Thus, the investigation of a single incident may lead to the investigation of a range of wider issues underlying the immediate cause and to taking a wide range of actions designed to prevent both the immediate and all the underlying causes being repeated.

REVISION QUESTION 1

(1)   What is the prime purpose of an accident investigation?

(2)   What are the four elements of the investigation process?

(3)   Identify the categories of staff who may be considered useful members of an internal accident investigation team.

(4)   List the types of documentation which may need to be consulted during an accident investigation.

(5)   What are the two categories of immediate cause of accidents/incidents?

The suggested answers are given at the end of the unit.

LEGAL REPORTING REQUIREMENTS

Different countries have different ideas about what constitutes an incident requiring reporting to government appointed agencies. They all agree that fatal accidents must be reported and they are likely to be the only type that are not under-reported. In an earlier unit, we defined the terms used for reportable events: Occupational Accident, Occupational Disease, Dangerous Occurrence. Typical examples of these include respectively chemical splashes involving eye injury, scaffold collapse and occupational cancer through exposure to asbestos.

The International Labour Organisation (ILO) has published several international standards on recommended reporting procedures. The principal reference here is the Protocol to the Occupational Safety and Health Convention 1981 (P155); this greatly expands on the general reporting standards of Article 4 of the Occupational Safety and Health Convention 1981 (C155). It is supported by Recommendation 194 (which lists types of diseases that should be reported to national governments,) and a code of practice. As mentioned in Unit 1, these minimum requirements will have legal effect in any State which has ratified the relevant Convention.

No additional details will be given here that have not already been mentioned in earlier units. Suffice it to say that incidents may have to be reported promptly to external agencies. It is your responsibility to find out what your local government reporting requirements are.

INTERNAL SYSTEMS FOR COLLECTING, ANALYSING AND COMMUNICATING DATA

We have seen that incidents usually have multiple causes, namely the immediate unsafe acts or unsafe conditions which lead directly to the incident; and a series of underlying causes which usually stem from some aspect of management control or effectiveness. All of them must be addressed in order to improve safety performance.

However, not all the information necessary to identify underlying and root causes may be disclosed by the investigation of single incidents. It may only be after analysis of a range of incidents that patterns in, for example, the types, locations and times of accidents may be identified. Thus, the incorrect installation which was a contributory cause of the broken guard we considered earlier may have occurred on a Friday afternoon and, on investigating a range of incidents, it may be the case that there is a pattern of such failings at that time of the week. This may require further investigation to identify the reason and take appropriate action to remedy it.

To enable management and safety specialists to undertake the necessary analysis and identify patterns of incidents, all incidents must be reported and a database of information about their circumstances built up. The basis is a reporting procedure which ensures that the information required is always collected and that it reaches the right people.

Reporting Procedures

The procedure for what to do in the case of an accident or safety-related incident will be laid down in the organisation's safety policy. Its primary objective is to ensure that in each case the causes are identified and appropriate precautions taken to prevent their recurrence.

The procedure will require that all accidents (including near misses) which occur on the premises to a worker, visitor or contractor must be reported to the member of staff with specific responsibility for safety. In large organisations this will be the safety officer, but in smaller workplaces it may be a manager with special responsibilities. Line managers and supervisors are responsible for reporting incidents involving their own staff or within the working areas under their control.

Also, the person involved in the incident has the responsibility of informing his or her supervisor of the incident to enable it to be reported. Indeed, it is in their best interest to do so as the employer must be informed of an accident to enable it to be classified as an industrial accident, and thus to ensure that any future welfare or insurance claims can be dealt with properly.

In the cases of minor incidents, reporting will normally be through the completion of an accident report form. This will note the main details of the incident, such as:

- Significant facts – who, what, when, where, how and why

- Factors that may have contributed to the accident

- Type of injury, part of body injured, severity of injury

- Information about third party contributors to the accident

- On-site first aid or medical service provided, as well as referrals to outside health providers.

Accident report forms must usually be completed and signed by the worker's supervisor immediately following the accident, although after the worker has received all appropriate

attention. Witnesses to the accident may be required to sign written accounts, and any worker who renders first aid to another worker is often required to indicate the type of first aid provided and to give a written account.

In many cases, the report form will cover all the necessary points which relate to identifying causes and remedial action. However, on receipt of the report, the safety officer/manager may decide to conduct a more detailed investigation of the circumstances and causes.

In cases of serious or potentially serious incidents, the safety officer or responsible manager will usually have to be informed immediately so that, if necessary, an investigation can be started before the scene is disturbed. The safety officer/manager will also have to consider whether a reportable incident has occurred and there is a need to inform the enforcement authority. Where investigations are conducted, the procedure will be decided by the nature of the incident and will be designed to cover the principles identified earlier, such as gathering information to establish the facts, identifying immediate and underlying causes, and identifying remedial action to be taken. Accident investigation forms will be used to report the outcomes in summary form; although in certain serious cases, detailed formal published reports may be necessary.

Completed and signed accident report forms and accident investigation forms will normally be collected for review and analysis by the safety officer/manager. He/she will then report conclusions in general (and the outcomes of specific serious incidents) to senior management and, where they exist, the safety committee.

There is no standard form for accident report forms and accident investigation forms, and we provide below four examples of the types of forms used to illustrate the range of approaches.

Sample Accident Report Form 1

SUPERVISOR'S REPORT OF INJURY
Dept: *Name:*   *Date:*
Name of victim *Works No.:*   *Age:*   *Sex:*
Details of injury Date of injury: Time: Nature of injury:
Where and how did accident occur?
Unsafe acts or conditions:
Witnesses:
Corrective/Remedial action
Recommendations

Sample Accident Report Form 2

INCIDENT INVESTIGATION REPORT		
Worker (if involved):		Works No.:
Department:	Section:	
Incident Date:	Time:	Reported Date:
Description of Incident *(including location, witnesses, and circumstances surrounding incident)*		
Actual or possible causal factors		
Corrective/Remedial action		
Signature (worker):		Date
Supervisor's Name		
Signature		Date

Sample Accident Report Form 3 (page 1 of 2)

INJURY REPORT FORM

VICTIM DETAILS

Name:

Department: Works No.:

Age: Sex:

Occupation when injured:

Was this his/her regular occupation?

If not, state regular occupation:

How long employed?

ACCIDENT DETAILS

Date: Time: Place:

Description of how accident happened (include name, part, and plant number of machine or tool involved):

Was part of m/c causing accident properly guarded?

Type of feed: Type of guard:

Was worker following safety rules?

If not, why not?

Was injury result of lack of ordinary care?

If so, how?

Did some other person cause the accident?

If so, how?

How could recurrence be prevented?

Sample Accident Report Form 3 (page 2 of 2)

INJURY DETAILS

Describe injury and part of person injured:

Did victim resume work after medical attention?

If not, was he/she sent home or to hospital?

Home or hospital address:

WITNESSES

Name	Department	Works No

Name of foreman/chargehand in charge of work:

Name of immediate supervisor:

ANY OTHER USEFUL INFORMATION

further description/cause of the accident together with sketch:

Completed by: Position:

Signature: Date:

Sample Accident Report Form 4 (Page 1 of 2)

INJURY REPORT FORM

Name:

Occupation:

Works No.:   Dept:

Date of injury: Time:

Foreman/Chargehand:

Nature of injury:

Immediate cause of injury:

Initial treatment:

Name of first-aider:

Signature: Date

Is further treatment required?   *Yes/No*

Nature of further treatment (if known):

Was the victim sent home or to hospital?

Will injury cause loss of time?   *Yes/No*

Estimated time to be lost:

Sample Accident Report Form 4 (page 2 of 2)

DETAILS OF INJURY	
(tick as appropriate)	
NATURE OF INJURY	**SITE OF INJURY**
WOUNDS: Laceration	Head
Contusion	Face
Puncture	Eyes
Foreign body	Nose
	Teeth
BURNS: Wet heat (scald)	Chin
Dry heat	Ear
Chemical	Neck
Friction	Throat
	Shoulder
SKIN: Dermatitis	Arm
Irritation	Elbow
Rash	Wrist
	Hand
FRACTURE	Fingers
SPRAIN	Thumb
STRAIN	Chest
PAIN	Ribs
POISON	Back
OTHER (detail):	Abdomen
	Hip
	Groin
	Leg
	Thigh
	Knee
	Shin
	Ankle
	Foot
	Instep
	Toe

Analysis of Information

Accident and accident investigation reports should be used as a tool to help develop controls for the underlying causes of accidents and safety-related incidents. Detailed and thorough study of the information they contain should have the following objectives.

- Identifying patterns in the occurrence of accidents/incidents which may indicate common underlying causes; for example, relating to types of machines, activities or people involved, or the location and timing of incidents, etc. These may not be readily apparent from the investigation of single incidents. The reasons for such patterns should be investigated and appropriate remedial action taken.

- Identifying trends in the occurrence of accidents/incidents which indicate changes in the identified patterns; for example, increasing numbers of Friday afternoon accidents or decreasing numbers of incidents involving new workers. Upward trends in a particular pattern of accidents will indicate a need for further investigation and some form of remedial action. Downward trends may indicate the success of remedial action previously taken (such as introducing new safety briefings within induction training).

- Identifying high risk activities, which may indicate deficiencies in existing preventive/precautionary measures and a need to review the hazards and methods of control, for example by undertaking a new risk assessment.

There are several statistical methods and indices which can be used for this, as we have seen elsewhere in the course; for example, frequency and severity ratios or accident triangles.

The data from incident reports may also have to be collated with other information about safety derived from other sources, including:

- Results from risk assessments

- Measurements, such as atmospheric or health monitoring

- Inspection and maintenance records, including legal examinations (such as those relating to scaffolding or lifting equipment)

- Worker suggestions/complaints relating to health and safety

- Minutes of safety meetings.

Health and safety data is often held on computer, which permits rapid analysis of information on a very wide range of indices; for example, numbers and frequency of incidents involving particular machines or particular types of worker. There are many specialist software programs available to handle safety data and most will have the ability to produce automatic reports about certain types of incident patterns; for example, when the numbers of reported incidents involving a particular machine reach a certain frequency, or there are a certain number of incidents at the same time of the week over a period. They are also able to produce information in a form which is suitable for reporting to enforcement agencies.

Using the Information

The purpose of collecting and analysing safety information is to continue the process of identifying causes, which must be related to taking action to prevent any recurrence of the problem. Thus the information must be directed to those responsible for improving safety performance and be presented in a way which meets their needs.

- **Safety committees/meetings**

  Accident and accident investigation information will usually be presented to safety committees in the form of general patterns and trends, where it forms the basis for a review of overall safety performance and the identification of key areas of concern for future action. Specific cases may also be communicated where they are particularly serious or they represent an example of more general issues (such as underlying causes).

- **External enforcement agencies and advisory bodies**

  These people are mainly interested in individual cases where there are serious consequences and there are set procedures (and standard forms) for communicating the information.

- **Managers**

  Information about the outcome of individual investigations should always be fed back to both those involved and the managers responsible (immediate supervisor and more senior manager). In addition, managers must have information about safety performance within their sections/departments, in general terms, in just the same way as they need information about, say, production levels or complaints. It is a measure of effectiveness upon which can be based decisions about improvements necessary and action to be taken. Thus managers will want to know about general trends and particular patterns as they relate to their own areas of responsibility.

  Up-to-date information derived from accident and accident investigation reports also has to be incorporated into management training and safety briefings to ensure that it remains a central concern.

- **Individual Workers**

  Safety information should be widely circulated and all staff should be encouraged to keep abreast of developments. This may be done by newsletters, e-mail circulars, brochures, notices (using dedicated safety noticeboards), etc., which draw attention to both positive improvements which are being achieved and continued failings.

  Training can be used as a tool for encouraging change in safety attitudes and performance where problems of individual or group commitment to safety are shown by analysis of accident information. Safety information also should be a strong feature of induction training.

INFORMATION FOR CIVIL CLAIMS

Civil claims against employers relating to health and safety are fairly widespread. It is often the case that workers, through their own solicitors or supported by trade union lawyers, will pursue a claim against their employer for injuries incurred in the course of their work. There have been a few large and well publicised cases involving work-related stress and WRULDs in recent years, but most are small scale civil claims.

Under these procedures, the employer is required to investigate and provide a response to the claim which, if it denies any aspect of liability, must be supported by documentary evidence. Such information must also be disclosed to the claimant. This will usually be done through the company's lawyers.

The type of information which will be necessary to provide a defence (and may be required by the claimant as well) will come from the safety records we have been discussing:

- Accident reports and accident investigation reports as relevant to the particular incident, possibly including the same documentation in relation to other similar incidents

- Risk assessments relating to the area and type of work within which the claim arises

- Results of any health or atmospheric monitoring, where relevant

- Inspection and maintenance records relating to any machinery or equipment involved in the incident

- Other recent and relevant documentation relating to health and safety in the area and type of work; for example, training records, safety committee reports and minutes, worker complaints, etc.

We can see now how important it is to ensure that all health and safety incidents are properly documented and the records retained.

REVISION QUESTION 2

(1) Who is responsible initially for the reporting of accidents and safety-related incidents?

(2) What is the purpose of analysing all information about accidents?

(3) To whom do the results of accident investigations have to be communicated?

(4) Apart from the accident documentation about the particular incident, what other information may be relevant to a claim for damages in respect of injuries suffered as a result of a chuck guard malfunctioning on a bench press or drilling machine?

The suggested answers are given at the end of the unit.

UNIT SUMMARY

The main purpose of an accident investigation is to establish the cause with the intention of preventing a recurrence. All safety-related incidents, not just accidents, should be investigated.

Accident/incident investigations should begin as soon as possible after the event, although the first priority must be to take care of the victim. The event should be recorded in an accident book and a report form sent to the safety officer. The nature of the investigation will vary, depending on the nature and severity of the incident, but will always involve four elements: establishing the facts, identifying the immediate causes, identifying the underlying causes and identifying remedial action.

Most incidents have both immediate causes in terms of the unsafe acts or unsafe conditions which lead directly to the incident, and underlying causes which are the reasons for the unsafe acts or unsafe conditions occurring. These are always failures of management control.

Establishing the facts of an incident involves collecting and recording evidence about the circumstances of the incident and the actions which occurred. Information about the immediate events will come from witnesses and observation of the scene. Further information, often relating to underlying causes, will come from the study of relevant records, such as risk assessments, inspection and maintenance records, worker complaints, etc.

All this evidence must be documented and kept, as it may be required in the event of any claim for civil liability arising out of the accident.

All the causes, both immediate and underlying, should be addressed in deciding on action to prevent any recurrence of the incident. Resolving underlying causes is likely also to prevent similar incidents in future.

Accident reports and investigations provide the information for more extensive analyses of safety performance and the identification of patterns of incidents, which may indicate further underlying causes.

Incidents may have to be reported to the enforcing authority or other external government agency.

SUGGESTED ANSWERS TO REVISION QUESTIONS

Revision Question 1

(1) The main purpose of an accident investigation is to find the cause, with the intention of preventing a recurrence.

(2) Establishing the facts, identifying immediate causes, identifying any underlying causes and identifying remedial action to prevent the causes from occurring again.

(3) The categories of staff might include the immediate supervisor or foreman, a member of management, a safety representative and a safety officer.

(4) The types of record to be consulted are:

–   Inspection and maintenance records

–   Risk assessments

–   Environmental measurements

–   Medical records

–   General and specific safety reports and analyses which relate to the circumstances

–   Training and other personnel records

–   Minutes of safety committee meetings.

(5) Unsafe acts and unsafe conditions.

Revision Question 2

(1) The first-line manager or supervisor.

(2) To identify underlying causes of accidents and to provide information about trends and other patterns in workplace accidents.

(3) The result of an individual accident investigation would be communicated to the victim, his/her immediate manager and the local safety representative in all instances. Depending on the seriousness of the accident and the extent of the underlying causes, it may also be necessary to inform other managers in the organisation, including senior management, and the safety committee. For reportable incidents, the results must also be notified to the enforcement agency.

(4) The types of information may include:

–   Accident documentation about any other similar incidents

–   Risk assessments relating to drilling work in that particular workplace

–   Inspection and maintenance records relating to the particular guard and to others in the area

–   Other recent and relevant documentation relating to the use of guards, reporting of faults, worker history (including training records), etc.

NEBOSH International General Certificate

Unit 15 | Investigation, Recording and Reporting of Events

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INTRODUCTION

So far we have looked at principles and techniques for preventing or controlling risks. Such measures are very important because they help prevent accidents, and this must be the first concern and duty of an employer. Unfortunately, despite the very best in preventive and control measures, accidents will happen.

The first response to an accident must be to care for the victim. After that, the employer must take steps to find out what happened and act to prevent it from happening again. Accident prevention is based on learning from those accidents and other incidents, so accurate information about them has to be obtained and analysed.

This unit looks at the way in which accidents are investigated and how information about them is used to identify immediate and underlying causes, and used as the basis for taking remedial action. We will also consider the role of such information in actions under civil law, such as negligence, and the requirements for reporting certain types of incident to the enforcement agencies or other government bodies. In doing so, the unit is designed to meet the following aims and learning outcomes as specified by NEBOSH for this part of the syllabus for the International General Certificate.

Overall Aims

On completion of this unit, you will have knowledge and understanding of:

- The need for an organisation to have a system for internally reporting, recording and investigating accidents, cases of work-related ill-health and other occurrences
- Local requirements for notifying certain events to external agencies.

Specific Intended Learning Outcomes

When you have worked through this unit, you will be able to:

- Explain the purpose of and procedures for investigating accidents and other events at work.
- Utilise records of accident and ill-health experience in an organisation.
- Explain the local requirements for notifying events to external agencies.

ROLE AND FUNCTION OF ACCIDENT AND INCIDENT INVESTIGATION

We have seen earlier undesired and unplanned events at work can give rise to incidents, which are any events the outcome of which may (but may not) cause harm to people and/or loss. Accidents are a particular type of incident which may result in loss, personal (minor) injury, serious injury or death. Where no such outcome results, the incident is classified as a near miss. Certain types of incidents, including accidents, may also be reportable to government organisations.

Since any incident could cause a fatality, a serious injury, a minor injury or just a near miss, all incidents should be investigated, not just accidents. The main purpose of an investigation is to find the cause, with the intention of preventing a recurrence, rather than to find somebody to blame.

Each accident or incident should be investigated as an individual event. However, looking at all the incidents which may have taken place at work may indicate that some appear to be linked; for example, the history of a number of similar incidents may indicate a trend of certain types of accident or failures of particular safety devices. So it is important to consider the particulars of the current incident and also to see if it fits a pattern with others. This means that the results of all investigations must be summarised and analysed, usually using statistical methods.

For the organisation, the main purpose of incident investigation and reporting is to prevent them from happening again by dealing with the issues identified as the immediate and underlying causes. This may include introducing new safeguards, procedures, training and information, or any combination of them. However, other people outside of the organisation may have different reasons for investigating incidents; for example:

- Enforcement agencies look for evidence of an offence and to identify those responsible (i.e. to blame)

- Insurance claims assessors look for evidence of liability.

In addition, governments are interested in obtaining general information on where and how certain types of incident and accident happen, to enable them to advise on preventive action and identify priorities for future legislation. As a result, certain types of incident are usually reportable to government agencies.

There are two aspects to the role of investigations:

- The investigation itself – inspecting the scene of the incident, interviewing those involved and other witnesses, drawing conclusions as to the causes and identifying action to prevent a recurrence.

- The reporting of both the incident and the results of the investigation, both within the organisation and to outside agencies such as the enforcing authorities.

BASIC ACCIDENT INVESTIGATION PROCEDURES

An investigation may be carried out by a single person or a team, depending on the nature and severity of the incident and its consequences. So, for example, the investigation of an accident using a machine guard on a grinder may be dealt with quickly by the supervisor on the spot, whereas a train crash will involve a large team of experts working for many weeks. In principle, though, both types of investigation go through the same process:

- Establishing the facts

- Identifying immediate causes

- Identifying any underlying causes; i.e. why were the immediate causes there?

- Identifying remedial action to prevent the causes from happening again.

Who Investigates?

The investigation should be conducted by or under the supervision of a competent person. This would be someone with knowledge and skills of the specific working environment in which the incident occurred, and who understands the nature of the safety requirements. There will be several people who might fill this role, depending on the nature and severity of the incident:

- **The immediate supervisor or foreman**

  Most minor incidents can be investigated and resolved effectively by the supervisor. He/she is on the spot and knows the situation, people and work involved better than anyone else. The supervisor also has an interest in sorting out the causes of accidents because it can have an effect on the efficiency and morale of the workforce.

- **A member of management**

  If the incident has implications wider than the immediate workplace, a more senior manager may have to be brought in to oversee or conduct the investigation. This may be because of the particular nature of the incident (such as involving a bad injury), or perhaps because the causes are more serious or the type of incident seems to fit a pattern.

- **A safety representative and/or an workers' representative**

  The staff representative must normally be told by management where a manager is involved in the investigation and in more serious cases the representative may actually be involved in the investigation itself.

- **A safety officer or one of his staff**

  The safety officer will be involved in more serious incidents where his/her expertise may be necessary. The safety officer will normally be in charge of the investigation, but will have to work through the supervisor and perhaps a number of safety and management personnel.

Establishing the Facts

The first task of the investigation is to find out what happened. The process of gathering evidence should begin as soon as possible.

Someone, usually the immediate supervisor, should assume responsibility for dealing with the consequences of the incident. The first priority should be to treat the victim(s) and secure the

area from further danger. After that, the circumstances should be observed and recorded, and any immediate evidence collected, both physical and from witnesses. In all serious accidents, and in all other cases where practicable, conditions at the accident or incident scene should remain undisturbed until they have been fully investigated. On occasions the site may have to be made safe, but otherwise left undisturbed for investigation by outside agencies; e.g. the police. The investigation should also cover clearing-up operations and reinstatement, as further evidence may emerge.

In the case of fire investigations it is useful if the investigator can safely be present during the fire or as soon as possible after it has been extinguished. The exact area in which the fire started may be more readily apparent, although it may be obscured by smoke, and heat may prevent access to the building. In such cases, it may be possible to gain useful information by watching the activities of the fire-fighters or by photographing the course of the fire.

Interviewing Witnesses

It is best to carry out interviews at the scene of the accident when possible, because it is generally easier for those involved to communicate better with the scene close at hand. It is usually much easier to explain clearly what happened if witnesses can point out specific things and recall their actions on the incident site.

There are three types of witness:

- Primary witnesses – those involved directly in the incident, including any victim(s). When an accident happens where someone is injured, the first priority should be treatment of the victim or victims. However, they and any others directly involved should always be the first to be interviewed. Where a victim's condition is such that immediate questioning is not possible, the interview should be delayed until the person has sufficiently recovered, but the initial stage of the investigation cannot be concluded until this has been done.

- Secondary witnesses – those who saw the incident. Eye-witness statements are best collected as soon as possible after the incident, whilst the details are fresh in mind.

- Tertiary witnesses – those who did not see the incident but can verify certain information about the actions of people or about aspects of the circumstances. This may include providing collaboration of other witness statements.

Witness interviews should be conducted with tact and care. The purpose should be to ascertain as much information about the incident as possible and witnesses should be encouraged to talk freely about all aspects of the particular incident and any other relevant matter. They should be assured that the purpose of the interview is not to blame anyone but to attempt to find out the cause and so reduce the possibility of it happening again.

It is important not to prejudge or assume your conclusions; allow witnesses to explain what happened from their own viewpoint, even where this conflicts with what appear to be the facts or with other witness statements. It may only be possible to find out exactly what happened after looking at all the different opinions and viewpoints. For this reason, in more serious cases it may be necessary to advise witnesses not to discuss the incident amongst themselves as they may influence each other's observations and judgment.

It is best to follow a procedure when interviewing by starting with "what" questions and then working through "where", "when", "how" and "who" before ending with the "why" questions:

- What happened? – What did you see? – What time was it?

- Where were you at the time? – Where was the victim?

- When did you realise something was wrong?

- How did it happen? – How were you involved? – How could it have been prevented?

- Who else was involved? – Who else saw it? – Who reported it?

- Why do you think it happened?

Starting with the "why" questions may seem aggressive and put a witness on the defensive or even antagonise him/her, so they should be lead up to by preliminary questioning about the facts.

When each witness's account of an accident has been heard, the investigator should repeat it back to the witness to make sure that the account has been fully understood before it is officially recorded. This also allows the witness to check and clarify any aspects.

When the investigator and the witness are both satisfied that a true account has been given, the interview should be finished on a positive note. This may be achieved by discussing any ideas the witness might have regarding prevention of a similar occurrence. It will also serve to repeat the purpose of the interview and encourage his/her further co-operation, if necessary.

Plans and Photographs

The physical layout should be recorded graphically through the use of plans, figures and diagrams, and by photographs.

Plans and diagrams should be used to show:

- The location of all the people involved (including all witnesses), together with their actions and movements

- The position and movement of all relevant objects, such as vehicles, machinery and equipment, etc.

- The extent and severity of the damage, both in the immediate and surrounding areas; for example, the main locations and the extent of splashes from a spillage.

The plans should also make clear any environmental conditions which may have had some bearing on the incident, such as temperature, ventilation, humidity and lighting (particularly glare).

All this information may have to be very precise, depending on the nature and severity of the incident. Thus, the plans may have to be marked to show such physical measurements as:

- Noise levels

- Light levels

- Substances involved, from samples analysed in a laboratory if necessary

- Electrical current/voltage flow levels

- Speeds of vehicles or the moving parts of machines

- Distances involved – for example, reach distances, size of openings, etc.

Photographs or video recordings can be very useful. These should show both general and close up views of the area from a range of different vantage points. They should particularly record any irregularities which may have contributed to the incident; for example, destroyed

appliances, overturned containers, absence of machine guards. They should also record any aspects of the clear-up and reinstatement operation, as new evidence may come to light, for example when rubble and fallen equipment is removed.

Relevant Records

If the investigation starts after the incident has happened and the immediate effects have been dealt with, the first record to be consulted should be the entry in the accident book. All organisations should have an accident book in which the basic details of accidents are recorded at the time they happen. This is only the first relevant document and should not be considered to be the definitive statement of what happened.

Any further existing information about the people, plant and machinery involved in the incident, and environment in which it occurred, should also be examined for any light that it can shed on the causes. There is likely to be a wealth of evidence available, including the following types of record:

- Inspection and maintenance records – All plant, machinery and equipment work should be examined and maintained on a regular basis. For those items which are inherently dangerous or which are crucial to maintaining safety, this should be in accordance with a planned programme. The inspection and maintenance records completed after each examination and, where necessary, servicing and repair, should provide a detailed history of the equipment, etc. involved.

- Risk assessments – The latest risk assessments covering the workplace involved should be examined to find out if the circumstances of the incident had been foreseen and whether any actions had been identified for dealing with it.

- Environmental measurements – for example, any measurements of workplace agents, such as noise levels, levels of airborne contaminants, etc., taken before, at the time of and after the incident.

- Medical records – The existing medical history of the victim may be relevant, particularly in relation to any occupational health monitoring undertaken due to workplace risks (such as radiation monitoring).

- General and specific safety reports and analyses which relate to the circumstances; for example, safety audits and formal in-depth inspections undertaken as part of safety sampling programmes.

- Training and other personnel records – These should provide relevant history about the individual workers involved, including their experience, level of training and involvement in any previous incidents, etc.

- Minutes of safety meetings – These may reveal previous discussions about relevant issues.

Checklists

In any organisation it is a requirement that all accidents and many types of incident are reported to management and, as we shall see later, there are usually specific forms for doing this. They will list key points which must be investigated, such as:

- What actually happened

- The nature of any injury or damage

- What inflicted the injury or damage

- What caused the accident, that is the physical conditions and what people did

- Who had control of the cause of the injury or damage.

Depending on the nature of the workplace and the operations undertaken, such checklists of investigatory points may be more or less detailed. For example, the general nature of the above list may be sufficient in low risk workplaces such as an office; but in a machine shop there may be very detailed points to cover, such as the position of machinery controls, floor conditions, lighting levels, etc.

Identifying Immediate Causes

Accident reports tend to concentrate on the cause of the injury, but the purpose of the investigation is identifying the cause of the incident. They are not necessarily the same thing; for example, the cause of an injury may be slipping on a wet floor, but the cause of the accident may be in neglecting to put up a barrier to prevent people walking on the hazardous surface.

The first priority of the investigation is to identify the immediate, direct cause of the incident because there is a risk that the same circumstances may occur again and steps must be taken to ensure that there is no repetition of the problem.

Accidents are caused, at least in the first instance, by unsafe acts on the part of people and/or unsafe conditions in respect of the machinery and equipment used, working practices or the application of control measures. Whilst there might be an underlying reason for these acts or conditions, it is important to establish exactly what has caused the incident.

- **Unsafe acts**

  These are where the actions (or omissions of action) of people in the workplace directly cause, or contribute to, the incident. They include the following types of action or omission (sometimes referred to as active or passive unsafe acts):

  – Operating without permission or in direct contravention of specific rules

  – Operating or working at unsafe speed, for example rushing, either in the use of machinery or in the person's own movements

  – Not using safety devices or rendering them inoperative

  – Knowingly using unsafe equipment

  – Using equipment in an unsafe manner; for example, not for its intended purpose or with reckless regard to safety

  – Using unsafe methods of work; for example, not following established safe systems

  – Adopting an unsafe position or posture; for example, when lifting or carrying objects

  – Failure to wear safe clothing or personal protective devices

  – Acting in a reckless manner; for example talking to or distracting, teasing or startling a colleague

  – Not reporting safety-related incidents, such as inoperative guards or minor accidents

  – Working whilst under the influence of alcohol or drugs, or when unfit due to fatigue or ill-health.

- **Unsafe conditions**

  These are where the physical conditions at the workplace, or the methods of work, directly cause or contribute to the incident. They include the following circumstances:

  – Unguarded machinery, or the absence of the required guards

  – Inadequate guarding; for example, guards of inadequate height, strength, mesh, etc.

  – The provision of unsafe equipment, because it is defective or improperly maintained

  – Unsafe floors and working surfaces; for example, slippery, decayed or cracked surfaces

  – Unsafe systems of work; for example, where the working processes and practices which are required to be followed put workers in danger

  – Unsafe PPE; not providing, or providing inadequate, clothing, goggles, gloves or masks, etc.

  – Inadequate housekeeping, resulting in accumulations of waste materials or dirt, blocked traffic routes (particularly emergency exits), etc.

  – Unsafe layout and design of the workplace; for example, poor lay-out of pedestrian and traffic routes resulting in congestion, or inadequate space at workstations

  – Unsafe environmental conditions, including inadequate lighting or excessive glare and reflection, inadequate ventilation, excessive noise, inappropriate working temperatures or humidity, etc.

Identifying the Root or Underlying Causes

This part of the investigation asks why the immediate causes occurred and what brought about the unsafe acts/omissions or the unsafe conditions.

It is not enough simply to establish the immediate cause of the incident and prevent that happening again; for example, a broken guard can be repaired. We have to know if there is a reason for the immediate cause, such as why did the guard break? If there are underlying reasons for the immediate cause, they must also be remedied to prevent the same circumstances occurring again. So, for example, if the guard that broke had not been inspected as required the week before, that may be a contributory reason. Or there may be a suspected defect in its installation. Then we have to explore the reason for these underlying causes, to find out why the inspection programme was not followed or why the installation was not carried out correctly; because if these are not corrected, there is a possibility of the same thing happening. This process of investigating the reason for each underlying cause goes on until the real root of the problem is established.

Consider another example. If a pipe fails and the cause is said to be corrosion, we must follow the trail of underlying causes by asking more questions:

- Was the material of construction specified correctly?

- Was the specified material actually used?

- Were operating conditions the same as those assumed by the designers?

- What corrosion monitoring did they ask for?

- Was it carried out?

- Were the results ignored?

And so on.

When we track back through the underlying causes, what we always find are more unsafe acts (or very often, omissions) by people and/or more unsafe conditions. All of these factors must be addressed, but at the heart of all investigations is a failure in management control.

It is the employer's responsibility to ensure the safety of the workplace, and it is part of management's role to carry it out. If the workplace is unsafe it must be management's responsibility, either for not establishing the appropriate controls or for failing to make sure that the established controls were effective at all times.

In most circumstances it is possible to identify a management failure which requires correcting in order to prevent the same or similar events from happening again. So, in respect of the example of the broken guard from above, the following root causes may be established:

- The failure to inspect may be the result of the supervisor being on holiday and no-one else carrying out the inspection in her absence, which is a failure in management organisation.

- Or it may be the result of a lack of understanding of the importance of inspection by the supervisor concerned, which is a failure in supervisory safety training, a management responsibility, and in the management of the individual supervisor.

- The failure to install the guard properly may be due to a mistake by the installer, which itself may be the result of a failure in training or recruitment processes, which again are management responsibilities.

- Or it may be because the instructions for fitting the guard were incorrect or confusing, which may be the fault of the supplier, which itself should then be investigated and the root cause identified, perhaps as a lack of checking instructions before publishing them.

Note that any of these circumstances may point to a breakdown in the safety culture which must be addressed as a wider issue for the organisation as a whole, or a particular part of it.

Of course, it is possible that the events were triggered by the reckless action of an individual which it was unreasonable for management to foresee. Also, the sequence or combination of underlying causes may have been so unusual that it would not have been reasonably practicable to have foreseen them and taken preventive measures. However, the purpose of the investigation is not to attribute blame, it is to establish all the reasons for the incident and to see if there are any lessons that can be learned for the future.

Identifying Remedial Actions

This is the final stage in the investigation. Having established the immediate and underlying causes of the incident, we have to determine what should be done to prevent the incident, or others with the same underlying causes, from happening again. If an underlying cause is remedied it should not only prevent the particular incident recurring, but also other similar incidents which may arise for the same reason.

Immediate causes are usually quite easy to deal with; for example, replacing a missing guard or telling a worker to use hearing protection. As a response to the immediate cause, it may be necessary to stop the activity or machine, etc., involved until remedial action has been carried out.

Underlying and root causes require management action at different levels, such as:

- Changing working practices; for example, to introduce checking of installers' work before passing it fit for use, or checking the effectiveness of assembly instructions before sending them out

- Improving safety or skills training

- Improving management and supervisory control

- Building a more positive safety culture.

Thus, the investigation of a single incident may lead to the investigation of a range of wider issues underlying the immediate cause and to taking a wide range of actions designed to prevent both the immediate and all the underlying causes being repeated.

REVISION QUESTION 1

(1)   What is the prime purpose of an accident investigation?

(2)   What are the four elements of the investigation process?

(3)   Identify the categories of staff who may be considered useful members of an internal accident investigation team.

(4)   List the types of documentation which may need to be consulted during an accident investigation.

(5)   What are the two categories of immediate cause of accidents/incidents?

The suggested answers are given at the end of the unit.

LEGAL REPORTING REQUIREMENTS

Different countries have different ideas about what constitutes an incident requiring reporting to government appointed agencies. They all agree that fatal accidents must be reported and they are likely to be the only type that are not under-reported. In an earlier unit, we defined the terms used for reportable events: Occupational Accident, Occupational Disease, Dangerous Occurrence. Typical examples of these include respectively chemical splashes involving eye injury, scaffold collapse and occupational cancer through exposure to asbestos.

The International Labour Organisation (ILO) has published several international standards on recommended reporting procedures. The principal reference here is the Protocol to the Occupational Safety and Health Convention 1981 (P155); this greatly expands on the general reporting standards of Article 4 of the Occupational Safety and Health Convention 1981 (C155). It is supported by Recommendation 194 (which lists types of diseases that should be reported to national governments,) and a code of practice. As mentioned in Unit 1, these minimum requirements will have legal effect in any State which has ratified the relevant Convention.

No additional details will be given here that have not already been mentioned in earlier units. Suffice it to say that incidents may have to be reported promptly to external agencies. It is your responsibility to find out what your local government reporting requirements are.

INTERNAL SYSTEMS FOR COLLECTING, ANALYSING AND COMMUNICATING DATA

We have seen that incidents usually have multiple causes, namely the immediate unsafe acts or unsafe conditions which lead directly to the incident; and a series of underlying causes which usually stem from some aspect of management control or effectiveness. All of them must be addressed in order to improve safety performance.

However, not all the information necessary to identify underlying and root causes may be disclosed by the investigation of single incidents. It may only be after analysis of a range of incidents that patterns in, for example, the types, locations and times of accidents may be identified. Thus, the incorrect installation which was a contributory cause of the broken guard we considered earlier may have occurred on a Friday afternoon and, on investigating a range of incidents, it may be the case that there is a pattern of such failings at that time of the week. This may require further investigation to identify the reason and take appropriate action to remedy it.

To enable management and safety specialists to undertake the necessary analysis and identify patterns of incidents, all incidents must be reported and a database of information about their circumstances built up. The basis is a reporting procedure which ensures that the information required is always collected and that it reaches the right people.

Reporting Procedures

The procedure for what to do in the case of an accident or safety-related incident will be laid down in the organisation's safety policy. Its primary objective is to ensure that in each case the causes are identified and appropriate precautions taken to prevent their recurrence.

The procedure will require that all accidents (including near misses) which occur on the premises to a worker, visitor or contractor must be reported to the member of staff with specific responsibility for safety. In large organisations this will be the safety officer, but in smaller workplaces it may be a manager with special responsibilities. Line managers and supervisors are responsible for reporting incidents involving their own staff or within the working areas under their control.

Also, the person involved in the incident has the responsibility of informing his or her supervisor of the incident to enable it to be reported. Indeed, it is in their best interest to do so as the employer must be informed of an accident to enable it to be classified as an industrial accident, and thus to ensure that any future welfare or insurance claims can be dealt with properly.

In the cases of minor incidents, reporting will normally be through the completion of an accident report form. This will note the main details of the incident, such as:

- Significant facts – who, what, when, where, how and why

- Factors that may have contributed to the accident

- Type of injury, part of body injured, severity of injury

- Information about third party contributors to the accident

- On-site first aid or medical service provided, as well as referrals to outside health providers.

Accident report forms must usually be completed and signed by the worker's supervisor immediately following the accident, although after the worker has received all appropriate

attention. Witnesses to the accident may be required to sign written accounts, and any worker who renders first aid to another worker is often required to indicate the type of first aid provided and to give a written account.

In many cases, the report form will cover all the necessary points which relate to identifying causes and remedial action. However, on receipt of the report, the safety officer/manager may decide to conduct a more detailed investigation of the circumstances and causes.

In cases of serious or potentially serious incidents, the safety officer or responsible manager will usually have to be informed immediately so that, if necessary, an investigation can be started before the scene is disturbed. The safety officer/manager will also have to consider whether a reportable incident has occurred and there is a need to inform the enforcement authority. Where investigations are conducted, the procedure will be decided by the nature of the incident and will be designed to cover the principles identified earlier, such as gathering information to establish the facts, identifying immediate and underlying causes, and identifying remedial action to be taken. Accident investigation forms will be used to report the outcomes in summary form; although in certain serious cases, detailed formal published reports may be necessary.

Completed and signed accident report forms and accident investigation forms will normally be collected for review and analysis by the safety officer/manager. He/she will then report conclusions in general (and the outcomes of specific serious incidents) to senior management and, where they exist, the safety committee.

There is no standard form for accident report forms and accident investigation forms, and we provide below four examples of the types of forms used to illustrate the range of approaches.

Sample Accident Report Form 1

SUPERVISOR'S REPORT OF INJURY
Dept: *Name:*   *Date:*
Name of victim *Works No.:*   *Age:*   *Sex:*
Details of injury Date of injury: Time: Nature of injury:
Where and how did accident occur?
Unsafe acts or conditions:
Witnesses:
Corrective/Remedial action
Recommendations

Sample Accident Report Form 2

INCIDENT INVESTIGATION REPORT	
Worker (if involved):	Works No.:
Department:	Section:
Incident Date: Time:	Reported Date:
Description of Incident *(including location, witnesses, and circumstances surrounding incident)*	
Actual or possible causal factors	
Corrective/Remedial action	
Signature (worker):	Date
Supervisor's Name	
Signature	Date

Sample Accident Report Form 3 (page 1 of 2)

INJURY REPORT FORM

VICTIM DETAILS

Name:

Department: Works No.:

Age: Sex:

Occupation when injured:

Was this his/her regular occupation?

If not, state regular occupation:

How long employed?

ACCIDENT DETAILS

Date: Time: Place:

Description of how accident happened (include name, part, and plant number of machine or tool involved):

Was part of m/c causing accident properly guarded?

Type of feed: Type of guard:

Was worker following safety rules?

If not, why not?

Was injury result of lack of ordinary care?

If so, how?

Did some other person cause the accident?

If so, how?

How could recurrence be prevented?

Sample Accident Report Form 3 (page 2 of 2)

INJURY DETAILS

Describe injury and part of person injured:

Did victim resume work after medical attention?

If not, was he/she sent home or to hospital?

Home or hospital address:

WITNESSES

Name	Department	Works No

Name of foreman/chargehand in charge of work:

Name of immediate supervisor:

ANY OTHER USEFUL INFORMATION

further description/cause of the accident together with sketch:

Completed by: Position:

Signature: Date:

Sample Accident Report Form 4 (Page 1 of 2)

INJURY REPORT FORM
Name: Occupation: Works No.:   Dept: Date of injury: Time: Foreman/Chargehand:
Nature of injury:
Immediate cause of injury:
Initial treatment:
Name of first-aider: Signature: Date
Is further treatment required?   *Yes/No* Nature of further treatment (if known): Was the victim sent home or to hospital? Will injury cause loss of time?   *Yes/No* Estimated time to be lost:

Sample Accident Report Form 4 (page 2 of 2)

DETAILS OF INJURY *(tick as appropriate)*	
NATURE OF INJURY	**SITE OF INJURY**

WOUNDS: Laceration
 	
             Contusion
 	
             Puncture
 	
             Foreign body
 	
BURNS: Wet heat (scald)
 	
             Dry heat
 	
             Chemical
 	
             Friction
 	
SKIN: Dermatitis
 	
             Irritation
 	
             Rash
 	
FRACTURE
 	
SPRAIN
 	
STRAIN
 	
PAIN
 	
POISON
 	
OTHER (detail):
	Head
	
	Face
	
	Eyes
	
	Nose
	
	Teeth
	
	Chin
	
	Ear
	
	Neck
	
	Throat
	
	Shoulder
	
	Arm
	
	Elbow
	
	Wrist
	
	Hand
	
	Fingers
	
	Thumb
	
	Chest
	
	Ribs
	
	Back
	
	Abdomen
	
	Hip
	
	Groin
	
	Leg
	
	Thigh
	
	Knee
	
	Shin
	
	Ankle
	
	Foot
	
	Instep
	
	Toe

Analysis of Information

Accident and accident investigation reports should be used as a tool to help develop controls for the underlying causes of accidents and safety-related incidents. Detailed and thorough study of the information they contain should have the following objectives.

- Identifying patterns in the occurrence of accidents/incidents which may indicate common underlying causes; for example, relating to types of machines, activities or people involved, or the location and timing of incidents, etc. These may not be readily apparent from the investigation of single incidents. The reasons for such patterns should be investigated and appropriate remedial action taken.

- Identifying trends in the occurrence of accidents/incidents which indicate changes in the identified patterns; for example, increasing numbers of Friday afternoon accidents or decreasing numbers of incidents involving new workers. Upward trends in a particular pattern of accidents will indicate a need for further investigation and some form of remedial action. Downward trends may indicate the success of remedial action previously taken (such as introducing new safety briefings within induction training).

- Identifying high risk activities, which may indicate deficiencies in existing preventive/precautionary measures and a need to review the hazards and methods of control, for example by undertaking a new risk assessment.

There are several statistical methods and indices which can be used for this, as we have seen elsewhere in the course; for example, frequency and severity ratios or accident triangles.

The data from incident reports may also have to be collated with other information about safety derived from other sources, including:

- Results from risk assessments

- Measurements, such as atmospheric or health monitoring

- Inspection and maintenance records, including legal examinations (such as those relating to scaffolding or lifting equipment)

- Worker suggestions/complaints relating to health and safety

- Minutes of safety meetings.

Health and safety data is often held on computer, which permits rapid analysis of information on a very wide range of indices; for example, numbers and frequency of incidents involving particular machines or particular types of worker. There are many specialist software programs available to handle safety data and most will have the ability to produce automatic reports about certain types of incident patterns; for example, when the numbers of reported incidents involving a particular machine reach a certain frequency, or there are a certain number of incidents at the same time of the week over a period. They are also able to produce information in a form which is suitable for reporting to enforcement agencies.

Using the Information

The purpose of collecting and analysing safety information is to continue the process of identifying causes, which must be related to taking action to prevent any recurrence of the problem. Thus the information must be directed to those responsible for improving safety performance and be presented in a way which meets their needs.

- **Safety committees/meetings**

  Accident and accident investigation information will usually be presented to safety committees in the form of general patterns and trends, where it forms the basis for a review of overall safety performance and the identification of key areas of concern for future action. Specific cases may also be communicated where they are particularly serious or they represent an example of more general issues (such as underlying causes).

- **External enforcement agencies and advisory bodies**

  These people are mainly interested in individual cases where there are serious consequences and there are set procedures (and standard forms) for communicating the information.

- **Managers**

  Information about the outcome of individual investigations should always be fed back to both those involved and the managers responsible (immediate supervisor and more senior manager). In addition, managers must have information about safety performance within their sections/departments, in general terms, in just the same way as they need information about, say, production levels or complaints. It is a measure of effectiveness upon which can be based decisions about improvements necessary and action to be taken. Thus managers will want to know about general trends and particular patterns as they relate to their own areas of responsibility.

  Up-to-date information derived from accident and accident investigation reports also has to be incorporated into management training and safety briefings to ensure that it remains a central concern.

- **Individual Workers**

  Safety information should be widely circulated and all staff should be encouraged to keep abreast of developments. This may be done by newsletters, e-mail circulars, brochures, notices (using dedicated safety noticeboards), etc., which draw attention to both positive improvements which are being achieved and continued failings.

  Training can be used as a tool for encouraging change in safety attitudes and performance where problems of individual or group commitment to safety are shown by analysis of accident information. Safety information also should be a strong feature of induction training.

INFORMATION FOR CIVIL CLAIMS

Civil claims against employers relating to health and safety are fairly widespread. It is often the case that workers, through their own solicitors or supported by trade union lawyers, will pursue a claim against their employer for injuries incurred in the course of their work. There have been a few large and well publicised cases involving work-related stress and WRULDs in recent years, but most are small scale civil claims.

Under these procedures, the employer is required to investigate and provide a response to the claim which, if it denies any aspect of liability, must be supported by documentary evidence. Such information must also be disclosed to the claimant. This will usually be done through the company's lawyers.

The type of information which will be necessary to provide a defence (and may be required by the claimant as well) will come from the safety records we have been discussing:

- Accident reports and accident investigation reports as relevant to the particular incident, possibly including the same documentation in relation to other similar incidents

- Risk assessments relating to the area and type of work within which the claim arises

- Results of any health or atmospheric monitoring, where relevant

- Inspection and maintenance records relating to any machinery or equipment involved in the incident

- Other recent and relevant documentation relating to health and safety in the area and type of work; for example, training records, safety committee reports and minutes, worker complaints, etc.

We can see now how important it is to ensure that all health and safety incidents are properly documented and the records retained.

REVISION QUESTION 2

(1)   Who is responsible initially for the reporting of accidents and safety-related incidents?

(2)   What is the purpose of analysing all information about accidents?

(3)   To whom do the results of accident investigations have to be communicated?

(4)   Apart from the accident documentation about the particular incident, what other information may be relevant to a claim for damages in respect of injuries suffered as a result of a chuck guard malfunctioning on a bench press or drilling machine?

The suggested answers are given at the end of the unit.

UNIT SUMMARY

The main purpose of an accident investigation is to establish the cause with the intention of preventing a recurrence. All safety-related incidents, not just accidents, should be investigated.

Accident/incident investigations should begin as soon as possible after the event, although the first priority must be to take care of the victim. The event should be recorded in an accident book and a report form sent to the safety officer. The nature of the investigation will vary, depending on the nature and severity of the incident, but will always involve four elements: establishing the facts, identifying the immediate causes, identifying the underlying causes and identifying remedial action.

Most incidents have both immediate causes in terms of the unsafe acts or unsafe conditions which lead directly to the incident, and underlying causes which are the reasons for the unsafe acts or unsafe conditions occurring. These are always failures of management control.

Establishing the facts of an incident involves collecting and recording evidence about the circumstances of the incident and the actions which occurred. Information about the immediate events will come from witnesses and observation of the scene. Further information, often relating to underlying causes, will come from the study of relevant records, such as risk assessments, inspection and maintenance records, worker complaints, etc.

All this evidence must be documented and kept, as it may be required in the event of any claim for civil liability arising out of the accident.

All the causes, both immediate and underlying, should be addressed in deciding on action to prevent any recurrence of the incident. Resolving underlying causes is likely also to prevent similar incidents in future.

Accident reports and investigations provide the information for more extensive analyses of safety performance and the identification of patterns of incidents, which may indicate further underlying causes.

Incidents may have to be reported to the enforcing authority or other external government agency.

SUGGESTED ANSWERS TO REVISION QUESTIONS

Revision Question 1

(1) The main purpose of an accident investigation is to find the cause, with the intention of preventing a recurrence.

(2) Establishing the facts, identifying immediate causes, identifying any underlying causes and identifying remedial action to prevent the causes from occurring again.

(3) The categories of staff might include the immediate supervisor or foreman, a member of management, a safety representative and a safety officer.

(4) The types of record to be consulted are:

– Inspection and maintenance records

– Risk assessments

– Environmental measurements

– Medical records

– General and specific safety reports and analyses which relate to the circumstances

– Training and other personnel records

– Minutes of safety committee meetings.

(5) Unsafe acts and unsafe conditions.

Revision Question 2

(1) The first-line manager or supervisor.

(2) To identify underlying causes of accidents and to provide information about trends and other patterns in workplace accidents.

(3) The result of an individual accident investigation would be communicated to the victim, his/her immediate manager and the local safety representative in all instances. Depending on the seriousness of the accident and the extent of the underlying causes, it may also be necessary to inform other managers in the organisation, including senior management, and the safety committee. For reportable incidents, the results must also be notified to the enforcement agency.

(4) The types of information may include:

– Accident documentation about any other similar incidents

– Risk assessments relating to drilling work in that particular workplace

– Inspection and maintenance records relating to the particular guard and to others in the area

– Other recent and relevant documentation relating to the use of guards, reporting of faults, worker history (including training records), etc.

NEBOSH International General Certificate

Unit 16 | Monitoring, Review and Audit

Contents

INTRODUCTION

All safety arrangements must be monitored to ensure that they are operating as intended and that they are achieving their objectives. This monitoring process, which covers review, assessment and, when necessary, amendment, applies to the systems for planning and organising controls as much as to the actual procedures and measures taken to control hazards.

Here we will look at the types of monitoring which take place in organisations. We have already examined reactive monitoring, which is the investigation and analysis of accidents and other incidents with a view to identifying the problems which caused them. Now, whilst reviewing the role of reactive monitoring, we will concentrate on active methods. These involve measures to check how arrangements are operating in practice, including the management systems which ensure compliance with safety procedures. The main measures we shall consider are workplace inspections, safety sampling, performance review in general and safety audits.

In doing so, the unit is designed to meet the following aims and learning outcomes as specified by NEBOSH for this part of the syllabus for the International General Certificate.

Overall Aims

On completion of this unit, you will have knowledge and understanding of:

- Active and reactive health and safety monitoring procedures

- The scope and nature of a health and safety audit.

Specific Intended Learning Outcomes

When you have worked through this unit, you will be able to:

- Use a variety of active and reactive monitoring procedures

- Carry out a workplace inspection in order to set priorities and time scales for action and to assign action points to relevant personnel

- Communicate inspection findings in the form of an effective and persuasive report

- Differentiate between safety inspections, sampling and tours and explain their roles within a monitoring regime

- Explain the purpose of regular reviews of health and safety performance, the means by which reviews might be undertaken and the criteria that will influence the frequency of such reviews

- Explain the meaning of the term "health and safety audit" and describe the preparations that may be needed prior to an audit and the information that may be needed during an audit.

ACTIVE MONITORING

There are two approaches to monitoring health and safety:

- **Reactive monitoring** – where accidents and other safety-related incidents are investigated to find out what went wrong and identify action to put it right so that there will be no recurrence.

- **Active monitoring** – where the existing safety measures are inspected to find out if anything may go wrong and identify action to put it right before there is an incident.

Reactive monitoring takes place in response to, and after, an event whereas active monitoring takes place before any event has happened. Both have their place. With the best systems and procedures, accidents will sometimes happen. In that case we have to find out what the causes are (immediate and underlying) and correct them. Active monitoring seeks to ensure that the chances of an accident happening are minimised by checking that the potential causes are being properly controlled.

The main focus of active measures are the methods of control, such as the protective devices, the safe systems of work, maintenance procedures, etc., together with the management of those methods. The approach is to check that they are all working properly and providing the protection against risks that they were designed to do, and that they meet all the necessary technical and legislative standards.

Active monitoring can be seen as the means of assessing the effectiveness of the organisation's safety policy. As we discussed earlier, the safety policy sets out:

- The organisational framework of roles and responsibilities through which health and safety matters are addressed

- The working arrangements for the identification of hazards and risks, and the precautionary and preventive measures taken to control those risks.

So we see that active monitoring is the essential final element of the policy which measures the effectiveness of the organisation and arrangements it specifies, and provides the basis for remedying any shortcomings.

Performance Standards

The basis of planning the arrangements for health and safety is the risk assessment. Risk assessment provides the means for identifying new issues for control and ensuring that the existing measures are effective. The controls which are put in place will be specified as written "performance standards" comprising, for each risk, a statement of:

- What has to be done – physical aspects of the working process (such as noise/dust/light levels, containment measures) and/or certain actions which are required to be taken at predetermined intervals (such as maintenance checks, health surveillance)

- Who does it, how often and with what equipment

- What records should be created and maintained.

We can assess performance by measuring how well the stated standards are being achieved; for example, the level of accident rates, numbers of safety failures identified on inspection, degree of compliance with the requirements in respect of who does what, when and with what result.

This measurement should be set against the "levels of acceptability" built into the standard, relating to what is thought to be an acceptable level of performance. Possibly there is no room to argue over this; we require 100% effectiveness in all cases and at all times. However, in all but the most high risk operations, there is likely to be some degree of tolerance of imperfections. Thus, a single incidence of a failure to maintain noise levels below the stated level may not be of great consequence, but several failures would. The important thing is that we know what is happening and can make a judgment as to how acceptable it is.

This approach to measuring performance can also be applied successfully to the various parts which make up the safety management system. Performance standards can be stated in terms of who does what, when and with what result in the organisational arrangements for:

- Conducting risk assessments, including frequency, suitability and involvement of different personnel

- Preparation of health and safety rules, procedures and documentation

- The active involvement of senior managers in safety matters, including tours, incident investigations, etc.

- Specifying the key safety posts and roles, and ensuring that they are filled at all times

- The structure and functioning of consultation processes, including membership of safety committees, the frequency of meetings and the distribution of minutes, etc.

- How incidents are to be reported, investigated and acted upon

- Collection and dissemination of information from external sources

- Audit and review.

It is important that monitoring takes over the whole range of health and safety arrangements, not just the actual control measures. The effectiveness of those measures in terms of both how comprehensive they are in protecting people against risks and how well they operate in practice is a management responsibility. If there are failings in that responsibility, the result may well be a preventable accident. Not only is the avoidance of that outcome a moral duty, it is also a legal requirement and may result in criminal prosecution or civil liability.

Thus, active monitoring is concerned with the totality of performance standards for health and safety at work.

Systematic Inspection

The foundations of effective performance measurement are the specifications and performance standards for the management arrangements and risk control systems. These provide the yardsticks for the measurement process.

The measurement process will gather information about performance through:

- Direct observation of conditions and of people's behaviour

- Talking to people to elicit facts and their experiences as well as gauging their views and opinions

- Examining written reports, documents and records.

These information sources can be used independently or in combination.

Direct observation includes inspection activities and monitoring the work environment (such as temperature, dust levels, solvent levels, noise levels) and people's health and safety related behaviour. This lies at the heart of the measurement process, since most of the reports and records to be examined will have been developed from previous inspection and monitoring activities.

In order to be an effective means of monitoring the state of health and safety arrangements, it cannot be something which is done every now and again, and certainly not something which can be left until there is an incident. These activities must be carried out on a planned regular basis. In other words, there must be a system for doing it.

Systematic monitoring, involving inspections and other forms of examining health and safety arrangements and control measures, will be based on the nature and severity of the risks. High risk situations will require a greater depth and frequency of monitoring than situations of lower risk. Thus, some measures may have to be checked on a daily basis, or even before any work activity. Others may only need examining every week or month, and others every few months or every year. However, we have seen that it is important to monitor all aspects of health and safety, so there must be a plan to ensure that this is done. Only in this way will the adequacy if the arrangements and measures be measured.

There are a variety of ways for doing this, including:

- Workplace inspections – the systematic examination of the controls in operation, such as the condition of guards and the level of compliance with safe systems of work, and the effectiveness of the level of information, instruction, training, information and management

- Safety sampling – the in-depth study of particular aspects of the safety arrangements, both to assess the adequacy of the specific arrangements examined and to identify issues which may be of wider concern

- Performance review – the systematic collection and review of information drawn from inspections, interviews/consultation and reports, etc. to assess the achievement of the organisation's objectives in respect of health and safety

- Safety audits – the regular comprehensive review of all management systems which support the procedures and measures for ensuring health and safety in the workplace.

It is these which will form our main areas of study.

REACTIVE MONITORING

We have noted that reactive monitoring involves the investigation of accidents and other safety-related incidents to find out what went wrong and identify action to put it right so that there will be no recurrence. In this sense it is concerned with failures in the health and safety arrangements.

However, we still want to know what has failed and take steps to put it right. Thus, there must be effective arrangements to gather and analyse information about what has gone wrong. This comes essentially from three sources:

- Accidents and other safety-related incidents

- Concerns and other health and safety issues raised by workers in the form of complaints and suggestions, etc.

- From external agencies identifying failings, usually following inspections by enforcement bodies and often involving the issuing of enforcement notices.

All these situations require investigation to identify the immediate and underlying causes, as we have seen earlier by reference to accidents. The results of such investigations will be used to take remedial action. However, the process in general, and the adequacy of the response in particular, will also be the subject of active monitoring to ensure that the system is working satisfactorily.

Incident Data

It is an interesting thought that if a managing director was asked how the company's performance is measured, the answer would mention a range of measures like profit, return on investment or market share, which are all generally positive achievements. On the other hand, if you asked about how the company's health and safety performance is measured, the answer is likely to be through accident statistics, which are a single negative measure.

Health and safety differs from many areas measured by managers because success results in the absence of an outcome (accidents or ill-health) rather than a presence. However, a low accident rate, even over a long period, is no guarantee that risks are being controlled and that there will not be accidents or ill health in the future. There is no single reliable measure of health and safety performance. What is required is a "basket" of measures which provide information on a range of health and safety activities, and it is supplied by the range of active monitoring measures we have seen.

Data on accidents, incidents, ill-health and near misses does have a significant part to play. Accident data in particular is easy to collect, as injuries are usually reported and investigated, so the information is readily available. Management can easily link accidents with safety performance, so it is easy to discuss accident reports and get management to take action. There are also a number of standard calculations of accident rate which are fairly easy to understand and may stimulate management action. Further analysis of the data can be used to build up an understanding of the incidents which occur in the workplace and therefore to identify patterns which may disclose underlying causes (failings) which may otherwise not be clear. Analysis of information collected nationally and even internationally also contributes to our understanding of causes and risks and the development of programmes designed to control them.

That said, there are certain limitations on the reliability of accident data as a source of information about safety performance:

- It is historical, that is it relates to past events and does not necessarily predict what may happen in the future.

- Most ill-health problems are chronic effects, meaning they have built up over a long time; and the reporting of an instance of work-related ill-health may be too late to prevent many other cases.

- There is often considerable under-reporting of incidents, particularly of minor injuries and near-misses which people think have little consequence at the time. This can be especially so where there is an emphasis on injury and ill-health rates as a measure of management control (possibly related to reward systems) and not reporting incidents helps to "maintain" performance.

- Whether a particular incident results in an injury is often a matter of chance, so it will not necessarily reflect whether or not a hazard is under control. An organisation can have a low injury rate because of luck or fewer people exposed rather than good health and safety management.

- Injury statistics often do not reflect the potential severity of an event, merely the consequence. For example, failing to guard a machine adequately could result in a cut finger or an amputation.

- People might stay off work for reasons which do not reflect the severity of the event.

- There is no necessary relationship between minor injury statistics (such as slips, trips and falls) and the control of major hazards (such as a spillage of toxic material).

- A low injury rate can lead to complacency.

- Incident data reflects outcomes not causes.

Data on near-misses is generally regarded as being a better guide to accident potential than actual injury data. To some extent, such data can be seen as falling between reactive and active measures, because it represents information on accidents that have not yet happened, but where the potential for them exists already. Near-miss data is very difficult to collect. It is difficult enough to get accurate information about actual accidents, so it is even more difficult to get reports of those which did not happen. Also, management is less inclined to take action in response to events which might have happened but did not.

Complaints by the Workforce

It is the workforce who are at risk from the hazards in the workplace and their opinions, complaints and suggestions are likely to be a good indication of the adequacy of health and safety measures.

These opinions may be voiced through the normal consultative channels, such as safety/worker representatives and the safety committee, or may be individual issues raised with management. Evidence of worker attitudes may also be obtained through such information as absence rates (which may be related to stress or to an unwillingness to undertake certain types of work).

Generally, the fact that workers have seen fit to raise an issue, in whatever form, may be taken as an indication of a failure in the current arrangements. This may be because there are physical failings in the control systems which are in place, meaning that workers are actually at risk.

Alternatively, it may indicate a lack of understanding of the control systems, so that they feel they are at risk even though the risk is properly controlled. Either way, there is a need to address the issue.

If concerns are raised it is important they are acted upon. This not only demonstrates management commitment but also encourages a positive health and safety culture where the contribution of workers is valued.

Enforcement Action

The regulatory authorities in your country probably have a legal right to inspect premises at any time, particularly where a breach of legal duty is suspected. The inspecting authority may well offer compliance advice or make suggestions for further improvements. Any indication that the standards of the existing arrangements are deficient must be taken seriously. In some cases the issuing of advice may be a technical issue and there may be no underlying problem; indeed, the seeking of external advice may be seen as a demonstration that the management system is working effectively. However, where enforcement action is taken against the company (e.g. a warning or prosecution), this is clear evidence that management controls are not effective.

REVISION QUESTION 1

(1) Define reactive and active monitoring.

(2) What are performance standards and what role do they play in monitoring?

(3) What do we mean by systematic monitoring?

(4) State the sources of information used in reactive monitoring.

(5) What are the limitations of accident and ill-health data as a performance measure for health and safety?

The suggested answers are given at the end of the unit.

WORKPLACE INSPECTIONS

Workplace inspections are concerned with ensuring that the control arrangements specified in the safety policy are operating effectively and that they cover all the risks. So they are the foundation of systematic health and safety monitoring.

There are a variety of types of inspection, as we discuss below, but they all have the same three basic features:

- An assessment of the standards of workplace health and safety against the specified performance standards and the risks

- The identification and reporting of any deficiencies

- The identification of causes and of action to be taken to remedy the problem.

In addition, the inspection should be carried out by a competent person, that is someone with the knowledge and skills to appreciate the requirements of the performance standards and assess the actual situation against them.

The frequency of the inspections will be decided by the nature of the risks and the importance of the measures to their control. However, workplace inspections also provide an active demonstration of commitment to health and safety and should take place sufficiently often to assure the workforce that safety issues are important and demand constant vigilance.

Types and Frequency of Inspection

The type and frequency of inspections will reflect the nature of the risks in the workplace and the methods used to control them. There is a range of inspection methods or types which are designed to ensure the effectiveness of control systems:

- **Routine inspections**

  The first level of inspections are those carried out as a matter of routine at all times or at very frequent intervals.

  Some precautions required to control a particular risk may have to be monitored on an almost continuous basis to ensure their effectiveness; for example, local exhaust ventilation systems to remove toxic fumes. Others must be checked prior to beginning operations to ensure that it is safe to carry out the activity; for example, that guards are in place and working properly, or that PPE is in good condition and correctly put on. Generally, these will be systems to control hazards which present a high risk of personal injury and may be incorporated with permit-to-work systems.

  The requirement to carry out such inspections will be written into the safe system of work for the particular operation and it will be the responsibility of the operator and/or the immediate supervisor to ensure compliance.

  Routine inspections are also good practice in most situations where there is some measure of risk. Thus workers should be encouraged always to carry out at least a quick visual check of equipment before using it; for example, to ensure that the cable on a portable drill is not frayed or the wiring into the plug is not loose.

  It will not usually be necessary to document that routine inspections have been carried out, although where they form part of a permit-to-work system this will be required. However,

any deficiencies must be reported to a manager immediately and work should not commence before the issue has been resolved.

- **Maintenance inspections**

  Many control systems or items of plant, machinery and equipment have to be checked on a regular basis to ensure that they remain fit for their purpose. These inspections will involve examining, testing and making repairs/adjustments to such items as fire extinguishers, portable electrical equipment, vehicles, etc. This should be done in accordance with a maintenance schedule which is designed to ensure that all items are checked within defined periods, depending on the rate at which they may be expected to deteriorate and thus present a risk in their use. Thus for vehicles the requirement may be that they are inspected every six months or after having travelled 10,000 km, or for adjustable machine guards it may be every two weeks.

  The maintenance schedule is often specified by the manufacturer or supplier of the plant and machinery, etc., and in some cases it is reinforced by legal requirements (as in the case of fire-fighting equipment).

  Maintenance inspections will normally have to be documented and the record should include the general state of repair of the item, results of any tests and what repairs/adjustments were made, if any.

- **One-off equipment, etc. inspections**

  There will always be a requirement to inspect particular items of plant, machinery and equipment in certain circumstances, such as:

  – After a breakdown, accident or other incident affecting the item

  – After a period of non-use – for example, on resuming operations after a weekend or holiday period

  – After resetting the equipment – for example, checking the positioning of the fixed guard which had been removed to allow for the changing of a grinding wheel.

  The circumstances in which any items of plant, machinery and equipment will have to be inspected will usually be stated in the safe system of work and it is normal for there to be a ban on operations using the item until the inspection has been carried out.

  Such inspections will normally be documented.

- **Safety inspections**

  These are formal inspections of a whole area or section of the workplace to check on either all the safety measures applicable or particular aspects of them. This will include such issues as:

  – General maintenance, including the conditions of floors, work surfaces, machinery and equipment, etc.

  – Compliance with safe systems of work

  – Housekeeping and cleanliness

  – Condition of information and warning signs

  – Fire precautions and means of escape in case of fire

- Effective guarding of machinery

- Condition of, and compliance with, PPE.

These inspections are usually conducted by a team of people, which includes the workplace supervisors, section manager and safety representative. Depending on the level of technical detail or complexity, a safety officer may also be involved. Such inspections may also include examination of safety documentation such as maintenance records and the accident book, and discussions with workers about the general approach to safety issues and any particular concerns they may have.

The schedule for the inspections will be specified in the safety policy and there may be particular legislative requirements. In general, safety inspections will be carried out at least once a year but for high risk workplaces this is likely to be more frequent. In addition, special inspections may be ordered where there is evidence of particular problems in the workplace derived from reactive monitoring (such as an increase in accidents or worker complaints).

Note that the whole workplace does not necessarily have to be inspected, nor all the items included in an inspection checklist (see below) be covered during each inspection. Selection of certain activities, priority lists and discussions on specific topics can often be far more beneficial than a tedious "walk through" survey of the whole department. It is vital that enthusiasm and interest are maintained.

Safety inspections should be fully documented and any problems encountered reported.

- **Safety tours**

These are generally unplanned inspections by a safety officer, safety representative and/ or manager designed to observe the workplace in operation without any prior warning. They will not be as thorough as a full safety inspection but have the advantage of being quick, easy to organise and relatively informal.

Tours usually follow a predetermined route through the area or workshop which is designed to cover the main health and safety measures applicable. They are relatively short – say, just fifteen minutes – and can be conducted at regular intervals to keep workers on their toes.

They are a particularly effective method of checking that standards of housekeeping are acceptable and that gangways and fire exits are unobstructed.

Safety tours will not generally be documented in detail, except in so far as any deficiencies are found. These will be reported and follow-up action checked (perhaps on the next tour or, if urgent, by a special inspection).

- **Safety surveys**

These are a narrower more in-depth examination of specific issues or procedures following such events as the introduction of new equipment or changes in working practices. They may also be initiated after problems have been highlighted by other monitoring techniques; for example, where there has been a rise in particular types of accident or a deficiency has been disclosed by a safety audit.

One example is in a large office block where, following a safety audit, it was established that some fire extinguishers did not seem to have been tested or examined for a number of years, certain floors did not seem to be adequately protected; and there was doubt about

the efficiency of some extinguishers. A safety survey was ordered which examined all aspects of the provision of fire extinguishers throughout the building.

Safety surveys are conducted by the managers responsible for the workplace(s) being inspected, together with safety officers. The findings will be fully documented in the form of a formal report to management.

In the case of safety inspections and surveys, the length of time allocated to the inspection can be crucial in maintaining a good standard of observation and interest. Inspections should not generally take more than two hours. It may be necessary to allocate time to discuss the findings and the construction of the report.

Roles and Responsibilities

The person responsible for conducting the inspection must be competent to carry out all the necessary checks and draw the correct conclusions from them in terms of deficiencies in any aspect of the workplace safety arrangements. This will involve reporting problems in the appropriate form to the appropriate person and may involve identifying causes and remedial action.

The extent of knowledge and skills necessary to demonstrate competence will vary with the extent of the responsibilities involved in the inspection. The more detailed and extensive the inspection and the wider the implications of deficiencies, the greater the competence required. Since there is a general duty on employers to ensure the competence of their workers to carry out their workplace roles effectively this means that appropriate instruction and training must be provided.

Safety inspections, tours and surveys will usually involve the safety officer. In addition, inspections carried out under specific legal requirements must usually be led by a person with competence in that area of work, with the requirements often being specified in the Regulations (as is the case with inspections of construction activities).

The various people involved in inspections are as follows:

- **Individual workers** – Operators should make sure that all appropriate inspections to ensure that their work area is free from hazards – for example, all safety devices (including guards) are in place and in operation and that the immediate work area is sufficiently clean and tidy to allow safe operation.

- **Supervisors** – They have greater responsibilities involving ensuring that operators under their control are operating safely, in accordance with safe systems of work, and that safe conditions apply throughout the workplace. This applies to the operation of all control measures, including the use of PPE. Supervisors have specific responsibility for ensuring routine inspections are carried out and for leading maintenance and one-off inspections. They will also be involved in all other inspections affecting their own work areas.

- **Safety officers** – They have a much wider role in inspections, particularly as regards the identification of causes of problems and identifying remedial actions. They will be involved in all safety inspections, tours and surveys, leading them in some cases.

- **Management** – Middle and senior managers, whilst not having any specific front line responsibility for the more regular inspections, must ensure that supervisors are fulfilling their responsibilities. Part of this will be the review of inspection reports, especially where action is required. Section/departmental managers are responsible for safety inspections

covering their entire work area and are likely to be involved in safety tours and surveys as well. Visible management participation in all types of inspection, from all levels of management and from the safety committee, is valuable in demonstrating commitment to health and safety and is an essential element in promoting a positive health and safety culture.

- **Enforcement authority inspectors** – Inspectors will have a legal right to examine workplaces where a breach of legal duty is suspected. They will normally be accompanied by a member of management.

Use of Checklists

In order to ensure a consistent and comprehensive approach to checking all the safety elements to be covered during an inspection, it is usual to develop a checklist or inspection form which covers the key issues to be monitored. It will list all items which have to be inspected in the particular type of inspection, that is pre-operational checks, maintenance checks for particular types of equipment, items to be covered in a full departmental safety inspection, etc.

Checklists should also be designed to provide a clear and understandable approach to the inspection process. This aids monitoring the process of inspection and analysing the results, as well as simplifying the task of actually carrying out the inspection itself. One checklist is the "4 Ps" structure as follows:

- Premises, including

    – Access/escape

    – Housekeeping

    – Working environment

- Plant and substances, including

    – Machinery guarding

    – Local exhaust ventilation

    – Use/storage/separation of materials/chemicals

- Procedures, including

    – Permits to work

    – Use of personal protective equipment

    – Procedures followed

- People, including

    – Health surveillance

    – People's behaviour

    – Appropriate authorised person.

(Note that the examples given are purely for illustration and are not intended to be a definitive list.)

Whilst checklists are often included in safety procedures and manuals they should not be seen as unalterable. In terms of maintenance and safety inspections, the list should not act as a

constraint on the inspector(s) identifying other potential problems or hazards. Checklists should be reviewed from time to time to take account of recent or proposed developments in health and safety issues in the particular workplace.

In order to get maximum value from inspection checklists they should be designed so that they require objective rather than subjective judgments of conditions. For example, asking the people undertaking a general inspection of the workplace to rate housekeeping as good or bad requires them to use their own opinions to make a judgment; how does somebody else know exactly what they mean?

All of the above points are illustrated in the following specimen checklist.

Specimen Checklist

This checklist is based on a document "*Safety for the Smaller Firm*", published by the Chemical and Allied Products Industry Training Board. It was produced as a quick reference for distribution to those concerned in the inspection of safety and good housekeeping standards in all work areas. It is recommended that inspections should be carried out by the line manager, with the assistance of the safety adviser, at frequent but random intervals. The list is intended to be adapted in the light of the specific needs of each organisation.

Note that the third column ("Comments") is reserved for any statements of proposed action where the answer is NO.

Specimen Accident Prevention Checklist

(Reproduced by permission of the Chemical and Allied Products Industry Training Board)

		Comments
Commitment		
Is it accepted that accident prevention is an essential part of management function?	YES/NO	
Is this made clear to supervisors?	YES/NO	
Do supervisors except that accident prevention is an essential part of their function?	YES/NO	
Do they make this clear to operators?	YES/NO	
Communications		
How often is accident prevention discussed with supervisors?	Weekly Monthly Quarterly	
Do supervisors discuss accident prevention with their operators?	YES/NO	
How effective are communications on accident prevention?	Poor Fair Good	
Safety Training		
Is safety training an integral part of all job instruction?	YES/NO	
Is safety training done by:		
Safety advisers?	YES/NO	
Supervisors?	YES/NO	
Other operators?	YES/NO	
Is there any follow-up?	YES/NO	
What percentage of operators have attended accident prevention courses?	.........%	
How many trained auxiliary fire-fighters are there?	....	
Have all operators had training in the use of portable fire equipment?	YES/NO	
If the answer is NO, what percentage have had training?	.........%	
When did this training take place?	....	
How many trained first-aiders are there?	....	
Is a record kept of safety training of each operator?	YES/NO	
Access		
Is adequate safe access and egress provided at all points where operators work?	YES/NO	
If portable access platforms are necessary:	YES/NO	
Are they sufficient?	YES/NO	
Are they regularly inspected?	YES/NO	

Are they of good construction and adequate for their intended use?	YES/NO	
Are floors free from standing water?	YES/NO	
Machinery and Electrics		
Are all moving parts of machinery adequately guarded?	YES/NO	
Are all fixed guards secured in position, and in good condition?	YES/NO	
Are all interlock guards mechanically and electrically in good condition?	YES/NO	
Are all automatic guards properly adjusted?	YES/NO	
Can all machinery be positively isolated for maintenance?	YES/NO	
Are any circuits overloaded?	YES/NO	
Are cables in good condition and tidy?	YES/NO	
Are there any trailing cables?	YES/NO	
Are light fittings clean and in good repair?	YES/NO	
Is there an effective permit system to control work on electrics?	YES/NO	
Are all emergency stop buttons effective, clearly labelled and easily accessible?	YES/NO	
Are checks made to ensure that automatic controls and interlocks are working properly?	YES/NO	
Have you safe procedure for handing over plant to maintenance department and receiving back?	YES/NO	
Is the procedure consistently applied?	YES/NO	
Lifting Equipment		
Are all lifting appliances marked with the safe working load?	YES/NO	
Are all examinations and tests up-to-date?	YES/NO	
Is there adequate lifting equipment at all places where it is required?	YES/NO	
Are all slings in good condition?	YES/NO	
Are all operators using the equipment properly trained?	YES/NO	
Mobile Equipment		
Is all mobile equipment in good condition?	YES/NO	
Are there sufficient qualified drivers for forklift trucks?	YES/NO	
What is the standard of driving?	Poor Fair Good	
Are there adequate warning signs in truck operating areas for both pedestrians and drivers?	YES/NO	
Are gangways clearly marked?	YES/NO	
Are they kept free from obstruction?	YES/NO	
Are floors in good condition in truck operating areas?	YES/NO	

Handling and Storing Materials		
Are there adequate storage facilities?	YES/NO	
Are stacks properly built and sound?	YES/NO	
Are storage areas clearly defined?	YES/NO	
Is there adequate equipment for handling materials?	YES/NO	
Where manual handling is necessary, have operators been trained in kinetic handling?	YES/NO	
Do they practise this?	YES/NO	
Do operators follow safety procedures for storage of materials?	YES/NO	
Are there adequate clearances where handling of materials is necessary?	YES/NO	
Fire Prevention		
Are "no-smoking" areas clearly defined?	YES/NO	
Are solvent pipelines and storage tanks clearly marked?	YES/NO	
Are solvent pipelines free from leaks?	YES/NO	
Are there adequate precautions to prevent spillage entering drains?	YES/NO	
Are interceptors incorporated in drainage when necessary?	YES/NO	
Where necessary, are adequate earthing facilities fitted?	YES/NO	
Are there safe containers for the movements of small quantities of flammable liquids?	YES/NO	
Are there safe disposal facilities for contaminated rags?	YES/NO	
Are there safe disposal procedures for residues?	YES/NO	
Are anti-static devices fitted where necessary?	YES/NO	
Are these in good condition?	YES/NO	
Are self-closing doors kept shut?	YES/NO	
Are such doors kept free from obstruction?	YES/NO	
Are sprinkler heads free from obstruction?	YES/NO	
Are all personnel conversant with the action to be taken in the event of fire?	YES/NO	
Do they know their evacuation drill?	YES/NO	
Are fire alarms adequate?	YES/NO	
Are fire alarm points kept free from obstruction and clearly marked?	YES/NO	
Are there sufficient portable fire extinguishers?	YES/NO	
Have all personnel been trained in their use?	YES/NO	
How many fires have occurred in the last year?	....	
As a result of these, are any further fire precautions necessary?	YES/NO	

Housekeeping and Environment		
Are all floors in clean condition?	YES/NO	
Do operators keep their working areas clean?	YES/NO	
Are there sufficient disposal bins?	YES/NO	
Are these regularly emptied?	YES/NO	
Is the general standard of lighting adequate?	YES/NO	
Are there adequate washing and toilet facilities?	YES/NO	
Are they kept in clean condition?	YES/NO	
Are there adequate extraction facilities for fumes and dust?	YES/NO	
Are these exhausted to a safe point?	YES/NO	
Is there a noise problem?	YES/NO	
Protective Equipment		
Where necessary, is personal protection provided under the following headings?		
Helmets	YES/NO	
Eye protection	YES/NO	
Ear protection	YES/NO	
Respiratory protection – dust	YES/NO	
Respiratory protection – canister respirators	YES/NO	
Respiratory protection – self-contained breathing apparatus	YES/NO	
Body clothing	YES/NO	
Gloves	YES/NO	
Footwear	YES/NO	
Are areas in which this protection should be worn clearly specified?	YES/NO	
Do operators use the personal protection?	YES/NO	
Is there an adequate supply of emergency equipment such as eye-wash, showers, first aid boxes, etc. where necessary?	YES/NO	
Is equipment checked and maintained as necessary?	YES/NO	
Are adequate records kept of issues, checks, etc.?	YES/NO	

Priorities for Action

Inspections are not usually designed to provide a problem-solving mechanism at the very instant a hazard or risk is identified. It would normally be more appropriate to analyse any deficiencies in the safety arrangements during a post-inspection discussion. However, action may have to be taken if there is an immediate risk to life or limb.

The purpose of inspection is to identify remedial action to be taken in relation to any deficiencies. This has to be based on an assessment of the causes of the problem, both immediate and underlying. Priority should be given to remedying any immediate causes of risk since they may have the potential to cause accidents and action should be taken at the earliest opportunity. Other underlying causes must also be addressed, but they are likely to involve

further investigation and consultation with management to identify the root cause of the problem. They must not be overlooked.

It is also useful to rank the outstanding issues, which are those that are not earmarked for immediate action, so that priority can be given to those deficiencies which appear to present the greatest risk.

It is important too that the outcome of any safety inspection, tour or survey should be communicated to all personnel involved, whether the results are positive or negative. This will help to improve safety awareness and develop the safety culture. Summaries of the findings, using graphical presentation where appropriate (for example, simple graphs and bar charts, etc.), may be displayed on notice boards or in safety bulletins, and comparisons drawn with previous inspections and other similar workplaces. Discussion could be held to consider the outcomes and encourage involvement in identifying improvements.

Effective Report Writing

When writing any sort of a report, the key considerations must always be:

- What is the objective and what are you trying to achieve?

- Who is going to read it?

You will then present the information in a way that the reader will understand, recognise what is required and be convinced of the need to act accordingly.

The aim of a safety inspection report will be to set out the findings of the inspection and bring key issues to the attention of management for action. Managers are usually busy people and will not have time to wade through a mass of information to try and pick out the key points, so it is up to you to make their job as easy as possible. The secret of report writing is to present your information in a form which can be easy to read, emphasises the key points and clearly identifies what action is required.

There are two main aspects to this, namely style and structure.

Style

A useful approach to getting the style right is to consider the "seven Cs".

- **Clear**

    Clarity is achieved through the use of the right language, using words which the reader will understand, set out in a logical order with appropriate structuring of the information. Take your reader through the points you want to make one by one, so that each leads on to the next.

    You should use clear language which avoids doubtful or double meaning and puts your points across in a way which can be easily understood by the reader; words and phrases must be chosen with care and unavoidable jargon and technical terms should be explained. Short, simple, structured sentences help, as does the use of headings and picture forms of presentation such as plans, diagrams, etc.

    One problem often encountered is the need to refer to other documents or extracts from them, or to detailed background information, say about particular measurements. The inclusion of such material in the body of a report can upset the flow and be quite confusing as the reader feels he/she has to read through and understand it. Such material, if it is

necessary at all to getting your points across, should be placed in appendices or attached as a supporting document. This helps to keep the main communication to the point throughout.

- **Concise**

  Being concise means keeping the report as short as possible. You do not want the reader to have to read through vast amounts of material to find the key points, nor do you want your arguments or points to become submerged in a long story.

  Being concise or brief does not necessarily mean just stating the basic points. The use of explanations and examples all contribute to clarifying the key issues and should be used where appropriate. However, the essence is to stick to the point and not over-elaborate or wander off into other areas which may confuse the issue or lose the reader.

  Your report should be as short and to the point as possible, taking into account the complexity of the information you wish to transmit. Thus, it is better to say "Unfortunately ....." rather than "I regret that I have to say that ....". One of the trends in report writing has been to be more direct and use less of the rather vague and tediously lengthy language of formal business communications from the past. That tendency has not disappeared completely, particularly in some formal old established organisations, but every effort should be made to cut down on the number of words used to say something.

- **Correct**

  The information conveyed must be as accurate as possible at the time of presentation, an obvious point but one which has a number of implications.

  In order to be truly accurate it may seem necessary to use very complicated language, particularly legal language; for example, when explaining the limitations of what you were able to observe (such as not being able to check the condition of certain measures because, say, they were not operational at the time or you lacked the necessary testing equipment for one reason or another). This may be very off-putting or difficult to understand for many readers and should be avoided. (It clashes with C for clear). In most circumstances some degree of absolute accuracy may be sacrificed for clarity.

  All reports should be dated. This sets the information in a particular time frame and allows editing to reflect new information at a later date.

  Being accurate is not always easy. In many cases the information being conveyed is not precise or complete, and this should be openly stated where the reader has to be aware of any limitations.

- **Courteous**

  It pays to consider a report as a personal address to the reader(s). Thus in trying to be brief do not be curt, do not be afraid to introduce personal references where appropriate (using "I" or "you"), be polite and use friendly language rather than formal or pompous writing.

- **Complete**

  The report should contain everything you want to say and nothing more and nothing less. As far as possible nothing should be left out, although you may have to say that certain points cannot be covered at this particular time and will be dealt with later. In that way the reader will be aware that he/she has everything they need.

This may mean going beyond what were the original terms of the inspection when writing the report as additional information may have to be brought in for the complete picture to be presented.

- **Consistent**

  The flow of language is helped greatly by being consistent in how you use it, for example by standardising the use of person and tense in verbs and sticking to a particular style and tone throughout. A number of problems arise from this:

  – Adopting a consistent and clear usage of non-gender specific phrasing (to avoid the use of "he" all the time which you will find in most older texts) can mean using rather difficult phrasing or an overuse of "he/she" or "(s)he" which can look and sound clumsy

  – Choosing between "I" and the more anonymous "we", both of which have their advantages at different times

  – The convention of writing reports in the passive tense ("it may be seen that ....") can give rise to phrasing difficulties and also conflicts with the more direct and courteous use of active tenses ("you will see that ...."), but it can be confusing to switch between the two too often.

- **Convincing**

  This last point is often overlooked. It is very important to show confidence and commitment in what you write, even though there may be times when you do not actually feel that in what you have to do at work. Doubt, ambiguity and vagueness come through very clearly in all forms of communication. Messages have to be conveyed with conviction or they will not be taken seriously.

Structure

Virtually all communications can be structured along the same overall lines. A very basic principle which works nearly all the time is:

- Say what you are going to say

- Say it

- Say that you've said it.

This principle can be interpreted as the basic "introduction – body of the communication – summary/conclusion". Let's look at this in a little more detail.

- **Introduction**

  It is vital to get off to a good start. The first sentence sets the tone and style for the rest of the report and you should give that some thought. Often getting that first sentence right sparks off the flow of language for the rest of the communication.

  The introduction sets the scene. It directs the reader to what is going to be said and importantly, how it will be said (the general approach, tone, etc.). Thus an introduction has to cover the background to the issue, why it is being dealt with and briefly, what is to come.

- **Middle section**

  The main body of the communication conveys the information. If necessary it should be structured into paragraphs (not too long), headings, lists, etc. Careful consideration should

be given to the numbering of headings, paragraphs or lists as they help in referring to particular points. It is likely that every organisation will have conventions about how to do these in formal reports.

• **Conclusion**

Including a summary at the end is a useful means of bringing together the various points made in a concise way. (It is also helpful to hard-pressed managers who, it is often said, just turn to the summary and recommendations without bothering to read the rest of a report.) Recommendations are often included in this part of a report, although many organisations have a convention of putting them right at the beginning.

We can develop this basic structure in rather more detail to describe a recommended form of organisation for a safety inspection report as follows.

Preface

At the very outset the report should identify the following key points:

• The title for the report

• To whom the report is made

• By whom the report is written

• The date the report was written

• The authority under which it is written

• The reference of the report (for filing, the date of the meeting when it will be considered, and so on).

For longer reports with many sections and sub-sections, it is useful to follow this with a list of contents. The main sections of the report should be listed together with their page numbers.

This should be followed by a brief summary (sometimes called an executive summary) which states the aims of the report and the main findings and recommendations.

Introduction

In your introduction you should make the purpose and objectives of the report clear. You should provide a short description, no more than a paragraph, of the organisational context of the inspection (such as the nature of the workplace and any other general issues which set the scene in which it was carried out). Then briefly identify the problems or issues you are addressing and explain what approach you are going to take. It is also useful to set out here any general legal aspects of health and safety which apply.

Main body

The main body of the report should contain the data or findings to support your arguments and recommendations as well as refer to any legal, economic or moral reasons for proposed actions. State the facts simply, one point at a time and in a logical sequence of events. Explain:

• What was observed

• Why it was a hazard

• How the law applies to the situation(s)

• What the possible consequences are.

Headings are of great significance, especially in longer reports. They should be as explicit as possible in referring to the material which follows. It is also wise, especially in longer reports, to make full use of side headings and sub-headings to group together connected paragraphs. Not only do they assist the writer in keeping to an orderly presentation, but they assist the reader by breaking up into convenient sections what might otherwise be large tracts of unbroken text.

The numbering of headings or paragraphs is also important in all but the shortest of reports as it helps both cross-referencing within the report and subsequent reference at any meeting where the report is under discussion. A number of techniques are available. Some reports use decimal numbering of headings or sections of the report; for example, main sections are denoted as 1, 2, 3 ..., whilst sub-headings are 1.1, 1.2, 2.1, 2.2 ..... Particularly in longer reports, consecutive numbering of paragraphs is probably better than numbering separate sections, so you could have un-numbered headings and each paragraph numbered 1, 2, 3 ... 11, 12 ... etc.

Try to avoid unnecessary numbering, especially in shorter reports. Excessive numbering can suggest a bureaucratic approach. In any report, for example, third tier decimals, such as 1.1.1, 1.1.2, 1.2.1, etc., begin to look ugly. Also they can interrupt the flow of the report and distract the reader.

Remember to put long check-lists, risk assessments, graphs and tables in an appendix rather than make the body of the report overlong. The main thrust of the report should concentrate solely on discussing findings.

Conclusions and recommendations

The conclusion to your report should draw together the main findings and summarise the action which is required. Never introduce new information at this stage because everything in your conclusions must be backed up by the findings as discussed in the main body of the report.

The report should close with your recommendations for action. These may be cross-referenced to the discussion in the main body of the report and possibly to the conclusions, so that the reader can clearly follow the line of your argument from findings through to action required.

Each recommendation should be clearly explained and realistic, by stating priorities, likely timings and costs involved. Where there is a choice of courses of action you should make it clear which you favour and why, and give a plan of action outlining the priorities, likely timing and costs involved.

Appendices

Avoid lengthy appendices wherever possible. You should demonstrate an ability to extract and summarise relevant information from different sources.

Only include material which is essential to the understanding of the report; for example, inspection forms, risk assessments, long tables and diagrams. They should be clearly indexed for each cross-referencing. It may be appropriate to use only extracts of documents rather than full documents.

REVISION QUESTION 2

(1)   State the purpose of workplace inspections.

(2)   What three key elements do all forms of workplace inspection include?

(3)   What inspections involve operators?

(4)   What is the difference between a safety survey and safety tour?

(5)   What role does senior management have in workplace inspections?

(6)   Why are checklists used in inspections?

(7)   Identify the seven Cs which underpin effective report writing.

(8)   What should the introductory part of a report contain?

The suggested answers are given at the end of the unit.

SAFETY SAMPLING

Safety sampling is an organised system of regular random sampling, the purpose of which is to obtain a measure of attitudes towards health and safety and of possible sources of accidents by systematically recording hazard situations observed during inspections made along predetermined routes in a factory or on a site.

The premises are first divided into a number of walking routes so that at least 90% of all the normal working locations are covered. An observer is then assigned to each route. Supervisors and junior management staff are generally thought to make the most suitable observers because they are familiar with the plant and personnel and are competent persons in respect of inspection procedures. Observers will be drawn from several departments to help stimulate interest in the exercise and reinforce the idea that health and safety is a common responsibility shared by all the workforce.

At a given signal or time, the observers begin their inspection, each following his/her prescribed route and taking a similar time to complete the inspection. (The time allowed is usually twice the time normally taken to walk the route at a steady but not fast pace.) This provides a snapshot of the state of health and safety at this particular time throughout the premises (the sample).

Each observer will record the various safety defects which they notice on a standard tabulated form or checklist. The sampling sheets will be handed to the safety officer for detailed analysis. When the forms are handed over, observers must also report any serious defects or hazards which have been observed so that action can be taken to have them remedied immediately. It is not the role of the observer to carry out corrections.

The key to good safety sampling is the use of a simple but comprehensive checklist. This will be some form of classification of unsafe acts and unsafe conditions which can be directly observed; for example, the following extracts from a sampling list cover prescribed protective clothing which is not worn or is defective, and the misuse, abuse, non-use or neglect of protective equipment:

Group 1: Protective clothing	
Code	Description
101	No eye protection
102	No head protection
103	Inadequate foot protection
104	No hair net or cap
105	Wearing rings
106	Not wearing apron/overalls/coat
107	Not wearing gloves/gauntlets

Group 2: Protective equipment	
Code	*Description*
201	Machine guard removed
202	Machine guard defective
203	Foot pedal unguarded
204	Guard improperly adjusted

As with all checklists there should be scope for noting additional items which are not on the list.

The simplest way of using the information obtained is to count the total number of defects for the whole plant, which gives a numerical index of accident potential. More sophisticated analyses can be performed to give total numbers of particular types of unsafe act or unsafe conditions, which can be collated with incident data to broaden the picture. Results may also be compared with previous samples to give an indication of trends.

The purpose of the sample is not to investigate working practices in any detail, but simply to highlight areas of concern which may then be subject to more detailed inspection and investigation. The main outcomes are:

- The provision of a numerical basis for assessing accident potential in terms of unsafe acts and unsafe conditions

- An indication of those areas where accident prevention measures should be concentrated (i.e. those areas with high indices)

- A warning to management of matters needing urgent attention.

It may also be seen as a participatory exercise which involves all levels of management across different parts of the organisation in the common pursuit of improved health and safety. This will help to build the safety culture.

PERFORMANCE REVIEW

Performance review describes the part of the safety management process by which information collected by monitoring and auditing is then used to make judgments about the adequacy of performance and take decisions about actions necessary to maintain continuous improvement.

The effectiveness of any system depends on getting feedback about how it is doing; there are financial reviews and sales reviews which provide the means by which improvements are made. The same is true in health and safety.

Aims of Performance Review

The aim of performance review is to ensure that the health and safety management system is being operated as designed.

This includes making sure that the systems are in place to monitor, check and measure the effectiveness of all aspects of the health and safety arrangements (including the organisation and management) and where there are deficiencies, that they are reported and action taken at the appropriate level to remedy them.

It is the role of performance review to ensure that health and safety management is effective in ensuring that these systems operate effectively; that inspections, for example, are taking place and reports are reviewed and acted upon by those responsible.

It also requires the development of the safety management system to respond to changing circumstances.

The plan must include the specification of performance standards for the review process itself, such as periodic (often annual) management/safety committee reviews of key documentation about performance. Many organisations now include health and safety performance in their published annual reports as part of the demonstration of corporate responsibility.

Key performance indicators which emphasise achievement and success, rather than merely measuring failure, are:

- Extent of compliance with health and safety system requirements

- Identification of omissions from or inadequacies in the safety management system

- Achievement of specific goals

- Analysis of statistics on ill-health, accidents and near misses to identify immediate and root causes, trends and common features.

These are consistent with the development of a positive safety culture.

Organisations may also benchmark their performance against that of similar companies.

Frequency of Review

Measuring health and safety performance is an ongoing activity, so in one sense the monitoring process is continuous. However, like any other activity, measurement should be both efficient and effective, so the frequency with which it takes place has to be planned appropriately. The following factors will determine the frequency:

- Suitable intervals to ensure that specific planned milestones are achieved; monitoring progress with plans should be aligned with the particular timescales for achievement.

- The potential for change in conditions over time; where conditions do not change much over time (for example, a particular management arrangement) checks may only be required:

  - At the initial design and installation stage

  - Whenever changes are made which could have an impact on the operation of the systems

  - When information is obtained which indicates that the system as designed has failed in some way; for example, when there has been an accident

  - When data from the monitoring of the operation of the system indicates the design is flawed.

- The relative importance of the activity or particular precaution relative to the overall control of risk.

- Where inspection and maintenance intervals are prescribed by suppliers of plant and equipment to ensure optimum performance.

- Where intervals for monitoring are prescribed by legislation.

- Where there is evidence of non-compliance, which indicates there should be more frequent monitoring to check that remedial action has been successful.

- Where there is evidence of compliance it may be appropriate to consider reducing the frequency of that monitoring and targeting resources elsewhere.

Organisations should decide the appropriate frequency for reviews at various levels, e.g.:

- Monthly reviews within sections

- Quarterly reviews at departmental level

- Annual reviews of sites or of the organisation as a whole.

HEALTH AND SAFETY AUDITS

Auditing is a long established tool which originated in financial management and was later adapted for monitoring quality, environmental and safety performance. It provides a systematic, documented, periodic and objective evaluation of how well the organisations management systems are performing by a critical examination of each area of activity.

It has been defined as:

The structured process of collecting independent information on the efficiency, effectiveness and reliability of the total health and safety management system and drawing up plans for corrective action.

Scope and Purpose of Audits

Auditing supports monitoring by assessing the effectiveness of the health and safety management system, usually throughout the whole organisation (but occasionally in defined parts), by ensuring that:

- Appropriate management arrangements are in place

- Adequate risk control systems exist, they are implemented, and are consistent with the hazard profile of the organisation

- Appropriate workplace precautions are in place.

It provides verified feedback to management that the standards and procedures are satisfactory, and recommends any changes necessary. Together with performance review, it enables an organisation to maintain and develop the effectiveness of its safety management system. Audits are designed to assess the following key elements of health and safety management by reference to performance standards:

Policy	Its intent, scope, adequacy and whether or not it sets realistic safety targets.
Organisation	The acceptance of health and safety responsibilities by line management, the adequacy of arrangements to consult and empower workers, the effectiveness of communication on health and safety issues and the arrangements for ensuring the competence of staff.
Planning	The overall control and direction of the health and safety effort and the adequacy of risk control measures and risk assessment procedures.
Measurement	Its adequacy, relevance and design.
Review	The ability of the organisation to learn from experience, improve performance, develop the health and safety management system and respond to change.

To achieve these very broad objectives the audit has to be an in-depth, systematic, critical investigation into all aspects of safety in the organisation being audited. This is based on an evaluation of a wide range of performance standards of health and safety management, such as:

- Health and safety policy

- Management organisation

- The training and instruction of workers

- Supervision

- Hazard control

- The investigation of accidents and other incidents

- Legislative compliance

- Hazardous materials and health monitoring

- Regular inspections

- First-aid services and emergency response, including fire precautions

- Review processes.

During the audit, actual performance in relation to each standard will be rated as a percentage of full compliance to give a "compliance rating". This rating is established by the answers found to a series of questions which detail the way in which the standard is designed to operate. These questions are similar to a checklist of points to be addressed in relation to the standard, although in the case of an audit, the answers will be judgments about the extent to which the organisation meets it, rather than a simple "yes/no". Some examples of questions are given in the next section.

The way in which compliance ratings may be interpreted varies between organisations and the nature of the risks faced. However, in general terms the following table indicates what different ratings might mean:

- 85 – 100%   Functioning effectively

- 65 – 84%   Documented and implemented

- 50 – 64%   Meets minimum requirements

- 0 – 49%   Requires immediate attention

Audits are time-consuming and costly. They are therefore only carried out at reasonable intervals, at most once a year but often less frequently. The frequency will depend on the nature of the risks, the extent of change in the organisation and existing compliance levels.

Some components of the system do not need to be audited as often as others. Technical audits verify the continued effectiveness of critical risk control systems in high hazard industries and require frequent auditing. An auditing plan or programme indicates when and how each component part of the SMS (safety management system) will be audited.

Distinction Between Audits and Inspections

In relation to safety management the term auditing is sometimes used loosely to describe various monitoring activities such as workplace inspections. This should be resisted. Monitoring is principally a line management role, undertaken continuously or frequently to ensure compliance with the organisation's adopted standards and procedures. Auditing is a more fundamental examination undertaken by people outside the line management structure, challenging whether the standards and procedures are appropriate, as well as their application. It usually requires some sampling and selectivity and is undertaken periodically. Auditing includes checks on the monitoring programme. Just as an annual financial audit is a check on the company's solvency (that the business has been managed prudently and cash has not been misappropriated) so a safety audit is a check on the management of health and safety.

Pre-Audit Preparations

Information Gathering

A wide range of documentation has to be examined at the outset. This includes:

- The company safety policy

- Safety handbooks and manuals

- Written work procedures

- Safety committee minutes

- Accident statistics and investigation reports

- Planned inspection reports

- First-aid record books

- Planned maintenance checks

- Training records

- Hazardous substance record.

To ensure that the audit is effective you should go back at least a year in the documentation, although longer may be necessary if there are any problems. This ensures a solid base of understanding of the system before moving on to gather information about the present situation.

The Audit Process

The process of auditing involves:

- Collecting information about the health and safety management system

- Making judgments about its adequacy and performance.

In addition to the preliminary inspection of documentary evidence, information will also be gathered through **interviews**. These should be structured around specific questions to be addressed in relation to each performance standard. The number of workers to be interviewed will vary according to the size of the workforce, but it is important to include a range of different perspectives on the issues. Thus three sets of questions may have to be developed for each standard, as in the following examples:

- For operatives – What instructions were you given when you began work at this workplace?

- For supervisors – Does the company's policy state your responsibilities regarding safety?

- For managers – What training in effective supervision is done for your line supervisors?

The audit plan should include a scheme for interviewing a cross-section of staff. It is not essential that they are notified in advance, though to ensure their availability it is advantageous to at least put people on 'stand-by'. It might also help matters if they are told in advance of any records they will be required to produce.

Questionnaires offer the opportunity to reach a larger number of people than interviews in a more cost-efficient way. However, there is little opportunity to explore exactly what particular answers mean.

Other methods of gathering information can include formal workplace inspections, informal workplace observation and planned task observation.

Making Judgments

The assessment process must be carried out by comparison between what is found against a relevant standard or benchmark.

An example of the question set relating to a performance standard for supervision is shown below. This illustrates the way in which the requirements for achievement of the standard are expressed and the relative value given to each requirement. A judgment will be made on the evidence collected about the degree of compliance of the system being audited with each requirement and this score is entered onto the form.

Audit Question Set: Supervision Performance Standard

	Rating attained	Max score
A system of effective two-way communication exists between management and supervisors to discuss health and safety concerns, internal responsibility systems, and accountability. Comment:		10
Supervisors are trained in techniques of effective supervision and worker motivation, instruction and training of workers. Comment:		10
Supervisors have received training or direction on accident investigation. Comment:		10
Supervisors ensure that worker orientation is done and that specific job instruction is delivered to workers. Comment:		10

Supervisors conduct:
    Regular process and equipment inspections;
    Frequent informal observation of work procedures.
Comment:
		5
		5

Supervisors conduct documented staff briefings and set a good example. Comment:		10

A supervisor is responsible for:
    The proper training of workers under his/her direction and control, ensuring that their work is performed without undue risk.
    Ensuring that the worker uses or wears the equipment, protective devices, or clothing required by the nature of the work.
    Advising the worker of the existence of any danger to his/her health and safety.
    Providing the worker with written instruction on the measures and procedures he/she is to take for his/her own protection.
Comment:
		10
		10
		10
		10

Total for standard		100

Analysis

As we have noted, the basis of analysis is the scoring method used. There are various approaches used, but most use some means of rating for each individual question which can be totalled to give an overall compliance rating for the standard as a whole. This can then be interpreted against the type of scale quoted above.

Where particular questions do not apply in particular workplaces they can be easily left out and the overall rating calculated just on the basis of those aspects of the standard which are applicable.

A system using numerical ratings to a series of questions is useful as it provides objective results that can be directly compared to future audits, thereby allowing any changes in performance to be tracked. Ratings systems also allow establishments to be compared relative to each other and for benchmarks to be set.

Reports and Action

Following completion of the audit, the findings should be presented to the senior management of the organisation and/or the safety committee. There will initially be no action appended to it as the main purpose of the audit process is simply to present an honest appraisal of the management system.

It is very much up to management to respond to the information that it contains. Thus the report has to be considered and recommendations for action developed. It may be possible to make substantial improvements in some areas as problems are spotted during the audit process, but it is more likely that a planned programme of improvements will be necessary.

Once action plans are agreed, responsibility for monitoring their achievement should rest with management and the safety committee.

Responsibility for Audits

Because audits are concerned with the health and management system, responsibility for which rests with the employer (in fulfilling his/her legal duties) and senior management, responsibility for the audit also rests with senior management. However, the remit of the safety committee will also include the monitoring of the safety policy and the management arrangements therein, and this makes it an equally important party to the process.

Senior management involvement is also key to the success of the process. There has to be a commitment to see the audit through and take appropriate action at management level to make improvements, otherwise there will not be change. This demonstration of commitment by undertaking corrective action as needed will also help to convince the workforce that management strongly supports workplace health and safety.

However, it would be wrong to make senior management solely responsible. Management in general has to share the responsibility for ensuring the effectiveness of the process; and indeed their capability to do that may be one of the elements of performance in respect of their role which is itself measured.

External and Internal Audits

There is some debate as to whether safety audits are best carried out internally or by an external agency. There are certainly plenty of consultants available to take on the role.

- **External consultants**

  The advantages of using external consultants to conduct the audit include:

  – They are independent of any links with the organisation and should be able to offer an objective assessment service

  – They are likely to have greater experience and expertise than is available within any but the largest organisations

  – They are likely to have knowledge and experience of other organisations which they can bring to the analysis, including being able to provide benchmark comparisons

  – They are likely to be flexible in the arrangements made for the conduct of the audit.

  On the other hand, there are limitations:

  – They will not be familiar with the particular nature of the work activities and the workplace, so may take longer in the first instance to develop a proper understanding of the systems in place

  – The audit scheme they provide may not be tailored specifically to the needs of the organisation

  – They will be more expensive than undertaking the process "in-house"

  – There is the potential for the organisation to lose control of the process and be led by the consultants

  – There is the potential for a lack of continuity over time if the consultants used constantly change.

  Apart from the cost these disadvantages of using external consultants can be overcome by clear roles and responsibilities and open dialogue.

- **In-house audit teams**

  The advantages of using internal auditing are the exact opposite of the disadvantages noted for external audit. However, there are significant disadvantages too:

  – There is the potential for subjective judgments and bias to colour both the information gathering process and the assessment

  – The relative lack of broader expertise may be a handicap in recognising the scope for improvement.

  One way of overcoming these problems is the use of external consultants in more limited roles; for example, checking results and advising on strategy.

If the audit is conducted in-house there is a further choice to make. There are now a number of "off-the-shelf" packages available, both print based and computer applications, which provide detailed guidance through the process, including the provision of performance standard question sets, interview forms and questionnaires. Where time is at a premium these packages provide a tried and tested system which has the benefit of lessons learned from previous experience. They can be tailored and expanded to meet the needs of individual establishments.

The development of an in-house system may at first sight appear better value for money but a safety manager should not under-estimate the time required to develop a comprehensive and effective audit system. The in-house system does, however, ensure that the audit will

acknowledge the uniqueness of a particular organisation that a commercial package may not achieve.

REVISION QUESTION 3

(1) What is the "sample" taken in safety sampling?

(2) Performance review is concerned with ensuring that incident investigations are properly concluded. True or false?

(3) State five factors which influence the frequency of monitoring activities.

(4) Define health and safety auditing.

(5) What is a compliance rating and what does a compliance rating of 54% indicate?

The suggested answers are given at the end of the unit.

UNIT SUMMARY

The role of performance review is to ensure that the organisation's health and safety policy is complied with by monitoring the effectiveness of health and safety management arrangements.

There are two main means of monitoring the workplace precautions and risk control systems put in place by the safety policy. Active monitoring uses inspections to ensure that precautions and systems are operating effectively with the aim of identifying any deficiencies and remedying them before they can cause an accident. Reactive monitoring uses investigations of accidents, incidents and other reported failures in control to identify what went wrong and remedy it. Both have their part to play.

Active monitoring activities measure actual performance against specific statements of what is required under the organisation's health and safety policy. These "performance standards" should be set for all health and safety arrangements, including the organisation and management, to provide a yardstick for measurement.

Workplace inspections are the main means of active monitoring. Such inspections range from the limited responsibilities of individual operatives to check their own equipment and workspace to the broad responsibilities of managers for monitoring, review and remedial action in respect of all aspects of workplace precautions and risk controls. Formal inspection should always be fully documented and a full report prepared for management. In all other cases, where deficiencies are observed, reports should be made and acted upon.

Other forms of monitoring and review are concerned with measuring the effectiveness of health and safety management and organisation itself. Safety sampling provides general information on levels of compliance with safety procedures and systems as the basis for identifying areas of concern which merit further investigation and action. Safety audits are in-depth independent reviews of compliance levels both at the workplace and management level. These again provide information for identifying areas of concern and remedial action.

SUGGESTED ANSWERS TO REVISION QUESTIONS

Revision Question 1

(1) Reactive monitoring is where accidents and other safety-related incidents are investigated to find out what went wrong and identify action to put it right so that there will be no recurrence. Active monitoring is where the existing safety measures are inspected to find out if anything may go wrong and identify action to put it right before there is an incident.

(2) Performance standards are the statements of who does what, when and with what result in the organisational arrangements and control measures designed to ensure health and safety at work. They form the basis against which actual performance may be measured to identify how effective the safety policy is in practice.

(3) Systematic monitoring involves the taking of planned regular action to seek information about the effectiveness of the organisation and arrangements regarding health and safety.

(4) The information for reactive monitoring comes from the investigation of accidents and other safety-related incidents, issues raised by workers and failings identified by external agencies (usually enforcement authorities).

Revision Question 2

(1) The purpose of workplace inspections is to ensure that the control arrangements specified in the safety policy are operating effectively and that they cover all the risks.

(2) The three common elements of all inspections are:

– An assessment of the standards of workplace health and safety against the specified performance standards and the risks

– The identification and reporting of any deficiencies

– The identification of causes and of action to be taken to remedy the problem.

(3) Routine inspections of the immediate work area and plant, machinery and equipment used.

(4) Safety tours are generally unannounced inspections of the major control measures in a workplace following a predetermined route. Safety surveys are in-depth inspections of specific issues or procedures where there is reason to believe that there may be deficiencies in the existing safety systems, either because of changes in the workplace or on the basis of problems identified by other monitoring techniques.

(5) Senior management has responsibility for ensuring that effective workplace inspection regimes are in place and are operated effectively. This will include receiving reports and overseeing/agreeing action. In addition, the visible involvement of senior managers in all types of inspection is to be encouraged for the commitment it demonstrates towards safety and the effect on the promotion of a positive health and safety culture.

(6) Checklists help to ensure a consistent systematic and comprehensive approach to checking all the safety elements to be covered during an inspection.

(7) The seven Cs are be:

– Clear

– Concise

– Correct

– Courteous

– Complete

– Consistent

– Convincing

(8) The introductory part of a report should set the scene, covering the background to the issue, why it is being dealt with and briefly, what is to come. The following elements should be covered:

– Preface stating the title, who the report is to and who has written it, the date, general authority for its writing, and reference.

– List of contents.

– Brief summary of the aims, main findings and recommendations.

– Statement of purpose and objectives, including the organisational context of the inspection, problems or issues addressed, approach and any legal aspects which apply.

Revision Question 3

(1) The sample is the snapshot of the state of health and safety at one particular time throughout the premises.

(2) True, but it is concerned with more than just reactive monitoring. It encompasses all forms of systems for monitoring, checking and measuring the effectiveness of health and safety arrangements and, where there are deficiencies, for reporting and taking action at the appropriate level to remedy them.

(3) The main factors influencing the frequency of monitoring activities are:

– Suitable intervals to ensure that specific planned milestones are achieved

– The potential for change in conditions over time

– The relative importance of the activity or particular precaution relative to the overall control of risk

– Where inspection and maintenance intervals are prescribed by suppliers/manufacturers

– Where intervals for monitoring are prescribed by legislation

– Where there is evidence that there is non-compliance

– Where there is evidence of compliance.

(4)   Health and safety auditing is the structured process of collecting independent information on the efficiency, effectiveness and reliability of the total health and safety management system and drawing up plans for corrective action.

(5)   A compliance rating indicates the degree to which the organisation is meeting a particular performance standard. A rating of 54% would indicate that compliance is at the minimum acceptable level, probably sufficient only to meet legal requirements.
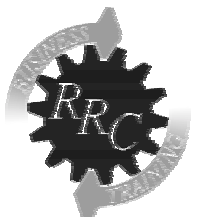
RRC Business Training

NEBOSH

International General Certificate

in Occupational Safety and Health

Examination and Assessment Preparation

RRC Module No. 915EAP.1.1

NEBOSH International General Certificate

Examination and Assessment Preparation

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INTRODUCTION TO 'EXAMINATION AND ASSESSMENT PREPARATION'

The primary objective of this part of the course is to help to prepare you for the NEBOSH International General Certificate examinations and practical assessment and if you work systematically and carefully through the course material we have every confidence that you will be successful in passing.

Tutor-Assessed Assignments 4, 5 and **6** act as Mock Examinations to prepare you for your final NEBOSH assessments. In addition, passing these TAA's will entitle you to receive the RRC Certificate of Successful Completion. You will need to complete these assessments under examination conditions and be invigilated by a senior manager nominated by you. Once you are ready to attempt these TAA's, you should inform your nominated manager who should then request them from RRC.

- **Tutor-Assessed Assignment 4** is a mock Paper A1.

- **Tutor-Assessed Assignment 5** is a mock Paper A2.

- **Tutor-Assessed Assignment 6** is a mock Practical Assessment.

THE EXAMINATION

Your written examination consists of two papers, covering Parts A1 and A2 of the syllabus. Both papers contain one 20-mark question and ten 8-mark questions. The time allowed for each paper is 2 hours and you should attempt **all** the questions.

To qualify for a pass grade, you must obtain a mark of 45% or greater in papers A1 and A2, and 60% in Part B. The marks for the two papers are no longer aggregated which means that a pass may be achieved on one paper irrespective of the mark awarded to the other. As a result of this, referrals can be given on individual components and candidates can carry over a pass result for one component provided that registration for the failed component is made within 6 months. Please note, however, that you can only sit failed components **once**.

Examination results are expressed as a grade, which relates to the marks obtained in Part A (Papers A1 and A2) and Part B (the practical assessment) as follows:

Distinction	At least 65% in each paper at Part A **and** at least 80% in Part B
Credit	At least 65% in each paper at Part A **and** at least 70% in Part B
Pass	At least 45% in each paper at Part A **and** at least 60% in Part B
Refer	Less than 45% in either paper at Part A **or** less than 60% in Part B
Fail	Less than 45% in both papers at Part A **and** less than 60% in Part B

Initial Preparation

It may be some time since you last took an examination. Examination technique is a skill, and we hope to go some way towards helping you to acquire it by asking you to attempt trial questions and assignments under exam conditions. Practice will provide experience and feedback will give you confidence and a good idea of what to expect.

REVISION TECHNIQUE

Revising the RRC Course Material

You should obviously ensure that you have read through all your course material carefully before beginning your revision in earnest. Make sure that you have understood everything and that any outstanding queries have been resolved with your personal tutor. Ideally you will have annotated or highlighted sections of the text which you think are important for various reasons.

If you have sufficient time, your revision might include reading all of the text again. If this is not possible, then rely on the notes you have made to focus attention on specific parts.

As you read through the material for a second time, ask yourself searching questions on each topic such as, '*What use is this?*', '*How would a health and safety practitioner apply this in real life?*', until you feel that you thoroughly understand why a health and safety practitioner would need to know this.

Utilising the Syllabus

Exam questions are set from the syllabus, not from the RRC notes. It is therefore an important revision technique to map your notes against the syllabus. You will find that in general your RRC materials follow the syllabus quite closely, but this exercise is important to help you see the 'big picture'. It is easy, when studying one specific section of an RRC unit, to lose sight of where the material fits into the grand scheme of things, what practical use it has or how the health and safety practitioner might use this in real life. Constant reference back to the syllabus will put that topic in perspective and help you to see how it relates to the field of health and safety generally. It will also help you to cross-refer to other related topics, which you may have to do in more complex examination questions.

Each unit in the NEBOSH International General Certificate syllabus contains the following important sections:

- '**Contents**' – This lists the topics that you should be fully familiar with.

- '**Overall Aims**' – These set out the knowledge and understanding that you should possess after studying the unit.

- '**Specific Intended Learning Outcomes**' – These specify what you should be able to explain, appreciate, carry out, assess, etc. after having completed the unit.

By using all of these sections of the syllabus, you can test whether you now possess the necessary skills, knowledge and understanding relevant to that unit or whether you need to do more.

As we have seen above, the 'overall aims' section of the syllabus refers to knowledge and understanding. You will find it easier if you ensure that you understand the topic first before you attempt to fill in the knowledge requirements (i.e. the detail). Once you have this level of understanding, the detailed knowledge will be much easier to retain.

An effective revision technique is to take a pin (blunt, of course, for health and safety reasons!) and randomly stick it in some part of the syllabus. Now write down what you know about that topic. Initially, the answer might be very little, in which case go back to your RRC notes and summarise the key issues that you have to know. Make a note of this topic and return to it a few weeks later and see how much more you can remember. If you practise this regularly, you will eventually cover all of the syllabus and in the process find that the material is understood and retained much more effectively. This is often referred to as 'active revision', where you are testing your memory to see what has been retained and is much more effective than 'passive revision' where you simply re-read the RRC notes.

Your revision aim is to achieve a comprehensive understanding of the syllabus. Once you have this, you are in a position to say something on each of the topic areas and consequently tackle any question set on the syllabus content.

Utilising Your Own Experiences

If you are already working in a health and safety related field, you are likely to have a wealth of experience which you will be able to draw on in the examination. Relevant examples are always valuable and you should not be afraid to introduce your own experiences into your answers. Even if you are not already working specifically in health and safety, you are still likely to have valuable experience which you can draw on – we have all walked past building sites, for example, and noticed examples of safe or unsafe practices. However, be careful not to digress from the precise context of the question.

EXAMINATION TECHNIQUE

The examination process may seem complex but success depends simply on averaging around half marks or more for each question. Marks are awarded for setting down ideas that are relevant to the requirements of the question, and convincing the examiner that you understand what you are talking about. If you have the knowledge and understanding derived from study of the syllabus as set out above, then this should not be a problem.

An important examination skill is carefully reading and analysing the question so that you are fully clear what is required to answer it. The more you can study sample examination questions, the more familiar you will become with the way they tend to be phrased and the 'shape' of the answer required.

The following words are commonly used in NEBOSH examination questions. Make sure you understand what they mean.

Question Word	Requirement
Define	State the precise meaning of something.
Describe	Relate what something looks (or sounds, feels, smells) like, how a sequence of events happened or what the main characteristics of a topic are.
Explain	Relate how things work, or how something happened, or give reasons for certain actions.
Identify	Single out the main features of something.
List	This is asking for an item-by-item record of relevant items. It would normally be in note form without any need to describe (but do check what the question actually says).
Outline	Point out the main features of a topic or sequence of events.
State	Write down the main points of something.

A common failing in answering questions is to go into too much detail on specific topics and fail to address the wider issues. If you only deal with half of the relevant issues, you can only achieve half of the marks. Try to give as wide an answer as you can, without stepping outside the subject matter of the question altogether. Ensure that you explain each issue in order to convince the examiner that you have this all-important understanding. Giving relevant workplace examples is a good way of doing this.

We mentioned earlier the value of using the syllabus to plan your revision. Another useful way of combining syllabus study with examination practice is to create your own exam questions by adding a question word (such as 'explain' or 'describe') in front of the syllabus topic areas. In this way you can produce a whole range of questions similar to those used in the sample papers.

Dealing with the Examination

- Know where the exam is to take place

- Arrive in good time

- Bring your candidate number, pens, pencils, protractors, etc

- Bring a drink and sweets to suck, if they help. It is important not to feel uncomfortable, which could be distracting.

NEBOSH has commented that candidates will not normally be penalised for any weakness in grammar and spelling, so long as answer scripts are clear and can be understood. Marks will be lost only if the examiners have difficulty in reading or understanding your handwriting.

Read carefully through the whole paper before starting work.

Try to remember the following points:

- Look at the amount of time you are allotted in which to answer a question. It gives you an idea of how much detail you are expected to provide. Remember that there is only a certain amount of points available for each question and spending a disproportionate amount of time on a single question will never get you more than this maximum. Therefore divide up the time available depending on the number of points available for each question and stick to this as much as possible.

- Pay particular attention to the wording of a question and make sure you understand what the examiner is looking for. Note the use of action verbs, such as 'describe', 'state', 'list', 'explain', 'define' or 'outline', all of which indicate the type of treatment which the examiners are seeking.

- Supply examples of practical applications from your own personal work experience whenever possible. This is a key point in all NEBOSH examinations, since you are expected to be a practical person.

- If you start to run out of time, write down your answers in bullet point or check list style, rather than fail to answer a question at all.

SPECIAL CIRCUMSTANCES AFFECTING THE EXAMINATION

Candidates who believe they may suffer a disadvantage in the examination and/or practical assessment due to a disability, medical condition, specific learning difficulty (such as dyslexia) or any other reason (e.g. family bereavement) which applies **before** the examination and/or practical assessment, and who are not given or do not wish to make use of any special arrangements must report the details of this in writing to NEBOSH (with medical or other evidence where appropriate) on registration or as soon as possible thereafter with a request that special consideration be given to their results.

Candidates who feel disadvantaged due to illness, distraction or any other reason **during** the examination or practical assessment must report this to the invigilator **before leaving** the examination room and request that their written statement, together with the invigilator's comments on the statement, be sent by the invigilator to NEBOSH.

THE PRACTICAL ASSESSMENT

For Part B of your examination you will be required to undertake a safety inspection of a workplace, without making reference to any document, checklist or other aid.

Aim of the Practical Assessment

The aim of this practical assessment is to prove your ability to complete two activities successfully:

- To carry out unaided a safety inspection of a workplace, identifying the more common hazards, deciding whether they are adequately controlled and where necessary, suggesting appropriate and cost effective remedial action.

  This information is recorded in the Observation/Action/Time Scale Form - this must be completed during the inspection and should take between 30 and 45 minutes.

- To prepare a report that urges management persuasively to take appropriate action, explaining why such action is required and identifying, with due consideration of reasonable practicability, the remedial measures that should be implemented.

  This takes the form of a formal report to management - it is undertaken on completion of the inspection and should take about one hour.

(**Source**: Guide to the NEBOSH International General Certificate)

You will have to prove your ability to:

(a)   Identify the more common and obvious hazards.

(b)   Ensure that safe systems of work are being observed and that there is general compliance with general and specific legal requirements.

(c)   Prepare two types of report:

   (i)   A **Practical Assessment Report**

   (ii)   A **Report to Management**

You will be expected to pay attention to environmental as well as physical, chemical and biological hazards. You are also encouraged to note where hazards are adequately controlled, i.e. to identify **good** as well as **bad** practices.

Setting and Marking of the Practical Assessment

The workplace or work area where the practical assessment is undertaken is decided by a person approved by NEBOSH. This same person, who must be a Fellow or Member of the Institution of Occupational Safety and Health (IOSH) with an academic qualification in occupational safety and health, will mark the assessment according to specific criteria established by NEBOSH (see Appendix A).

PRINCIPAL FEATURES OF A SAFETY INSPECTION

What is a Safety Inspection?

A safety inspection is generally taken to mean a scheduled inspection of a workplace or work area by a person from within the organisation, possibly accompanied by an external specialist.

A safety inspection examines, for instance, working practices, levels of housekeeping, structural safety aspects, fire protection arrangements, environmental factors, the safety aspects of work equipment, potential health risks and the adequacy of welfare amenity provisions. The principal objective is to identify hazards at a particular point in time.

> Imagine, right now, that you have been asked to carry out a safety inspection of your working area. Take no more than three to four minutes to list the points you would be looking for.

Having completed this activity, how many points did you list?

Did you reach double figures? Very few people do in the time available.

Did you consider basic points such as tripping hazards, fire risks, overloaded electrical points, poor lighting, slippery floors, dangerous staircases and defective hand tools?

Look around you. Answer the following questions.

(a)   Can you see a fire appliance and a FIRE EXIT sign?

(b)   Are there trailing flexes to electrical equipment?

(c)   Is the working area heavily congested with:

	Yes	No
Stored goods	☐	☐
Raw materials	☐	☐
Items of equipment and furniture?	☐	☐

(d)   Is there a risk of slips, trips and falls?

(e)   Is there a risk of things falling on to people below?

(f)   Can you see any hazardous substances in cans, bottles and other containers?

(g)   Is the level of lighting adequate for the jobs people are doing?

(h)   Are people lifting things correctly?

(j)   Are there any unguarded machinery hazards?

(k)   Are people wearing/using personal protective equipment correctly?

Note that many more questions could have been asked.

These two activities will have increased your awareness of the sort of things to be considered when carrying out a safety inspection. Many people use a standard form or checklist for this exercise. This

practice is acceptable, but the problem is that in most cases people carrying out an inspection only consider the points raised in the checklist and can miss hazards which are not listed.

A safety inspection therefore entails a **thorough** examination of the workplace on a room-by-room or area-by-area basis, including the observation of working practices which may or may not be incorporated in a formally-written safe system of work.

'Hazard' and 'Risk'

One definition of the term **'hazard'** is 'the result of a departure from the normal situation which has the potential to cause death, injury, damage or loss'. Hazards can take many forms and will present different levels of risk.

'Risk', on the other hand, is defined as 'the probability or likelihood of a hazard leading to personal injury and the severity of that injury'.

The principal objective of a safety inspection is the identification of hazards.

Classification of Hazards

Hazards may take many forms. The main types of hazard include those associated with:

Fire	Machinery	Electricity
Environmental factors	Manual handling	Mechanical handling
Slips, trips and falls	Workplace layout	Falling objects
Airborne contaminants	Work at heights	Work below ground level
Pressure systems	Hazardous substances	Noise and vibration
Vehicle operations	Structural features	Unsafe practices
Radiation	Housekeeping	Access
Storage systems	Workstation layouts	Biological agents
Personal protective equipment	Hand tools	Animals

'Safe Place' and 'Safe Person' Strategies

Accidents at work are frequently associated with unsafe **places** of work and unsafe **practices** on the part of people at work. Detailed below are some questions you should be considering when undertaking a safety inspection of a workplace or work area.

(1) A **Safe Place** strategy is aimed at reducing the objective danger in a workplace and takes into account the following factors:

- **Safe premises**

  Are the premises clean?

  Are the workplace, equipment, systems and devices maintained in an efficient state, efficient working order and in good repair?

  Are floors in good condition and free of obstructions?

  Are floor openings adequately protected against falls?

Is there a risk of someone falling out of a window?

Are staircases safe and fitted with a handrail?

Is an adequate level of lighting provided?

Is the workplace too hot or too cold?

- **Safe plant and machinery**

    Are machines adequately guarded and fitted with appropriate safety devices?

    Are power sources to machinery properly connected?

    Can machinery and plant be cleaned safely?

    Are machines maintained in an efficient state, efficient working order and in good repair?

    Is there a formally documented planned preventive maintenance schedule for machinery?

    Are hand tools in a good condition, well-maintained and used correctly?

- **Safe processes**

    Are the various operations carried out safely? Look at, particularly:

    Manual handling

    The driving of fork lift trucks

    The storage of raw materials and finished products

    Ergonomic aspects of machine operation

    The use of hazardous substances.

- **Safe materials**

    Are materials being handled safely?

    Are some of the materials dangerous, such as radioactive substances, chemical substances or biological agents?

    Are these substances correctly packaged and labelled?

    Is there adequate information on the safe handling of materials and substances?

- **Safe systems of work**

    Are safe systems of work established for potentially hazardous operations?

    Are these safe systems of work followed implicitly?

    Is a Permit-to-Work system used where there is a high degree of foreseeable risk?

- **Safe access to work**

    Are access roads and internal gangways kept clear, maintained and well-lit?

    Are specific provisions made for ensuring safe work at heights and below ground level, e.g. scaffolds, mobile access equipment, protection of excavations?

    Are ladders well-maintained and used correctly?

- **Adequate supervision**

  Is the level of safety supervision adequate?

  Are line managers adequately trained in their health and safety duties?

- **Competent and trained personnel**

  Are competent persons, e.g. for electrical maintenance work, clearly identified?

  Are operators adequately informed, instructed and trained in safe systems of work?

  Are First Aiders adequately trained?

(2) We also need to consider **Safe Person** strategies in a safety inspection. These strategies are concerned with increasing people's perception of risk. In your inspection it may be appropriate to consider the following factors:

- **Care of the vulnerable**

  Vulnerable groups are:

  Young persons

  Pregnant women

  Disabled persons

  Are they exposed to specific risks?

  Do such persons need to receive some form of medical or health surveillance?

  Are specific provisions made for the supervision of vulnerable groups?

- **Personal hygiene**

  Is there a risk of occupational skin conditions through poor levels of personal hygiene?

  Are adequate welfare amenity facilities provided?

  Is there a prohibition on the consumption of food and drink in working and storage areas?

- **Personal protective equipment**

  Does personal protective equipment (PPE) provided meet the requirements necessary for the particular hazards and risks of the workplace?

  Is there a formal procedure for selection and assessment of PPE?

  Do those workers exposed to risks wear their PPE correctly and all the time that they are exposed to risks?

- **Careful conduct**

  Do operators behave safely during their work?

  Were any unsafe practices noted?

(a) Take a notebook and inspect your working area, making a note of all the hazards you can see within the above categories. Take into account the **Safe Place** and **Safe Person** strategies outlined above. Start at the entrance and work your way round. Don't forget to note both **good** and **unsafe** working practices.

(b) Do any of the hazards you have identified come within the above categories?

(c) Do you know what needs to be done to prevent or control exposure to the hazards you have identified?

(d) Is it possible to evaluate the risks arising from these hazards on the basis of **High Risk**, **Medium Risk** or **Low Risk**?

(e) List those high risk situations which need immediate attention and the action required.

(f) Add an indication of whether these situations can be dealt with on a **High Cost**, **Medium Cost** or **Low Cost** basis.

Now that you have completed this exercise, which should take about 45 minutes, you are well on the way to completing a Practical Assessment Report Form.

COMPLETING THE PRACTICAL ASSESSMENT REPORT FORM

You are supplied with copies of the Practical Assessment Report Form prior to the inspection. This form must be completed during the inspection which should take between 30 to 45 minutes (see Appendix B).

The Practical Assessment Report Form incorporates four elements:

- **Observations**

    Here you are required to list any hazards, unsafe practices and good practice.

    It is vital that **hazards** are adequately described. A '*hazard*' is defined as '*something with the potential to cause harm*'. Here are a few examples:

    – Risk of slips, trips and falls due to the defective state of the floor finish.

    – Risk of head and body injuries due to careless high level storage of hand tools and items of equipment.

    – Risk of fire due to the haphazard storage of flammable wastes.

    It is not good enough to merely describe a hazard as '*defective floor*', '*bad storage*' or '*fire risk*'.

    Similar requirements apply in the case of **unsafe practices**. Here are a few examples:

    – Risk of injury to workers due to careless fork lift truck driving.

    – Risk of fire due to workers smoking in designated "No Smoking" areas.

    – Risk of falls from a height due to the dangerous pitch of a ladder.

    Good practice should also be commented upon where appropriate.

- **Action to be taken (if any)**

    The objective of this column of the Practical Assessment Report Form is to state, in sufficient detail, the action required by management to eliminate or control hazards and unsafe working practices. Short statements, such as "*Fit a guard*" or "*Segregate the area*" are inadequate. Here are a few examples:

    – Storage areas should be clearly marked out and gangways kept clear at all times.

    – The adjustable guard to the circular saw should be reinstated and maintained in position during use.

    – Workers should be trained in the correct use of ladders and supervised where such work is carried out.

    – The level of artificial lighting in the storage area should be increased (for example, to a minimum of 200 Lux).

    – A planned preventive maintenance system should be installed.

- **Priority/Time Scale**

    The second and fourth columns should indicate the priority and timescale of action required in respect of each observation. A coding system is recommended, such as:

    H   -   Immediate action

M - Medium-term action (i.e. action within the next 14-28 days)

L - Long-term action (i.e. action within the next 12 months)

An example of a completed Practical Assessment Report Form is shown in Appendix C.

Criteria for Assessment

In order to score well in this part of the practical assessment, you must pay considerable attention to the criteria for assessment and maximum marks awardable shown in the Assessor's Marking Sheet under the heading OBSERVATIONS (see Appendix A). Important features of these criteria are outlined below.

- **Range of issues identified (0 to 5 marks)**

  A workplace inspection will normally identify a range of hazards, of which some are well controlled and others need remedial action. To score well in this element of the practical assessment, you must show evidence of having paid attention to both **general** and **specific** hazards which could arise.

  General hazards include those relating to fire, the use of electricity, structural features, environmental features, layout and housekeeping. The more **specific hazards** will depend upon the type of workplace being inspected. For instance, in a workshop it is common to identify hazards associated with machinery, electrical appliances, materials, vehicle maintenance and flammable substances. In an office, the more common hazards are those arising from the use of display screen equipment, electrical appliances and access equipment.

- **Number of hazards identified (0 to 20 marks)**

  Providing hazards are well-described, you should be able to score highly in this element if you identify around 15 to 20 hazards.

- **Identification of immediate, medium and long-term actions (0 to 10 marks)**

  Marks are awarded on the basis of the priority of action allocated in respect of the stated remedial action.

  High Priority should be specified where there is risk of serious or imminent danger, or where there is a flagrant breach of legal requirements.

  Medium Priority should be specified where hazards can be eliminated or controlled without the need for capital expenditure, and where there is no serious or imminent danger present.

  Low Priority situations could include those where there may be a need, for example, for the provision of information, instruction and training, the writing of a safe system of work or the introduction of health surveillance. This category may also cover situations where some form of medium-term allocation of resources is necessary.

- **Suitability of remedial action/time scales (0 to 20 marks)**

  Many candidates lose marks in this element of the report by failing to give sufficient information on the remedial action necessary and how urgent this action is. Fundamentally, this element should provide the person undertaking the remedial action, who may not be aware of the legal and other requirements, with sufficient information to complete the action required. Remedial action must be cost-effective and realistic.

THE REPORT TO MANAGEMENT

Many candidates obtain low marks in this part of the Practical Assessment because of their inability to prepare a well-structured report and also their failure to write a report which would motivate a senior manager to take action, including the allocation of resources directed at eliminating or controlling hazards.

What is a Report?

A report is defined as a written record of activities based on authoritative sources, written by a qualified person and directed towards a predetermined group. In the preparation of the report always remember that the recipient may not be aware of technical or abbreviated terms. Avoid the use of technical jargon!

Broadly, a report is of an impersonal nature; it states the facts or findings of the writer and, most importantly, makes recommendations for immediate and future action, indicating, in some cases, the need for financial approval.

It should incorporate a title indicating the location and date of the inspection, an introduction, the findings of the author, recommendations as to immediate, short-term and long-term action and a conclusion which summarises the main findings and recommendations.

A report should provide the recipient with sufficient information on matters which require his attention, including breaches of the relevant legal provisions, the remedial action necessary and the financial implications of implementing this remedial action.

Writing the Report to Management

This part of the Practical Assessment is completed on lined paper in your own handwriting. A maximum of 45 marks is awardable for this report, which should be approximately 500 to 750 words in length. For average handwriting, this equates to two or three sides of A4 paper.

Remember that there is no standard format for your Report to Management. Study carefully the example of a completed Report shown in Appendix D. Note how all the guidance notes given above are incorporated into the report, and spend a few minutes comparing and relating the completed Practical Assessment Report Form (Appendix C) with the Report to Management in Appendix D.

Remember that the Report to Management should be signed and dated.

Criteria for Assessment

There are four elements in the assessment of this report (see Appendix A).

- **Selection of topics for urgent management action (0 to 10 marks)**

    Reference to the Practical Assessment Report Form will identify those hazards rated at Priority 1. Where possible, these hazards should be grouped under specific headings, such as fire hazards, electrical hazards and structural hazards, and reference made to the urgent action required.

- **Practical Recommendations including Cost, Timescales/Priorities and Actionees' (0 to 10 marks)**

    To allow the management team to decide on whether action should be taken, recommendations for improvement should be made based on the problems found. In addition to the action

required, an indication of priority of action (with suggested timescale, if reasonable), cost implications and suitable person(s) to carry out actions should be included.

- **Presentation of information (0 to 10 marks)**

    There is no standard format for this element of the Report to Management. However, you should take into account the guidance notes we gave earlier. Remember that the recipient may not be familiar with legal and technical terminology or abbreviated terms commonly used by health and safety practitioners.

- **Effectiveness in convincing management to take action (0 to 15 marks)**

    The basic question to be considered here is: "*Would this report motivate a manager to take immediate action or not?*" On this basis, the report must be concise, written in language that he understands and free from minor or trivial observations and recommendations. The report should specify why action is required and the benefits to be derived by the implementation of the recommendations.

APPENDIX A - PRACTICAL ASSESSMENT MARKING SHEET

INTERNATIONAL GENERAL CERTIFICATE

PART B - THE PRACTICAL ASSESSMENT

Assessor's marking sheet

Candidate's Name _____   Candidate Number **C** _____

Examination Centre _____

Date of practical assessment _____ / _____ / _____ Name of Assessor _____

	Maximum marks available	Assessor's marks	NEBOSH moderated marks *(if applicable)*
OBSERVATIONS			
1. Range of issues identified	**5**		
2. Number of hazards identified	**20**		
3. Identification of immediate, medium and long-term actions	**10**		
4. Suitability of remedial action/time scales	**20**		
REPORT TO MANAGEMENT			
5. Selection of topics for urgent management action	**10**		
6. Practical recommendations including cost, timescales/priorities and actionees	**10**		
7. Presentation of information	**10**		
8. Effectiveness in convincing management to take action	**15**		
TOTAL MARKS	**100**		

Outcome: SATISFACTORY (60% or more) ☐   **UNSATISFACTORY (less than 60%)** ☐

Date assessed _____ / _____ / _____

Assessor's signature _____

Date received by programme organiser _____ / _____ / _____

Date received by NEBOSH *(if applicable)* _____ / _____ / _____

please do not write in this box

APPENDIX B - SAMPLE PRACTICAL ASSESSMENT REPORT FORM

INTERNATIONAL GENERAL CERTIFICATE

PART B - THE PRACTICAL ASSESSMENT

nebosh

Candidate's observation sheet

Sheet Number _____ of _____

Candidate's Name _____

Candidate Number **C** _____

Place inspected _____

Date of inspection _____ / _____ /_____

Observations List hazards, unsafe practices and good practices	Priority/ risk (H, M, L)	Actions to be taken (if any) List any immediate or longer-term action required	Time scale (immediate, 1 week, etc)

Please use a continuation sheet if necessary.

APPENDIX C - EXAMPLE OF A COMPLETED PRACTICAL ASSESSMENT REPORT FORM

INTERNATIONAL GENERAL CERTIFICATE

PART B - THE PRACTICAL ASSESSMENT

nebosh

Candidate's observation sheet

Sheet Number _____ of _____

Candidate's Name _____

Candidate Number **C** _____

Place inspected   Engineer's workshop and store

Date of inspection   _____ / _____ /_____

Observations List hazards, unsafe practices and good practices	Priority/ risk (H, M, L)	Actions to be taken(if any) List any immediate or longer-term action required	Time scale (immediate, 1 week, etc)
Engineer's workshop			
Fire risk due to the storage of flammable substances on the bench	H	All flammable items to be stored in a fireproof cabinet	Immediate
Risk of injury in case of fire due to the current obstruction of the fire exit with an oil drum	H	Drum to be removed and exit kept clear at all times	Immediate
Slipping hazards due to untreated oil spillages on the floor	H	The floor should be cleaned and subject to regular cleaning	Immediate
Health risk due to the practice of preparing beverages on a dirty bench	H	This practice should be prohibited	Immediate
Health risk due to inadequate ventilation	M	Mechanical ventilation capable of achieving 10 air changes per hour should be installed	within 14-28 days
Risk of eye and face injury due to operator not wearing visor provided	H	Requirements relating to the wearing of visor should be enforced	Immediate
Risk of injury from falling items due to overloaded state of the storage racking	H	Storage racking should be reorganised	Immediate
	M	Further racking should be installed	within 14-28 days
Risk of back injury due to operators not lifting heavy items correctly	H	Training in safe manual handling should be provided and posters depicting correct techniques displayed	Immediate

Practical Assessment Report Form (continued)

Observations List hazards, unsafe practices and good practices	Priority/ risk (H, M, L)	Actions to be taken(if any) List any immediate or longer-term action required	Time scale (immediate, 1 week, etc)
Risk of electrocution due to the defective and dangerous state of the flex on the electric drill	H	The flex should be renewed	Immediate
Risk of finger amputation due to the lack of a fixed guard to the metal-cutting guillotine	H	A fixed guard should be installed	Immediate
Risk of falls from a height due to the dangerous state of the wooden ladder stored in the corner of the workshop adjacent to the fire exit	H	The wooden ladder should be destroyed and replaced with a new ladder	Immediate
Risk of fire due to the storage of flammable refuse in plastic sacks	H	A metal container with close fitting lid and suitably marked for such storage should be provided	Immediate
The sanitation and washing area at the rear of the workshop is in a dirty condition	H	This area should be cleaned and redecorated	Immediate
No facilities are provided for the storage of clothing not worn during working hours, for the changing of clothing, for rest and the taking of meals	L	A new amenity area should be provided to meet the current legal requirements. I would be pleased to advise management on the design of this area	Within next 12 months
Store			
The standard of housekeeping is appalling, creating numerous fire, tripping and contact hazards	H	The store should be cleared, superfluous items disposed of, and further racking and shelves installed	Immediate
Health risks due to the storage of chemical substances in unmarked mineral water bottles	H	The bottles and their contents should be destroyed	Immediate
Fire and explosion risk due to the storage of welding gas cylinders	H	The cylinders should be removed and stored separately in purpose-built enclosure	Immediate

APPENDIX D - EXAMPLE OF A COMPLETED REPORT TO MANAGEMENT

Report on an Inspection of the Engineer's Workshop and Store

Introduction

An inspection of the Engineer's Workshop and Store was carried out on Friday, 6th June 2003 with a view to assessing current safety standards and identifying any unsafe acts and conditions.

Generally, the standard of safety was poor and there are a number of issues which require urgent management attention as indicated below.

Findings

Those matters requiring urgent management attention are outlined below.

1.0 Fire Hazards

A number of fire hazards were present as a result of unsatisfactory working practices, including the storage of flammable substances on a workbench, the storage of flammable refuse in plastic refuse sacks and the use of the store for storage of welding gases (which should be kept in a special area). Additionally, one of the fire exits was blocked which could prevent an emergency evacuation.

2.0 Housekeeping

The standard of housekeeping in the store is not satisfactory to control risks. There are numerous fire, tripping and contact hazards due to the fact that the store is far too small for the range of items stored. The shortage of storage racking means that many items are stacked on the floor causing tripping hazards and blocking fire escape routes. The racking that is provided is overloaded and unstable. Serious injury could result if the racking collapsed.

3.0 Machinery and Equipment

Several items of machinery and equipment are in a dangerous state due to the absence of guarding and inadequate maintenance. The guard to the metal-cutting guillotine has been removed and a wooden ladder is in a highly dangerous state with three damaged rungs. Using the equipment in this condition could result in a very serious injury.

4.0 Working Practices

Due to the lack of safety awareness by staff in this workshop, a number of unsafe practices were noted, including failure to clear oil spillages, the preparation of beverages on a dirty workbench, failure to wear full face protection whilst welding, unsafe manual handling practice and the storage of chemicals in unmarked mineral water bottles. All of these practices can be associated with poor supervision and a lack of training in the appropriate safe working practices.

5.0 Welfare Amenity Provisions

The toilet and hand washing area is in a particularly dirty state and requires urgent cleaning and redecoration. It was also noted that there is no provision made for the storage and changing of clothing, for rest and taking meals.

CONCLUSION

There is clear evidence that little attention has been paid to maintaining good standards of health and safety performance in this area for some time. Because of the poor standard of provision of engineering facilities, staff have had to work under difficult conditions in order to fulfil their duties.

There are a number of problems and failures which could result in enforcement action. Vast improvements in the standard of cleanliness and housekeeping, the control of fire, chemical and equipment hazards, however, could be brought about rapidly through improved supervision and minimal expenditure.

On a long-term basis there is a need to consider future workshop arrangements, including the provision of more working space together with better storage and welfare arrangements. The following recommendations should be implemented.

RECOMMENDATIONS

1.0 Fire Hazards

Whilst unsatisfactory working practices can be eliminated at no cost through improved management control, there is an urgent need to provide a separate gas cylinder storage area. This might entail a high level of expenditure which has to be approved by the Managing Director. These improvements should be implemented as soon as possible by the Workshop Manager and Store Supervisor.

2.0 Housekeeping

The store requires completely clearing and the provision of extra racking to permit storage off the floor. This could be installed at minimal cost (unused racking on the workshop floor can be taken into the store). This work can be carried out, along with the disposal of unwanted items, at the next shutdown by the maintenance staff.

3.0 Machinery and Equipment

The guillotine must be removed from service immediately and not be used until the guard is replaced. Similarly, the ladder should be destroyed and replaced with a new one. All staff must be instructed in the importance of reporting hazards immediately. An informal talk by the Workshop Manager should be held in the next week to highlight the dangers of using unguarded machinery and defective equipment.

4.0 Working Practices

It is recommend that all staff attend a one-day training course on Workshop Safety in the near future. The contents of the course to be agreed with the Managing Director

These recommendations can be implemented at little or no cost.

5.0 Welfare Amenity Provisions

The toilets and washing facilities should be cleaned immediately by the contracted cleaners. Quotes for the refurbishment/improvement of the welfare facilities should be obtained with a view to providing good rest, changing and washing facilities. The Maintenance Manager should seek out suitable contractors and obtain quotes. As this will entail capital expenditure, so it should be an item for the next Directors meeting.

Date   *12/8/2003*   Signature   *J S Cox*