NEBOSH GENERAL CERTIFICATE - UNITS GC2 AND GC3

Controlling Workplace Hazards

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NEBOSH NATIONAL/INTERNATIONAL GENERAL CERTIFICATE

UNIT GC2: CONTROLLING WORKPLACE HAZARDS

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Introduction

Course Structure

This textbook has been designed to provide the reader with the core knowledge needed to successfully complete Unit GC2 of the NEBOSH National and International General Certificates in Occupational Health and Safety, as well as providing a useful overview of the practical control of various health and safety issues in the workplace. It follows the structure and content of the NEBOSH Unit GC2 syllabus.

The NEBOSH National and International General Certificates each consist of three units of study. When you successfully complete any of the units, you will receive a Unit Certificate, but to achieve a complete NEBOSH National or International General Certificate qualification, you need to pass all three units within a five-year period. For more detailed information about how the syllabus is structured, visit the NEBOSH website (www.nebosh.org.uk).

Each NEBOSH Certificate qualification can be achieved as follows:

NEBOSH National General Certificate in Occupational Health and Safety

Unit NGC1: Management of Health and Safety	
Unit GC2: Controlling Workplace Hazards	
Element 1	Workplace Hazards and Risk Control
Element 2	Transport Hazards and Risk Control
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Unit GC3: Health and Safety Practical Application
The Practical Assessment

Unit NGC1 Management of Health and Safety + Unit GC2 Controlling Workplace Hazards + Unit GC3 Health and Safety Practical Application = **NEBOSH National General Certificate in Occupational Health and Safety**

NEBOSH International General Certificate in Occupational Health and Safety

Unit IGC1: Management of International Health and Safety
Unit GC2: Controlling Workplace Hazards
Unit GC3: Health and Safety Practical Application

Unit IGC1 Management of International Health and Safety + Unit GC2 Controlling Workplace Hazards + Unit GC3 Health and Safety Practical Application = **NEBOSH International General Certificate in Occupational Health and Safety**

Assessment

To complete the qualification, you need to pass two formal written exams (one for either Unit NGC1 or IGC1 and one for Unit GC2), as well as practical assessment (Unit GC3).

Each written exam (NGC1/IGC1 and GC2) is two hours long and consists of eleven compulsory questions, each of which requires a full written answer.

The practical assessment (GC3) requires you to undertake a safety inspection in your workplace and write a short report on your findings.

Further information and help on the Unit GC2 exam is given in this textbook in the Exam Skills sections at the end of each element, and in the Revision and Examination section at the end. Further information and help on the Unit GC3 practical assessment is also given in this textbook at the back end.

Further information and help on the Unit NGC1/IGC1 exam is given in the relevant Unit 1 textbook.

Legal Standards

This textbook has been written to cover Unit GC2 content for both National and International General Certificate courses. Because there are no truly universal global legal standards that will apply in all national legislative frameworks, the book makes frequent use of UK legal standards (i.e. those that apply in Great Britain and Northern Ireland) as these often represent best practice. They also normally reflect the legal standards to be found in other European member states. It is not possible nor desirable to include all of the specific technical legal standards that apply in various countries around the world. But, it is useful to recognise that the International Labour Organisation (ILO) has established Conventions and Recommendations on many of the topics and issues dealt with in Unit GC2.

To help students on both NGC and IGC courses, two Legal Standards boxes are included at the end of most sections of the book. These highlight the specific legal standards that apply for NGC students and the relevant ILO Conventions and Recommendations for IGC students.

These boxes look like this:

National General Certificate Legal Standards	International General Certificate Standards
• Workplace (Health, Safety and Welfare) Regulations 1992. • Workplace (Health, Safety and Welfare) Regulations (Northern Ireland) 1993.	• ILO C120 - Hygiene (Commerce and Offices), Convention, 1964 (No. 120). • ILO R120 - Hygiene (Commerce and Offices), Recommendation, 1964 (No. 120). • ILO R102 - Welfare Facilities Recommendation, 1956 (No. 102).

Hopefully these legal standards references will help students to recognise and find the law relevant to specific topics and issues. This might be particularly useful when completing Unit GC3, the practical assessment.

Keeping Yourself Up to Date

The field of health and safety is constantly evolving and, as such, it will be necessary for you to keep up to date with changing legislation and best practice.

RRC International publishes updates to all its course materials via a quarterly e-newsletter (issued in February, May, August and November), which alerts students to key changes in legislation, best practice and other information pertinent to current courses.

Please visit www.rrc.co.uk/news-resources/newsletters.aspx to access these updates.

Other Textbooks in the Series

- NEBOSH National Fire Certificate - Fire Safety and Risk Management
- NEBOSH International Fire Certificate - Fire Safety and Risk Management
- NEBOSH National Certificate in Construction Health and Safety - Managing and Controlling Hazards in Construction Activities
- NEBOSH International Certificate in Construction Health and Safety - Managing and Controlling Hazards in International Construction Activities
- NEBOSH National Diploma Unit A - Managing Health and Safety
- NEBOSH National Diploma Unit B - Hazardous Substances/Agents
- NEBOSH National Diploma Unit C - Workplace and Work Equipment Safety
- NEBOSH International Diploma Unit IA - Managing Health and Safety
- NEBOSH International Diploma Unit IB - Hazardous Substances/Agents
- NEBOSH International Diploma Unit IC - Workplace and Work Equipment Safety

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Element 1

Workplace Hazards and Risk Control

Learning Outcomes

Once you've read this element, you'll understand how to:

1. Outline common health, welfare and work environment requirements in the workplace.
2. Explain the risk factors and appropriate controls for violence at work.
3. Explain the effects of substance misuse on health and safety at work and control measures to reduce such risks.
4. Explain the hazards and control measures for the safe movement of people in the workplace.
5. Explain the hazards and control measures for safe working at height.
6. Outline the hazards and control measures associated with works of a temporary nature.

Contents

Health, Welfare and Work Environment Requirements

IN THIS SECTION...

- Minimum welfare provision means ensuring that workers have access to drinking water, washing facilities, sanitary conveniences, changing rooms, accommodation for clothing, and rest and eating facilities.
- Workplace environment issues that affect worker health include the provision of suitable seating, ventilation, heating and lighting.
- Working in extreme temperatures can cause health effects such as dehydration, heat stress and heat stroke, and hypothermia and frostbite. These ill-health effects can be managed by controlling the environment, providing frequent breaks and facilities, personal protective equipment and training.

Welfare Provision

Here we outline good practice with regard to basic welfare requirements that apply to workplaces. These are subject to legal standards, for example those set by the EU Workplace Directive transposed in the UK as the **Workplace (Health, Safety and Welfare) Regulations 1992**. The **Construction (Design and Management) Regulations 2015** establish similar standards for construction sites. (Note that first aid is often considered to be part of an employer's welfare provision; this topic is covered in Unit 1.)

TOPIC FOCUS

Minimum welfare standards include:

- **Drinking water** - access to wholesome drinking water. If non-potable water is also available then supplies should be clearly labelled to distinguish between the two.
- **Sanitary conveniences** - access to a sufficient number of sanitary conveniences (WCs) for the number of workers present with separate facilities for men and women. They should be protected from the weather and adequately clean, lit and ventilated. Special provision should be made for the disabled.
- **Washing facilities** - access to suitable washing facilities by sanitary conveniences, changing facilities and as required in work areas. Showers may be necessary if the work is dirty, strenuous or involves potential contamination with hazardous substances. Washing facilities should have hot and cold (or warm) running water, soap and towels (or other means of drying).
- **Changing rooms** - suitable changing facilities if workers have to change into special workwear and this involves significant undressing. These should be adequately lit, clean and ventilated, with separate facilities for men and women.
- **Accommodation for clothing** - lockers or other storage facilities where workers have to change for work so that their personal clothing can be kept clean and secure. Separate storage for dirty work clothing may be necessary to prevent cross-contamination.
- **Resting and eating facilities** - access to suitable rest areas where workers can take a break from work. Such areas should have sufficient seating and be away from hazardous work areas, allowing workers to remove personal protective equipment and relax. Eating facilities should be provided so that food can be eaten in a hygienic environment. If hot food is not provided at work then basic facilities might be provided so workers can make their own hot drinks and food. Separate facilities may need to be provided for new and expectant mothers. Non-smoking facilities should be available to protect workers from second-hand smoke. (Note that smoking in workplaces is tightly regulated by statute law in many countries.)

Work Environment Requirements

The workplace environment should be designed and regulated as far as possible to ensure safety and freedom from health risk. This is often not possible for outdoor workplaces, or at least only possible to a limited extent. For indoor workplaces, basic workplace environment standards are established by legislation such as the **Workplace (Health, Safety and Welfare) Regulations 1992**:

- **Space** - provision of adequate space to allow workers to perform the task safely.
- **Seating** - provision of appropriate seating where work tasks allow. Seats should be stable, with a backrest and footrest where appropriate.
- **Ventilation** - provision of a sufficient supply of fresh or purified air.
- **Heating** - maintenance of a reasonable temperature in indoor workplaces. Note that workers carrying out hard manual work will generate more metabolic heat than those doing sedentary work. A lower minimum workplace temperature can be comfortably tolerated by those doing manual labour. The **Approved Code of Practice (ACoP)** to the regulations sets a minimum indoor temperature of 16°C for sedentary (inactive or seated) work and 13°C for manual work.
- **Lighting** - provision of adequate lighting.

TOPIC FOCUS

Factors to consider when providing workplace lighting:

- Minimum light levels (lux levels) should be achieved; these are indicated by ACoPs and guidance.
- Natural light should be used in preference to artificial light.
- Light levels should be adjusted to suit the level of detail required and the visual acuity of the workers.
- Local lighting, such as spotlights positioned above machinery, might be required to give higher levels of light on critical areas.
- Lighting must be arranged to avoid reflections and glare that might dazzle or temporarily disable.
- Lighting must be arranged to avoid the creation of shadows that might obscure areas and create risk.
- Flickering should be avoided to prevent nuisance and, in particular, the 'stroboscope effect' (see the section on machinery lighting in Element 4).
- Lighting must be suitable for the environment, (e.g. intrinsically safe lighting used in a flammable atmosphere).
- Emergency lighting should be provided to allow safety in the event of mains supply failure.

The Effects of Exposure to Extremes of Temperature

Effects of Exposure

Extreme temperature environments can be found in some workplaces. For example, workers in a foundry or bakery will be exposed to a very hot, dry environment; workers at a cold storage warehouse will be exposed to a very cold environment. Those who work outdoors may be exposed to both extremes, depending on climate and season.

Health and safety effects of working in a **hot environment** are:

- **Dehydration** - water is lost as a result of sweating.
- **Muscle cramps** - a result of salt loss through sweating.
- **Heat stress** - where core temperature (37°C) cannot be controlled and starts to increase; causes discomfort, lethargy and fainting.
- **Heat exhaustion** - a precursor to heat stroke.
- **Heat stroke** - where core temperature increases rapidly; causes hallucinations, coma and death.
- **Other effects** associated with the source of the heat, such as skin burns or cancer from exposure to sunlight, or burns from radiant heat (see Element 8) and contact with hot surfaces.

Health and safety effects of working in a **cold environment** are:

- **Hypothermia** - core temperature drops below 35°C; causes shivering, mood swings, irrational behaviour, lethargy, drowsiness, coma and death.
- **Frostbite** - body tissues are frozen causing tissue damage and, in extreme cases, necrosis, gangrene and amputation.
- **Slip hazards** - in particular, floors will become slippery with ice.
- **Freeze burn injuries** - from skin contact with very cold surfaces.

Apart from these specific effects, both environments create an increased risk of fatigue because of the stress on the body; this makes workers more prone to accidents and human error.

Preventive Measures

Inevitably, the first course of action is to eliminate the need for workers to enter the extreme temperature environment, (e.g. by automation of a process). Where this cannot be done, the environment might be regulated to reduce the temperature extremes, (e.g. heating a cold workplace to more reasonable temperatures). If these options are not possible then other controls might be.

For a **hot environment**:

- Provide good workplace ventilation - moving air has a cooling effect.
- Insulate heat sources - by lagging hot pipes.
- Shield heat sources - to control radiant heat and prevent contact burns.
- Provide cool refuges - where workers can escape the heat.
- Provide easy access to drinking water or isotonic drinks (which replace salts lost through sweating).
- Provide frequent breaks and job rotation.
- Provide appropriate clothing for use in the hot work environment but consideration must be given to other workplace hazards.

For a **cold environment**:

- Prevent or protect workers from draughts.
- Shield/lag extremely cold surfaces.
- Provide warm refuges - where workers can warm up.
- Provide PPE - such as insulated jackets, trousers, boots, balaclavas, etc.

- Provide frequent breaks and job rotation.
- Provide easy access to hot food and drinks.
- Scrape, salt or grit icy floors.

MORE...

Visit the following website for additional information on thermal comfort in the workplace:

www.hse.gov.uk/temperature/index.htm

In both types of environment information, instruction, training and supervision should be provided so that workers understand the health consequences of the environment and the early warning signs of problems. Workers might also be given the opportunity to acclimatise to the most extreme environments and may be subject to health surveillance.

National General Certificate Legal Standards	International General Certificate Standards
For most indoor workplaces: • Workplace (Health, Safety and Welfare) Regulations 1992. • Workplace (Health, Safety and Welfare) Regulations (Northern Ireland) 1993. For construction sites: • Construction (Design and Management) Regulations 2015. • Construction (Design and Management) Regulations (Northern Ireland) 2016.	For most workplaces: • ILO C120 - Hygiene (Commerce and Offices), Convention, 1964 (No. 120). • ILO R120 - Hygiene (Commerce and Offices), Recommendation, 1964 (No. 120). For construction sites: • ILO C167 - Safety and Health in Construction Convention, 1988 (No. 167). • R175 - Safety and Health in Construction Recommendation, 1988 (No. 175).

STUDY QUESTIONS

1. Identify the six main welfare requirements in any workplace.
2. Identify the protective measures to be used for working in conditions of extreme heat.

(Suggested Answers are at the end.)

Violence at Work

IN THIS SECTION...

- Work-related violence is any incident where a worker is abused, threatened or assaulted in circumstances relating to their work. Various factors influence the risk of work-related violence and many occupations are at risk.
- Risk of violence can be managed by providing workplace security measures, establishing safe systems of work (especially for lone workers) and providing information, instruction and training.

Risk Factors and Control Measures

Workers can be verbally abused, threatened (verbally and by physical gesture) and even assaulted as they carry out their normal work. There is a growing awareness of this issue and an understanding that abuse, threats and assault are not inevitable occupational risks that should simply be accepted and ignored.

DEFINITION

WORK-RELATED VIOLENCE

"Any incident in which a person is abused, threatened or assaulted in circumstances relating to their work."

(Source: HSE, www.hse.gov.uk/violence/index.htm)

Risk Factors for Violence

Certain occupations and types of work are associated with an increased risk of violence. The following factors are common to those occupations:

- **Cash handling** - any work that involves the handling of quantities of cash or valuables puts workers at risk of violence associated with robbery.
- **Lone working** - any lone working that takes the worker into urban areas or puts them in contact with members of the public at remote or private locations.
- **Representing authority** - any work where the worker represents authority, such as police, traffic wardens, etc.
- **Wearing a uniform** - uniforms are often seen as a symbol of authority, but even where they are not, workers may still be singled out for abuse.
- **Dealing with people under stress** - when people are under stress they are less capable of handling their emotions and can lose control.
- **Dealing with people under the influence** - of drugs and alcohol, or with mental health problems, when normal inhibitions on behaviour have been affected.
- **Censuring or saying no** - workers who have to give warnings, penalties, fines, or who have to refuse a service or say no, (e.g. bar staff).

A stressful situation can sometimes spill over into abuse, threat and assault

Occupations at risk of violence involve one or more of these risk factors, such as:

- Hospital accident and emergency staff.
- Police.
- Social workers.
- Bus and taxi drivers.
- Fire-fighters and paramedics.

- Traffic wardens.
- Railway staff.
- Teachers.

Control Measures for Violence

The first step in managing the risk of work-related violence is to find out the exact nature of the problem. Anecdotal evidence may suggest a problem, but its scale and nature may not be clear.

The extent of the problem can be investigated by:

- Collecting and analysing incident reports.
- Interviewing staff formally or informally.
- Staff surveys.

It will then be possible to identify and implement the correct preventive measures, which will be different depending on the nature of the workplace and of the work. In general, two distinct strategies can be adopted.

Preventing violence **at a central office can be achieved with**:

- Zero-tolerance policy and prosecution of offenders.
- Security staff.
- CCTV cameras.
- Security doors between public areas and staff areas.
- Minimising queues and waiting times.
- Clear announcements about waiting times.
- Training for staff, such as:
  - Providing a good quality service.
  - Diffusing aggression.
- Screens between staff and public.
- Panic alarms.
- Pleasant environment.

Preventing violence to workers **conducting home visits can be achieved with**:

- No lone working or no lone working in certain high-risk areas.
- Keeping records of past incidents.
- Vetting customers.
- Visit-logging with supervisor.
- Pre- and post-visit telephone calls.
- Training for staff, such as:
  - Lone working procedures.
  - Tension diffusion and conflict avoidance.
  - Break-away techniques (self-defence).

- Always having a means of communication, (e.g. mobile phone, GPS tracking devices on personnel).
- No visits after dark.
- Parking in secure areas.
- Not carrying cash or valuables.

MORE...

Follow the links below to read more about work-related violence and personal safety:

www.hse.gov.uk/violence/index.htm

www.suzylamplugh.org

National General Certificate Legal Standards	International General Certificate Standards
• Health and Safety at Work, etc. Act 1974. • Management of Health and Safety at Work Regulations 1999. • Health and Safety at Work (Northern Ireland) Order 1978. • Management of Health and Safety at Work Regulations (Northern Ireland) 2000.	• ILO C155 - Occupational Safety and Health Convention, 1981 (No. 155). • ILO R164 - Occupational Safety and Health Recommendation, 1981 (No. 164).

STUDY QUESTIONS

3. Identify some occupations at risk of violence at work.
4. What strategies are available to avoid the risk of violence?

(Suggested Answers are at the end.)

Substance Misuse at Work

IN THIS SECTION...

- Drug and alcohol misuse can have serious health and safety consequences in the workplace, both for the worker, others involved in any incident and the employer.
- Drugs and alcohol misuse must be controlled by the employer through clear policies, random testing where necessary, support for affected workers and awareness campaigns.

Types of Substances Misused at Work

There are several types of substances that may be misused at work. Notable examples include:

Drugs and alcohol must be controlled by the employer through clear policies

- **Alcohol** - sometimes, alcoholic drinks are taken at work or during lunchtime drinks in a local bar. Employees returning to work can then be under the influence of the drinks. Often, the effects of alcohol taken the night before can linger into the next day with detrimental effects, especially to vehicle drivers and machinery operators.
- **Legal or illegal drugs** - drugs can be in the form of over-the-counter, non-prescription drugs, such as common painkillers, or stronger medicinal treatments prescribed by a doctor. Illegal (controlled) drugs, such as cannabis, heroin, cocaine, etc. may be taken by people both in the workplace and away from it. In all cases, use of such drugs can have detrimental effects on a person - not only leading to higher risks if driving vehicles or operating machinery, but also on their personality, responses, decision making, attitude, etc., putting others at risk as well.
- **Solvents** - sometimes, hazardous substances, such as cleaning solvents, are deliberately misused, (e.g. 'glue-sniffing'). These substances can be highly addictive, have serious effects on a person's performance and will damage their health.

Risks to Health and Safety from Substance Misuse at Work

Alcohol is an addictive narcotic drug that significantly impairs the senses and reaction times, even at low doses. Social history has meant that it is widely available, used and misused.

'Drugs' is a very broad term that can be applied both to non-prescription and prescription drugs (such as painkillers) and controlled drugs (illegal drugs such as cocaine). Some prescription drugs and most controlled (illegal) drugs are addictive.

The effects of alcohol and drug misuse will vary, but some general symptoms might be observed, such as:

- Late attendance.
- Increased absenteeism.
- Reduction in quality of work.
- Reduction in work rate.
- Dishonesty.
- Theft, potentially to fund a habit.

- Irritability and mood swings.
- Deterioration in working relationships.

These will all be associated with costs to the employer, not to mention increased risk.

Drugs and alcohol cause sensory impairment, skewed perceptions, impairment to motor control and, in many cases, fatigue and drowsiness. There are obvious safety risks associated with drugs and alcohol, e.g. driving a vehicle or operating machinery under the influence increases the risk to the worker and to others, and critical decisions should not be made with impaired judgment. There are also health risks for the workers, usually associated with long-term abuse, (e.g. cirrhosis of the liver due to alcohol abuse).

Control Measures to Reduce Risks from Substance Misuse at Work

The employer might collect information about the state of the problem in the workplace. Company history may show a clear pattern of drug or alcohol misuse.

The employer should establish a clear **drugs and alcohol policy**. This policy might contain:

- Rules restricting access to alcohol in the workplace or during working hours.
- Statutory legal requirements prohibiting workers from being under the influence of drugs and alcohol, e.g. drink drive laws.
- Non-statutory requirements prohibiting workers from being under the influence that have been set by the employer.
- Arrangements for any random drugs and alcohol testing that workers will be subject to. In some cases, there will be a legal requirement on the employer to carry out random drug and alcohol testing.
- Arrangements for workers to have access to rehabilitation and treatment programmes if they admit to having a problem.
- Disciplinary procedures for workers who refuse assistance, refuse to be tested or who fail a test.
- Provision of information, instruction and training to workers, supervisors and managers.

Drug and alcohol awareness campaigns should also be considered.

Any drug and alcohol testing policy must be justified and clearly explained to workers. There are legal and ethical issues associated with testing regimes that must be carefully considered.

National General Certificate Legal Standards	International General Certificate Standards
• Health and Safety at Work, etc. Act 1974. • Management of Health and Safety at Work Regulations 1999. • Health and Safety at Work (Northern Ireland) Order 1978. • Management of Health and Safety at Work Regulations (Northern Ireland) 2000.	• ILO C155 - Occupational Safety and Health Convention, 1981 (No. 155). • ILO R164 - Occupational Safety and Health Recommendation, 1981 (No. 164).

STUDY QUESTION

5. Identify symptoms that an employer might notice in an employee who is misusing drugs or alcohol.

(Suggested Answer is at the end.)

Safe Movement of People in the Workplace

IN THIS SECTION...

- Pedestrians are exposed to various hazards as they move around the workplace. These hazards can cause: slips, trips and falls; falls from height; collisions with moving vehicles; striking by moving, flying or falling objects; and striking against fixed or stationary objects.
- These hazards can be controlled through the risk assessment process and by careful design and construction of the workplace. Some key controls are:
  - Use of non-slip surfaces.
  - Spill control and good drainage.
  - Designating pedestrian walkways.
  - Fencing and guarding.
  - Using signs and PPE.
  - Information, instruction, training and supervision.
  - Routine inspection and maintenance of control measures.

Hazards in the Workplace

When people move around in workplaces, they are exposed to a range of hazards simply by being pedestrians. These hazards can be categorised by the type of accident that they cause. Details of these categories, along with some typical conditions and environments in which each hazard might arise, follow.

Slip hazard - wet floor

Slips, Trips and Falls on the Same Level

Typical **slip** hazards include floor surface that are:

- Smooth and inherently slippery, e.g. polished marble.
- Wet because of rain, spills or cleaning operations.
- Contaminated with a slippery contaminant, e.g. fat or leaves.
- Covered with frost or ice, e.g. outside pavements in winter or the floor in a freezer.

Note that a person's footwear can make a big difference to how vulnerable they are to slipping on a floor.

Typical **trip** hazards include:

- Uneven or loose floor surfaces, e.g. broken paving slab or a poorly laid floor mat.
- Trailing cables, e.g. the flex of a vacuum cleaner.
- Objects on the floor, e.g. a bag left on the floor.

Note that people frequently 'trip over their own feet'.

When people slip or trip, they often (although not always) fall to the floor. Though falls on the same level do not always lead to serious injury, they may well lead to broken bones (especially in the hand, wrist or arm).

Steps and stairs are places of particular concern because they are locations where slip, trip and fall accidents can occur more frequently and the consequences of such accidents can be more serious.

Slips, trips and falls on stairs often cause serious injury

Falls from Height

Typical hazards leading to falls from height include:

- Working next to an unprotected edge, e.g. on a flat roof, on the deck of a partly built scaffold, by the open doors of a lift shaft when the lift is at another floor or by an excavation.
- Working on a fragile material above a drop, e.g. on a fragile roof or on a skylight.
- Using access equipment, e.g. a mobile elevating work platform or cherry picker (see later).
- Using ladders, e.g. a stepladder, extension ladder or fixed vertical access ladder.
- Standing on objects to reach high levels, e.g. using a chair to reach the top shelf of a storage rack.

Falls from height (even a low height) often cause very serious injury and are a common cause of fatal injury. Construction work routinely involves work at height.

Collisions with Moving Vehicles

Typical hazards include:

- Pedestrian walkways that require pedestrians to walk in vehicle traffic routes, e.g. in a warehouse or car park.
- Pedestrian crossing points.
- Exits that open onto vehicle traffic routes.
- Areas where people have to work adjacent to moving vehicles e.g. road works or loading bays.

Accidents resulting from these types of hazard are, again, often the cause of serious or fatal injury.

Being Struck by Moving, Flying or Falling Objects

Typical **moving object** hazards include:

- Automated machinery, such as a spot-welding robot.
- Unsecured objects, such as a container on the deck of a moving ship.

Typical **flying object** hazards include:

- Ejected parts, such as swarf (sharp metal waste) ejected during metal drilling.
- Thrown objects, such as scaffold clamp.

Typical **falling object** hazards include:

- Loads falling from height during lifting and handling operations, e.g. boxes falling from a pallet when being lifted by a forklift truck.
- Objects being dislodged during work at height, e.g. slates dislodged from a roof during roof work.

- Objects falling from height because of adverse weather conditions or wear and tear, e.g. scaffold boards blown off a scaffold in a gale, or duct work falling from a ceiling due to deterioration of fixings.
- Toppling of unstable objects, e.g. an unsecured ladder or a poorly stacked load on racking.

Though people are not injured by falling objects as often as they are by vehicles and falls from height, the injuries received may be serious or fatal.

Striking Against Fixed or Stationary Objects

Typical hazards include:

- Objects that project into a pedestrian area or route, e.g. stored stock metal sheets that partly project into a walkway.
- Narrow doorways in a pedestrian route.
- Low overheads, e.g. pipework at head height above a gantry walkway.

Maintenance Activities

All of the above incidents can occur while a person is involved in maintenance activities, due to the fact that the maintenance engineer is often in locations and situations that themselves are due to a fault or problem. These activities will be conducted in areas often where those issues exist; where there are spillages, damage to floors, confined areas, low ceilings, poor lighting, vehicle movements, etc.

Control Measures for Safe Movement of People in the Workplace

The control strategies for managing the risk inherent in the movement of people in a workplace are based on basic health and safety management principles:

- Eliminate the hazard.
- Create a safe place.
- Create a safe person.

The starting point is risk assessment.

Risk Assessment

A risk assessment covering the safe movement of pedestrians in a workplace would:

- Identify the various hazards that present risk to pedestrians (as indicated above).
- Identify the groups at risk (workers, members of the public, etc.) and those who might be especially vulnerable (young children, the elderly, people with certain disabilities such as visual impairment, etc.).
- Evaluate the risk by considering the existing controls, the adequacy of those controls and any further controls required to reduce the risks to an acceptable level.
- Be recorded and implemented.
- Be subject to review as the workplace changes, in response to incidents, and perhaps periodically.

During this risk assessment, it is important to consider the:

- Normal patterns of movement in and around the workplace.
- Predictable abnormal movements (such as taking shortcuts and fire evacuations).
- Accident history of the workplace that might indicate problem areas.
- Impact of adverse weather conditions (such as wind and rain).
- Maintenance requirements of the various controls, (e.g. floor surface cleaning and repair needs).

Slip-Resistant Surfaces

All floor surfaces where people may walk should be designed to ensure an appropriate level of slip resistance. If this is not done during construction, then slip-resistant surfaces may have to be fitted or applied at a later stage, (e.g. by applying a non-slip resin to an existing floor).

Several factors will affect the kind of slip resistance that is required, such as:

- The number of people who walk on the floor.
- The footwear those people might be wearing.
- The wear and tear that the surface will be subject to, (e.g. vehicle traffic).
- Foreseeable spills and contamination on the floor, (e.g. chemicals).
- Environmental conditions, such as weather, temperature or sunlight.

Spillage Control and Drainage

Floors and pedestrian routes should be designed and constructed to withstand foreseeable spillages. Such spillages might simply be of water, (e.g. drinks), but in other instances might be of oil, fuels, (e.g. diesel), solvents or corrosive chemicals, (e.g. sodium hydroxide).

Spills must be controlled to prevent slip hazards and degradation of the floor surface itself, which can lead to potholes and trip hazards.

Spill control is best achieved by preventing the spill from happening in the first place. This might be done by implementing:

- maintenance and inspection, (e.g. of pipelines, valves or taps); or
- behavioural controls, (e.g. banning drinks from an area).

If spills cannot be prevented, then measures can be taken to prevent them from contaminating walkways and floors, (e.g. drip trays under leaking oil sumps and bunds around storage tanks).

DEFINITION

BUND

A wall built around a storage tank or drum compound which is intended to contain any leaks or spills.

Where a floor or pedestrian route is likely to get wet, adequate drainage should be provided, since:

- Outdoor walkways may be subject to rainfall.
- Indoor walkways may be subject to frequent wetting during normal use, (e.g. shower rooms and changing facilities) or cleaning operations, (e.g. in a food production factory).

Designated Walkways

The use of designated walkways is a critical control measure in many workplace situations.


Designated pedestrian walkway

Walkways can be used to try to ensure that:

- Pedestrians stay within designated areas.
- Vehicles or other hazards do not stray into pedestrian areas.

Designated walkways can be used in many different situations, such as to provide a safe pedestrian route through a car park, warehouse or loading bay area where vehicles will be present, or through a workshop, factory or across a construction site where hazardous work activities (such as lifting operations) may be carried out.

Walkways might be designated by:

- Guardrails - this provides direct physical protection.
- Kerbs and pavements - such as outdoors, adjacent to a vehicle road.
- Markings on the floor.

Fencing and Guarding

Fencing and guarding can be used in a variety of situations to control hazards to pedestrians:

Perimeter fencing with safety signs

- Guardrails:
  - Designate and give protection to pedestrian walkways.
  - Protect an edge where pedestrians might fall, (e.g. at the edge of a mezzanine or a path near a cliff edge or steep slope).
- Perimeter fencing prevents unauthorised access to construction sites.
- Guarding and perimeter fencing prevents access to dangerous areas near machinery, (e.g. an industrial robot).
- Temporary fencing prevents access to a hazard such as a pothole.

Use of Signs and PPE

Clearly visible and easily understood signs and markings should be provided so that pedestrians (even those unfamiliar with the workplace) are made aware of hazards and what they must do to avoid them.

Signs should conform to the relevant standard, such as the UK **Health and Safety (Safety Signs and Signals) Regulations 1996**:

- Prohibition, e.g. no pedestrian access.
- Warning, e.g. forklift trucks operating in this area.

- Mandatory, e.g. high-visibility PPE must be worn.
- Safe conditions, e.g. fire escape route.

Hazard-warning markings, (e.g. yellow diagonal stripes on a black background) should be fixed onto pedestrian hazards, such as the edges of steps (that are not obvious) and overhead obstructions. Hazard markings might also be used on floors to indicate areas to avoid, (e.g. by doors used for vehicles).

Worker wearing high-visibility clothing

PPE may be necessary to protect pedestrians from various hazards as they move about the workplace. Some of this PPE will be to protect them from specific hazards inherent in an area, e.g. ear defenders in a high-noise area. More importantly, PPE might be used to make them more visible as a pedestrian. High-visibility clothing, such as coats, over-trousers and tabards, works by speeding up reaction times. A pedestrian wearing high visibility can be quickly identified as a person and from a greater distance. A driver can see when a highway worker is in the road in front of them. The driver will see them sooner, be able to identify them as a person more quickly and therefore be able to take earlier evasive action.

Information, Instruction, Training and Supervision

Safe movement of people in the workplace inevitably requires that those people are given information, instruction and training so that they understand what is required of them and can apply it. In some instances, this can be done with the use of appropriate signs; in others, it requires the provision of specific training to communicate safety rules. As you may remember from your studies of Unit 1, employee induction training should incorporate information about safe movement around the workplace. This should also be provided to contractors working on site and may also be necessary for visitors.

Since people do not always follow the instructions and training that they are given, there should be an adequate level of supervision. This usually means simply enforcing the rules that have been developed about safe use of walkways, etc.

Maintenance of a Safe Workplace

Once measures have been taken to ensure that pedestrians can move around the workplace safely, some thought must be given to the maintenance of that safe workplace.

TOPIC FOCUS

Various maintenance issues might be considered:

- Floors and walkways should be cleaned routinely to ensure that surfaces are kept free of contamination.
- Spills will have to be cleaned up quickly and safely.
- Housekeeping routines should be established to ensure that pedestrian routes are free of trip hazards and obstructions.
- Floors and walkways should be inspected and repaired to keep them in a safe condition, (e.g. potholes should be repaired as soon as possible).
- Guardrails and fencing should be inspected and repaired as necessary.
- Access and egress routes should be inspected routinely and cleaned or repaired as necessary. This is particularly important for outdoor areas where snow and ice can make external pedestrian walkways hazardous (in which case, gritting or clearing the snow and ice may be appropriate).
- Emergency exit routes should be kept free of slip and trip hazards and obstructions at all times.
- Lighting is essential for safe movement through a workplace and lights should therefore be routinely inspected and replaced/repaired as necessary.
- Noise levels should be kept as low as possible to enable pedestrians to hear any communications (such as tannoy announcements or shouts of warning), alarms (such as a fire alarm) and hazards (such as approaching vehicles).
- Special care should be taken during maintenance activities to ensure that required standards relating to environmental considerations (such as lighting, noise and dust) are maintained.

The frequency of cleaning and inspection and the timescales for repairs will depend on the nature of the workplace. For example, in an engineering workshop where swarf and waste may build up very quickly, the floor might be swept and inspected at the end of every shift, whereas weekly housekeeping might be more appropriate in an office.

Safety During Maintenance Activities

As discussed earlier, many types of incident can occur while a person is involved in maintenance activities. It is therefore important that:

- Risk assessment of the location and intended activity is thorough enough to cover all of the eventualities mentioned.
- Control measures are sufficient to reduce the risk to as low as possible. Housekeeping is important under such conditions; engineers ensuring that a 'clean up as you go' policy is followed is the common practice.

National General Certificate Legal Standards	International General Certificate Standards
For most workplaces: • Workplace (Health, Safety and Welfare) Regulations 1992. • Workplace (Health, Safety and Welfare) Regulations (Northern Ireland) 1993. For construction sites: • Construction (Design and Management) Regulations 2015. • Construction (Design and Management) Regulations (Northern Ireland) 2016. • Health and Safety (Safety Signs and Signals) Regulations 1996. • Health and Safety (Safety Signs and Signals) Regulations (Northern Ireland) 1996. • Personal Protective Equipment at Work Regulations 1992. • Personal Protective Equipment at Work Regulations (Northern Ireland) 1993.	• ILO C155 - Occupational Safety and Health Convention, 1981 (No. 155). • ILO R164 - Occupational Safety and Health Recommendation, 1981 (No. 164). For construction sites: • ILO C167 - Safety and Health in Construction Convention, 1988 (No. 167). • R175 - Safety and Health in Construction Recommendation, 1988 (No. 175). • ISO 7010: International standard for safety signs.

STUDY QUESTIONS

6. Other than slips, trips and falls, identify three types of hazard faced by pedestrians.
7. Identify the main hazards causing slips, trips and falls on the same level.
8. Identify four factors that a risk assessment should consider in relation to hazards to pedestrians.
9. Outline the meaning of the term 'designated walkway'.
10. Identify eight control measures that might be relevant to the safe movement of pedestrians in a workplace.

(Suggested Answers are at the end.)

Working at Height

IN THIS SECTION...

- Work at height is work where there is a risk of a fall liable to cause personal injury unless precautions are taken.
- Work at height results in more fatalities than any other work activity.
- The main risks associated with work at height are falls and falling objects. These are created by hazards such as fragile roofs, sloping roofs, deteriorating materials, unprotected edges, unstable access equipment and adverse weather conditions.
- Work at height should be avoided where possible. Where this is not possible, engineering measures, (e.g. edge protection) should be used to prevent falls. Where this cannot be done, measures should be taken to minimise the distance fallen and the consequences of the fall, (e.g. using a safety net).
- Scaffolds must have a securely guarded work platform, be constructed of appropriate materials by competent people and be routinely inspected to ensure their ongoing safety.
- Mobile tower scaffolds, Mobile Elevating Work Platforms (MEWPs) and ladders each have their own set of hazards and precautions for safe use.

Examples of Work at Height

DEFINITION

WORK AT HEIGHT

Work where there is a risk of a fall liable to cause personal injury unless precautions are taken.

Note that this definition is based on the definition found in the UK **Work at Height Regulations 2005**. Note also that the definition does not mention ground level, so it is possible to work at height while underground, or at ground level, e.g. at the side of a sheer drop such as an excavation. The definition does not include walking up and down staircases as being subject to the regulations.

Many types of work can expose people to working at height, including:

- Steel workers erecting the steel framework of a building.
- Scaffolders erecting or striking (taking down) a scaffold.
- Roofers cladding the roof of a steel-framed building.
- Demolition workers using machinery in a multi-storey building.
- Welders working at the side of a deep excavation.
- Pipe fitters fixing pipework to the ceiling of a factory workshop.
- Painters working on the external walls of a building.

Some of these types of work will inherently involve work at height, (e.g. scaffolding) and so those involved will be very used to working at height. This can lead to complacency. Some of the other types of work, however, do not always involve work at height so those involved may lack competence.

The main risks associated with work at height are:

- The worker falling from height.
- An object falling onto people below.

Working at height causes a higher proportion of fatalities than any other types of work activity. Falls from height can result in:

- Death.
- Neck or spinal injury leading to permanent paralysis.
- Brain damage.
- Multiple broken bones.

Falling objects can also cause severe injuries that may result in the above.

Risk Factors for Work at Height

There are several factors that influence the risks associated with work at height. Here we review some of the main risk factors.

Vertical Distance

The vertical distance is an obvious consideration in the potential risk of injury from work at height. However, although there is some truth in the expectation that the further a person falls, the greater the injury will be, a large number of fatalities actually occur as a result of falls from a height of just two metres or less, so it is not the only important consideration.

Roofs

Roof work includes construction and maintenance of roofs, such as replacing tiles, gutter cleaning and chimney repairs. Many accidents occur during small jobs and maintenance work.

Particular dangers arise with two types of roof:

- **Fragile Roofs**

  Any roofing structure that is not specifically designed to carry loads and only has sufficient strength to withstand the forces produced by the weather should be considered a fragile roof. Roofing materials, such as cement, asbestos, glass, reinforced plastics and light tongue, and groove wood covered with roofing felt, are all liable to collapse under the weight of a worker.

  Fragile roofs should be clearly signed. The safe working method for fragile roofs is usually 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.

- **Sloping (Pitched) 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 so 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 when exposed to the weather and attacked by insects, etc.

Unsound materials represent a hazard in two ways:

- The material breaking when a person puts his/her weight on it, causing a fall through the surface.
- The material breaking off and falling to hit people below.

It may not always be evident that deterioration has occurred until it is too late, so care must be taken to ensure that materials are sound and secure.

Unprotected Edges

Where the edges of surfaces on which people are working are open, the risk of falls or falling objects is greatly increased. This applies to roofs, elevated walkways, scaffolding and access platforms, etc. We deal with the use of guardrails, fencing and protective boarding required to prevent such accidents later.

Though this sloping roof is not steeply angled, the unprotected edge still presents a hazard

Unprotected edges may exist at the edges of an area, such as the edges of a flat room. They may also exist temporarily as a surface is worked on or created. For example, as a steel frame building has sheets of roofing material added to form the roof, an unprotected edge is created at the edge of the roof sheets as they are added. This is normally referred to as a **leading edge**.

Unstable or Poorly Maintained Access Equipment

Access equipment includes scaffolding, towers, platforms and ladders. There are in-built risks in using such equipment, but they are compounded if the equipment is not properly stable and secured in some way.

Any access equipment that is incorrectly sited, poorly built or poorly secured will be inherently unstable and conditions such as overloading of the equipment, high winds or overreaching can then cause a catastrophic collapse or topple.

(See later for details on the ways in which access equipment can become unstable and the controls necessary for safe use.)

Weather

The weather can increase the risks associated with working at height:

- Rain or freezing conditions can increase the risk of slipping.
- High winds can make access equipment unstable, blow loose materials off and, in extreme cases, blow workers off.
- Cold conditions cause loss of manual dexterity and can lead to increased risk of muscle injuries.

Falling Materials

Objects falling from height are capable of causing considerable damage to both people and other materials that they hit. The objects themselves may be loose structural material, waste materials, or equipment or tools that are dropped.

Circumstances contributing to the likelihood of falling materials include:

- Deterioration of structures, causing crumbling brickwork or loose tiles.
- Bad storage of materials, e.g. 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 from ground level to the working area.
- Incorrect methods of getting materials down to ground level, e.g. throwing.

Controlling the Risks of Work at Height

Because of the very high risks associated with work at height, this is work activity that is regulated. For example, in the UK, it is regulated by a specific set of regulations, the **Work at Height Regulations 2005**. The regulations apply a risk assessment-based approach to the management of work at height. This requires that all work at height must be risk assessed.

TOPIC FOCUS

The regulations then impose a simple **risk prevention hierarchy**:

- **Avoid** work at height.
- Use work equipment or other measures to **prevent falls** where work at height cannot be avoided.
- Use work equipment or other measures to **minimise the distance and consequences** of a fall where the risk of a fall cannot be eliminated.

When applying the last two controls, prioritise collective protection over personal protection. In other words, choose control measures that will protect groups of workers rather than choosing PPE that only protect the one person that is using it and using it correctly. For example, a fall arrest safety net is preferable to fall arrest harnesses and lanyards because the net protects all workers who may fall whilst working at height, whereas the fall arrest PPE only protects those workers that are wearing it if they have fitted and used it correctly (i.e. it is very reliant on personal behaviour).

The regulations also require the provision of appropriate information, instruction and training to workers.

If fall arrest equipment is to be used, then procedures must be developed to allow for the speedy recovery of workers who fall into the fall arrest equipment.

Methods of Avoiding Work at Height

The best way of managing the risks inherent in work at height is to eliminate the need to work at height entirely.

Avoiding the need for work at height can be achieved by:

- Good design, e.g. erecting guardrails or steelwork at ground level and then craning the steel and guardrails into place.
- Modifying the work process, e.g. cleaning windows from the ground by pole cleaning rather than off ladders.

In many instances, however, avoidance will not be possible and control measures for working at height will be required. The exact nature of the control measures should be decided during the risk assessment and will depend on various factors.

TOPIC FOCUS

The factors to consider when identifying control measures for work at height:

- Nature and duration of the task to be carried out.
- Level of competence of the persons to be involved.
- Training that may need to be provided.
- Planning and level of supervision required.
- Means of access and egress.
- Suitability of any equipment to be used, and its maintenance and pre-use inspection.
- The use of personal protective equipment, such as harnesses and helmets.
- Weather conditions.
- Health condition of the individuals, (e.g. vertigo or a heart condition).
- The need for a rescue plan and emergency procedures.
- Compliance with the regulations.

Finally, adequate supervision must be provided to ensure that the controls developed at the planning stage are implemented in practice.

Preventing Falls and Falling Materials

Proper planning and supervision of work is important to prevent falls from height and falling materials. Those responsible for such work should themselves be experienced, and use that knowledge to ensure the selection and use of correct access equipment, correct provision and handling of tools and materials (especially getting them up and down from work locations) and adequate information, instruction and training of all persons who will be involved.

Regular inspection of the workplace, work equipment and work methods is essential to reduce the risks; this will include modifying or stopping work in adverse weather conditions. Unsafe acts should not be tolerated and must be stopped immediately, ensuring all employees know why and the consequences if further unsafe work is carried out. Unsafe conditions should be corrected on the spot.

A simple hierarchy can be adopted to **prevent falls**:

- Provide a **safe working platform** with guardrails, fences, toe boards, etc. that are strong enough to prevent a fall.
- Where this is not possible or reasonable, provide **properly installed personal equipment**, such as rope access or boatswain's chairs (see later).
- If this is not possible, and a worker can approach an unprotected edge, provide **equipment which will arrest falls**, such as a safety harness or safety net.

This last option does not prevent falls but it does minimise the distance of the fall and the consequences (i.e. injury).

An independent tied scaffold with guardrails and toeboards. Note the debris chute for safe disposal of rubble

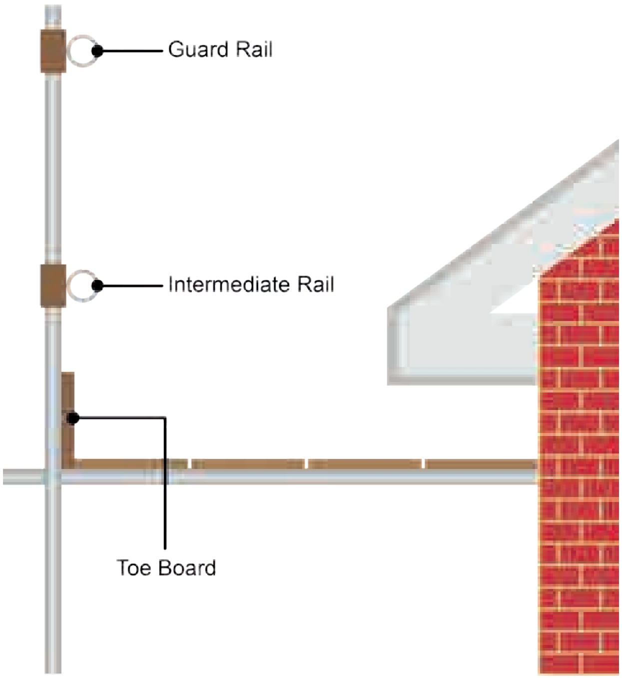
Prevention of injury caused by falling materials should be controlled using a similar approach:

- Prevent materials from falling using physical safeguards, such as toe boards and brick guards (see later).
- If risk remains, use physical safeguards to prevent falling objects from hitting people below, such as debris netting, fans (wooden shielding angled to catch debris) and covered walkways.

Guardrails and Toe Boards

Protection should be provided wherever possible, at all unprotected edges to prevent people and materials from falling. This can be achieved by means of guardrails, toe boards and brick guards on scaffolding and other platforms.

Guardrails are designed to prevent people from falling, whereas toe boards and brick guards are principally designed to stop materials from falling.



Guardrails on scaffold platform

Key characteristics of any guardrail:

- Should fully enclose all of the exposed unprotected edge.
- Robust enough so that it will not bend or distort when fallen against, (e.g. not chain or rope).
- Securely fixed in position so it will withstand any foreseeable impact.
- High enough to prevent a person from toppling over the top.
- No excessively large gaps in it so that a person could fall through.

Toe boards are usually scaffold boards 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. Toe boards prevent small objects, such as rubble and tools, from being casually kicked off the platform.

Use of a brick guard

Brick guards prevent a more substantial amount of material from falling and have a secondary function of helping prevent people from falling as well.

The principle of using guardrails, toe boards and brick guards can be applied to the edge of flat roofs, scaffolds, mobile tower scaffolds and mobile elevating work platforms (such as cherry pickers), and access cradles (as used for window cleaning).

Any gaps in edge protection, (e.g. to allow access by ladder) should be the minimum required for reasonable access.

Work Platforms

Work platforms, (e.g. on a scaffold) should be:

- Sufficiently large to allow safe use.
- Capable of bearing the loads imposed upon them.
- Fully boarded to prevent gaps that could present tripping hazards or allow materials or people to fall through.

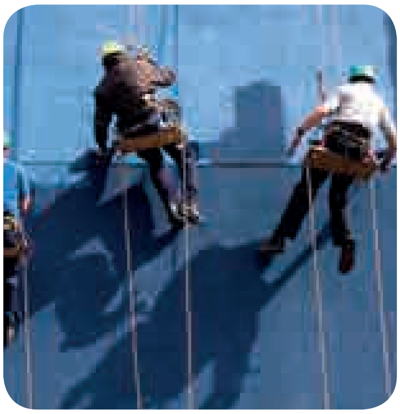
The platform is usually made up of scaffold boards resting on the scaffold framework. The boards should be free from significant defects, such as rotted timber, large cracks, split ends or large or many notches cut into the wood. Usually, boards should be supported across three support members. Boards should not have long overlaps beyond their supports (because of the possible 'see-saw' effect).

Suspended Access Equipment

Suspended access equipment usually consists of a suspended cradle lowered into position from above. The cradle can be fully guarded in with guardrails and toe boards to provide a safe work platform.

In some instances, it is not practicable to use this sort of equipment, so it may be necessary to use personal suspended access equipment, such as a boatswain's chair.

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.



Boatswain's chairs being used for painting

Emergency Rescue

Emergency procedures need to be developed for reasonably foreseeable events where workers might become trapped while working at height, (e.g. if they cannot climb back after falling in a safety harness).

The method of rescue may well be simple, such as putting a ladder up to a net and allowing the fallen person to descend. In other circumstances, the use of other work equipment may need to be considered, such as mobile elevating work platforms or proprietary rescue systems.

Whatever method is selected, there should be arrangements in place capable of rescuing a person, and employers must ensure that those involved are trained in the procedures and that the equipment required is available.

Minimising Distance and Consequences of a Fall

Fall Arrest

If it is not possible to provide a safe work platform with guardrails and toe boards, or an alternative means of safe access (such as suspended access equipment), and workers might fall from height, then it will be necessary to provide some form of fall arrest. Fall arrest comes in two main forms:

- **Collective protection systems**, such as safety nets and air bags.
- **Personal protective systems**, such as a fall arrest harness.

Ideally, collective protection should be used because this will protect all workers, irrespective of whether they are using their PPE correctly or not. For example, safety nets might be suspended underneath the open steel frame of a roof while workers fix the roof cladding material into place. Nets must be properly installed and securely attached by competent riggers as close as possible below the roof, to minimise the distance fallen.

A worker using fall arrest equipment. Note the full body harness with lanyard attached at the back

Personal fall arrest equipment usually consists of a full-body harness connected to one or two lanyards (or wire rope on an inertia reel). The lanyard is connected to an anchor point during use.

Personal fall arrest equipment should only be used by trained workers. Harnesses, lanyards and anchor points should be routinely inspected to ensure they are in safe working order.

Provision of Equipment, Training and Instruction

Workers should be trained in order to work at height safely, but the exact content of training will depend on the nature of the work and the access methods or controls used.

As a minimum, workers should have an awareness of the hazards, such as the possible presence of fragile roofing materials, unprotected edges, etc. Additional training may be required by law for the use of some equipment.

For example, those erecting or modifying scaffolding should be competent, and those driving or using mobile elevating work platforms should have attended a recognised operator training course.

Head Protection

Work at height often involves a risk of falling or moving objects, so hard hats should be mandatory. A hard hat protects the wearer from severe head injury as a result of impact from small objects. It will not protect the wearer from heavy impact as might occur if the object is very large and heavy, (e.g. a scaffold tube) or is dropped from a great height, (e.g. a hammer from 10 storeys up).

Effective alternative methods should therefore be used to prevent such falling objects.

In certain situations, where a worker is at risk of striking their head in the event of a fall, it is more appropriate for them to wear a climbing helmet rather than a hard hat. A climbing helmet is designed to give protection against falling objects and impact to the head in the event of a fall and will have a chin strap with four points of attachment.

Hard hat

Safe Working Practices for Access Equipment

Ladders

Ladders are really only suitable for short-duration work. When climbing, the worker should maintain three points of contact, (one hand and two feet, or two hands and one foot), and also try to maintain two feet and one hand on the ladder whenever possible at the work positions, (e.g. inspection work or painting).

They are also suitable for use as a means of access and egress and are commonly used for access into excavations and onto scaffolds.

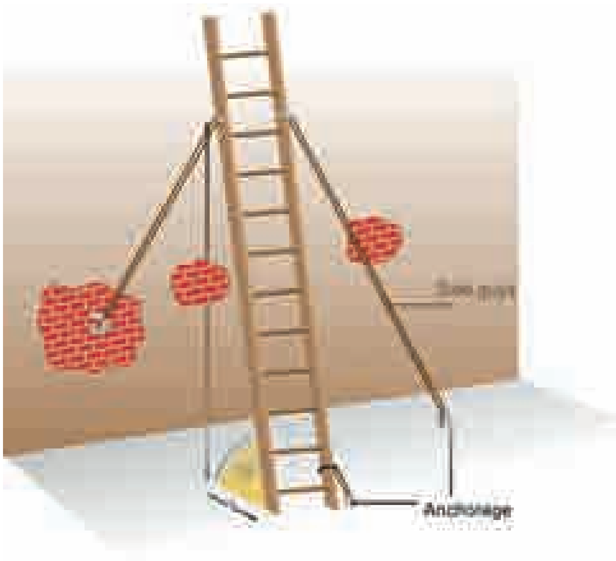
Main risks associated with use of ladders include:

- Falls from height:
  - Falling off the ladders.
  - The ladder toppling sideways.
  - The ladder base slipping out from the wall.

- Objects falling from height.
- Contact with live overheads.

Safety precautions for use of ladders include the following:

- Not siting or handling near live overheads.
- Siting on a solid, flat base so that the feet do not sink into the ground. Weight should only be supported on the stiles - never on the rungs.
- 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 (1 out: 4 up).
- The top of the ladder must rest against a solid support.
- Ideally, the ladder should be secured at the top.
- If this is not possible, then guy ropes should be attached and secured to firm supports.
- If this is not possible, ladder should be 'footed' by someone standing on the bottom rung.
- 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. This should be at least one metre or five rungs. The stepping-off point should be safe and clear.
- Only one person should climb on the ladder at any one time.
- Nothing should be carried in hands while climbing, so that both hands are free to grasp the stiles.
- Maintain three points of contact whilst working.
- Wooden ladders should not be painted as this can hide defects such as rot.



Various ways of anchoring a ladder

Stepladders

Like ladders, stepladders are intended for short-duration, light work.

Safety precautions for the use of stepladders:

- Carry out a daily check of the stepladder before use.
- Always ensure that the ladder is fully open.
- Make sure that the locking devices are in place.
- Only use on firm, level ground which is not slippery.
- Do not work off the top two steps (top three steps for swing-back/double-sided stepladders) unless there is a safe handhold on the steps.
- Avoid over-reaching.
- Avoid side-on working.


Correct use of a stepladder for a brief task where two hands need to be free. (Source: INDG455 Safe use of ladders and stepladders - A brief guide, HSE, 2014 - www.hse.gov.uk/pubns/indg455.pdf)

Trestles and Staging Boards

MORE...

For more information see:

www.hse.gov.uk/work-at-height/index.htm

Trestles are used with boards to provide a working platform. Trestles should be:

- Big enough to allow safe passage and safe use of equipment and materials.
- Free from trip hazards or gaps through which persons or materials could fall.
- Fitted with toe boards and handrails. If these are not fitted, the risk assessment would need to show that installing a guardrail had been considered and reasons why it was not considered necessary.
- Kept clean and tidy, e.g. no accumulation of mortar and debris on platforms.
- Not loaded in a way to risk collapse or deformation that could affect its safe use (particularly relevant in relation to blockwork loaded on trestles).
- Erected on firm, level ground to ensure stability during use.

Independent Tied Scaffolds

Scaffolding is made up of the following basic components:

- **Standards** - uprights or vertical tubes used to support the load to the ground.
- **Ledgers** - horizontal tubes tying the structure together longitudinally, usually running parallel to the face of the building.
- **Transoms** - short horizontal tubes spanning across ledgers normally at right angles (90°) to the face of the building. They may also be used to support a working platform.
- **Bracing** - diagonal tubes that give the structure its rigidity.
- **Base plates** - small square metal plates that the standards (uprights) rest on to prevent them sinking into the ground.
- **Sole boards** - large pieces of timber put under the base plates to spread the load over a wide surface area when scaffold is erected on soft ground.
- **Work platform** - fully boarded.
- **Guardrails** - fixed to the standards (uprights) to fully enclose the work platform.
- **Toe boards** - fixed to the standards (uprights) to provide a lip to the platform.

An independent tied scaffold is designed to carry its own weight and the full load of all materials and workers on the platform. It must be tied to the building where it is sited, to give stability and prevent movement.

As the total weight of the structure is supported by the ground, it is very important that the ground conditions are suitable to cope with the load. Base plates and sole boards may be used to spread the weight over a large surface area.

There are a number of ways in which the scaffold can be tied to the building to prevent movement:

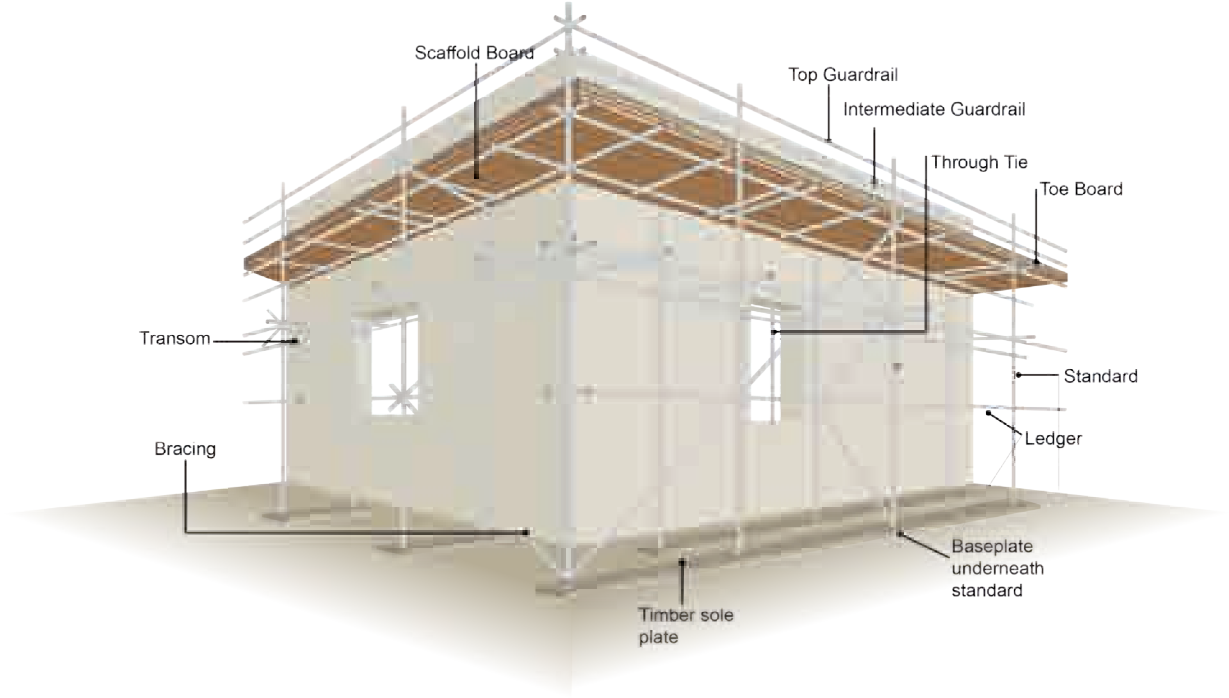
- **Anchor bolts** - one end of a metal bolt is screwed into the wall of the building and the other end is attached to the scaffold tubing. These must be used with other types of tie and are tested for strength.
- **Through ties** - a scaffold tube extends into the building through an opening (such as a doorway or window frame). The end of the tube inside the building is coupled to another tube bridging across the opening.
- **Reveal ties** - a scaffold tube is coupled to a reveal pin that is wedged tightly across an opening, such as a window reveal.
- **Rakers** - these are supports that push the scaffold onto the building. This system takes up space and may not be suitable in urban environments.

Bracing is another important component of the scaffold and is used to stiffen the scaffold framework to prevent collapse. Bracing consists of tubes running diagonally through the structure. These tubes may run perpendicular or parallel to the building façade.

Key hazards associated with use of scaffolds include:

- Falls from the work platform.
- Objects falling from the platform.
- Collapse of the structure.

Scaffolds should be erected by trained workers and inspected by a competent person.



Independent tied scaffold

TOPIC FOCUS

Factors that might cause the collapse of an independent tied scaffold are:

- Overloaded work platform.
- Scaffold built on soft ground without use of adequate sole boards.
- Scaffold not tied adequately to the building.
- Insufficient bracing incorporated into the scaffold.
- Standards not upright.
- Standards bent, buckled or heavily corroded.
- High winds.
- Incorrect couplers used to join tubes together.
- Scaffold struck by mobile plant.
- Scaffold erected by incompetent workers.
- Scaffold not inspected prior to use.

Mobile Tower Scaffolds

Mobile tower scaffolds are often used for painting and maintenance jobs, both inside and outside buildings.

A worker gains entry to the top work platform of a tower platform of a tower scaffold through an internal trapdoor. Note the ladder built into the side of the frame. Note also the rakers or outriggers

They are light-duty scaffolds and their use should be restricted to light work. They have a working platform at the top which is accessible by a ladder fitted internally. They can be constructed using normal scaffolding tubes, but are mostly proprietary-made modular structures. The whole structure is usually mounted on wheels so it can be moved about.

Since tower scaffolds are inherently unstable, they can only be built to a certain maximum height. This height depends on the size of the base - the larger the base, the higher the tower can go, and to enlarge the base it is usual to use outriggers. The maximum height will be determined by the 'base-to-height ratio' which is set by the manufacturer.

The tower can also be made more stable by guying or using ballast.

Main **risks** associated with mobile tower scaffolds include:

- Falls from the work platform.
- Objects falling from the platform.
- Collapse of the structure.
- Overturn (toppling) of the structure.
- Unintended movement of the wheels.
- Contact with live overheads.

TOPIC FOCUS

Safety precautions for safe use of mobile tower scaffolds include the following:

- The guardrail must be fitted to the work platform.
- The tower must not be overloaded.
- Wheels should be locked when the tower is in use.
- The tower must be sited on firm, level ground.
- People and materials should not remain on the tower when it is moved.
- Care should be taken to avoid overheads when the tower is moved.
- Outriggers should be used where necessary to ensure stability.
- People should not climb up the outside of the tower.
- The tower must be built by trained workers (e.g. Prefabricated Access Suppliers' and Manufacturers' Association (PASMA)).
- The tower must not exceed the relevant base-to-height ratio.
- The tower must be inspected prior to use and routinely during use, e.g. at the start of every shift and after any event which might affect its strength and stability.

Mobile Elevating Work Platforms (MEWPs)

Mobile Elevating Work Platforms (MEWPs) are motorised vehicles or trailers with powered extending arms or lifting mechanisms supporting a work cradle. There are many different types of MEWP, such as scissor lifts and cherry pickers.

Mobile elevating work platform

Risks associated with use of MEWPs include:

- Falls from the work cradle/platform.
- Objects falling from the cradle/platform.
- Collapse of the MEWP.
- Overturn (toppling) of the MEWP.
- Contact with live overheads.
- Entrapment of the cradle/platform against adjacent structures.
- Shearing against adjacent structures.
- Unauthorised use.

Steel workers use MEWPs to gain access to a structural steel that is being lifted into place. Note the use of full body harness despite being in an enclosed cradle

TOPIC FOCUS

Safety precautions for use of MEWPs include the following:

- The vehicle should be sited on firm, stable ground.
- There should be sufficient clearance from obstructions and overheads when operating.
- Barriers around the MEWP prevent it being struck by vehicles or mobile plant.
- Barriers also act to keep people out from underneath the cradle/platform.
- Guardrails should be incorporated into the cradle/platform and must not be removed.
- Fall arrest safety harnesses and lanyards should usually be worn and attached to an anchor point in the cradle (subject to risk assessment).
- They should not be driven with the cradle raised unless specifically designed to do so.
- They must not be overloaded.
- They must be inspected and maintained as an item of lifting equipment designed to carry people. This will include statutory examination which would usually be carried out every six months.
- Use must be restricted to trained, authorised staff (e.g. International Powered Access Federation (IPAF) certificated operator).

Leading Edge Protection

MORE...

Find out what you need to know about work at height here:

www.hse.gov.uk/work-at-height/index.htm

Leading edges are unprotected edges that are created and move as work progresses. Typical leading edges are created when sheet materials are added to a steel framed building to clad the roof of the building.

Precautions must be taken to prevent falls from these leading edges.

Nets, staging or soft landing systems (such as bags filled with polystyrene balls) placed immediately below the leading edge are the preferred options in this instance. However, where these are not reasonably practicable, consideration must be given to using work restraint safety harnesses with running line systems or temporary barriers at the leading edge.

Safety netting is the preferred method of fall protection as it provides collective protection and does not rely on personal behaviour to ensure safety. Nets protect every person working at height who might fall from the leading edge.

If safety nets are used, make sure that they:

- are installed as close as possible beneath the roof surface;
- are securely attached and will withstand a person falling onto them; and
- are installed and maintained by competent personnel.

Harness and running line systems involve installing an anchor line or wire that allows workers to move forwards with the leading edge as work progresses. If harnesses and running line systems are used, make sure that they:

- are securely attached to an adequate anchorage point;
- are appropriate for the user and in good condition;
- are properly used - ensuring this requires tight discipline; and
- the running line and harness are compatible.

Inspection of Access Equipment

It is good management practice (and usually a legal requirement) to inspect scaffolds routinely. Scaffolds should be inspected:

- When they are first erected.
- After any substantial alteration.
- After any event that may affect their stability, e.g. after being struck by a vehicle or after high winds.
- Periodically (typically weekly).

Points to check would include:

- Condition of the tubes (especially standards).
- Tying and bracing.

- Condition of the work platform.
- Edge protection (guardrails, toe boards).
- Ground conditions (use of base plates and sole boards).
- Safe access.
- Safe working load.

Details of these inspections should be carefully recorded. The check is usually indicated by the use of a green tag to confirm that it passed the inspection. It is particularly important that any defects noted are acted upon.

Other work equipment used for work at height should also be inspected, e.g. MEWPs, ladders, mobile tower scaffolds, full-body harnesses, lanyards, anchor points and safety nets.

Prevention of Falling Materials Through Safe Stacking and Storage

Workplaces can easily become very untidy if housekeeping is not managed. Spoil heaps at excavations, piles of new materials, debris and waste can all accumulate very quickly. This can hinder or even prevent the safe movement of pedestrians and vehicles around the workplace, and can block light and access to essential services, such as fire equipment. In some instances, stacks and piles of materials can present an immediate danger of collapse, and stacked materials in particular can topple over if not stacked correctly.

Good housekeeping starts with good design and layout of the workplace; sufficient space must be allocated for the **storage of materials** at the planning stage:

- Storage areas should be clearly defined.
- Separate areas should be used for different items (for ease of identification).
- Certain materials and substances should be segregated during storage, or purpose-built secure storage may be required, (e.g. gas bottle cages).
- Areas should be kept clean and tidy and routinely inspected.
- Appropriate warning signs should be displayed where necessary, (e.g. flammable materials).
- Storage areas should not be used for work activities.

Stacking materials is an effective way to utilise space.

When stacking:

- Each stack should be for one material only, not mixed.
- A maximum stack height must be set (dependent on strength and stability of the material being stacked).
- Stack should be vertical (not leaning).
- Pallets should be used to keep materials off the ground.
- Sufficient space must be allowed between stacks for safe movement.
- Stacks must be protected from being struck by vehicles.

National General Certificate Legal Standards	International General Certificate Standards
• The Work at Height Regulations 2005. • Work at Height Regulations (Northern Ireland) 2005. • Personal Protective Equipment at Work Regulations 1992. • Personal Protective Equipment at Work Regulations (Northern Ireland) 1993.	• ILO C155 - Occupational Safety and Health Convention, 1981 (No. 155). • ILO R164 - Occupational Safety and Health Recommendation, 1981 (No. 164). For construction sites: • ILO C167 - Safety and Health in Construction Convention, 1988 (No. 167). • R175 - Safety and Health in Construction Recommendation, 1988 (No. 175).

STUDY QUESTIONS

11. Outline the safe method of working on a fragile roof.
12. Identify the main risks of using ladders.
13. Identify the measures that should be taken to prevent materials falling from a height.
14. In respect of scaffolding:
    (a) What is the difference between standards, ledgers and transoms?
    (b) What is the difference between tying and bracing?
15. State the safety precautions which need to be taken when mobile elevating work platforms are in use.
16. Identify the angle at which ladders should be positioned.
17. Identify when scaffolding should be inspected.

(Suggested Answers are at the end.)

Temporary Works

IN THIS SECTION...

- Temporary works include short-term building projects, building maintenance, renovation, demolition and excavations.
- The hazards on sites where temporary works take place include all of the hazards associated with the work itself (such as work at height and collapse of excavations) and also hazards created by the impact of the temporary works on the workplace in which they are taking place, such as obstruction of emergency escape routes, vehicle movements, etc.
- The control measures for management of temporary works include risk assessment of the works and their impact; effective communication and co-operation between those undertaking the work and those who might be affected; appointment of competent people to manage and undertake the work; effective segregation of work areas; amendment to emergency procedures where necessary and appropriate welfare provision for the workers.
- There are specific hazards associated with excavation and demolition works and specific control measures required.

The Impact of Temporary Works

Temporary works include short-term building projects, building maintenance, renovation, demolition and excavation works. Temporary works can be very minor, short-duration work, such as painting and decorating a small office, repair of damage to coping stones on top of a brick wall or excavation of a shallow trench to give access to buried telephone wires. They can also include major construction projects, such as the construction of a large extension to a distribution depot, demolition of a derelict building on factory premises or major refurbishment works to both the exterior and interior of a 100-year-old civic building.


Temporary works include demolition

The hazards associated with these temporary works will, of course, vary depending on the nature of the works themselves. These might include:

- Hazards associated with the work environment, such as extreme outdoor temperatures.
- Hazards associated with safe movement through the temporary work site (such as slips, trips and falls).
- Working at height (such as falls from height and falling objects).
- Vehicle hazards (such as vehicle overturn).
- Manual handling (such as lifting of components during maintenance activities).
- Lifting operation hazards (such as collapse of a mobile crane).
- Tools and equipment hazards (such as mechanical hazards).
- Fire hazards associated with work activities (such as cutting and grinding) and flammable liquid and gas use (such as propane).
- Excavations (such as collapse of the excavation).
- Demolition hazards (such as premature collapse of structures).
- Chemical and biological hazards (such as asbestos disturbed during refurbishment works).
- Noise and vibration hazards (such as those generated by machinery such as a disc cutter).

In short, temporary works can include all of the hazards that are the subject of the GC2 course and are characterised in this textbook.

These hazards can present a risk to the workers and others affected by the temporary works. These workers may be contractors working for an external employer engaged to undertake the work (such as a building company engaged by a client to undertake construction work). They may be in-house employees (such as the employer's own in-house building maintenance team). The workers will often be a mixture of in-house employees working alongside external contractors.

Very importantly, the hazards of temporary works can also present risk to others who are working in the workplace when the work is underway and those who might be visiting or passing through or by the work area.

For example, external lamp cleaning and maintenance work undertaken by external contractors at a leisure centre run by a local council could potentially present risk to:

- The contractor workers themselves.
- Leisure centre staff.
- Leisure centre customers (including children, the elderly and the disabled).
- Members of the public passing by outside the site.

The establishment of a temporary work site within an existing workplace can disrupt the 'usual' control measures that will already exist within that workplace. Again, the disruption caused will depend very much on the nature of the existing workplace and the nature of the temporary works. Examples would include:

- Disruption to the one-way system of an on-site vehicle traffic route caused by emergency drain repair works to part of the traffic route.
- Isolation of part of an automatic fire detection system because of hot works in one part of a multi-storey building.
- Closure of a fire escape route because of refurbishment works to the corridor and stairway that forms a part of the escape route.

Control Measures Relating to Management of Temporary Works

Risk Assessment

The temporary works and its impact on the existing workplace must be fully risk assessed. This assessment must include consideration of the hazards associated with the temporary works and those created by the impact of the work on the existing workplace. Proper consideration must be given to all of the people who might be affected by the hazards with special consideration given to vulnerable groups such as children, the elderly, the disabled, etc.

It is the employer's duty to carry out a suitable and sufficient risk assessment for the work activity. This duty would therefore fall to any contractor engaged in the work activity but would also fall to any employer occupying a workplace where the work was taking place. The risk assessment requirement is, in effect, a shared duty.

Communication and Co-operation

Effective communication and co-operation between the various parties undertaking the work and all those affected by the work is essential. This must be achieved by proper planning of the temporary works. Information on the hazards and risks present in the existing workplace and created by the temporary works must be exchanged. In this way, the employer in control of the existing workplace can anticipate foreseeable risks to their employees created by the works.

This communication and co-operation is best achieved by pre-work planning meetings of all of the parties involved. Such meetings are best conducted at the works site in order to anticipate site-specific issues.

Appointment of Competent People

All of the people involved in temporary works must be competent. This includes not only the workers involved in the work itself, but also those involved in the management of the work. 'Competent' means sufficient training, skills, experience and knowledge (and perhaps other abilities such as attitude and physical ability) to be able to carry out their work safely.

Segregation

The area where the temporary works are to take place must be effectively segregated from the existing workplace. This should be accomplished by use of physical barriers and signage. Access points to the temporary work site must be controlled to prevent unauthorised access. Signage may need to be used at these access points to indicate additional rules that may apply within the work area (such as use of PPE).

Segregation is necessary to prevent unauthorised people getting into the areas where the temporary works are taking place. This might include employees of the workplace where the work is taking place, customers and members of the public who want to pass through the work area. Segregation is also necessary to protect the worker engaging in the temporary works from other routine work activities taking place in their vicinity, such as workplace vehicle movements.

Emergency Procedures

Consideration must be given to the emergency procedures that may have to be established because of the nature of the temporary works. For example, work involving the use of cherry pickers (mobile elevating work platform) may require the development of an emergency procedure in case a worker should become stranded in the cradle of the machine. Inevitably, some emergency procedures will involve the existing workplace where the temporary works are taking place. For example, procedures for dealing with a chemical release might have to be adopted if a hazardous chemical were used as a part of the temporary works.

Consideration must also be given to existing emergency procedures that have to be modified as a consequence of the impact of the temporary works. For example:

- Alternative fire detection and alarm procedures that are put in place because of the temporary isolation of part of an automatic fire detection and alarm system during hot works.
- Alternative emergency escape routes that have to be designated because of the closure of an existing escape route. This may require the use of temporary signage and emergency lighting.

Welfare Provision

Adequate welfare provision must be made for the workers engaged in the temporary works. This will include all of the welfare requirements that were covered in the early parts of this element:

- Drinking water.
- Changing rooms.
- Accommodation for clothing.
- Sanitary conveniences.
- Washing facilities.
- Resting and eating facilities.

Workers should have access to drinking water

Specific Hazards and Control Measures for Excavation and Demolition Work

Hazards of Excavations

The hazards of excavation work include:

- **Collapse** - when the unsupported sides of the excavation slip and cave in. Severe crush injuries can result from even relatively small collapses because soil is very heavy. Workers buried or entrapped in soil can asphyxiate in minutes. Workers do not have to be completely buried for asphyxiation to occur; being buried to the chest will lock the rib cage and have the same effect.
- **Striking buried services** - when high-voltage electrical cables, gas pipes, mains pipes or other buried services are struck during the excavation work. This can lead to electric arcing, shock, burns and fire, or gas explosion or rapid flooding of the excavation, not to mention major business disruption to service users.

A shallow excavation revealing a collection of buried services

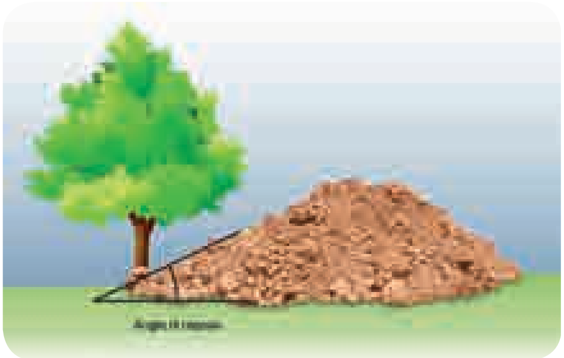
- **People falling in** - when people fall into the excavation from an unfenced edge or whilst climbing into or out of the excavation from ladders.
- **Objects falling in** - when tools or materials fall from an unprotected edge into the excavation and onto occupants, such as:
  - Vehicles driving close to the side of the excavation.
  - Spoil (loose soil) piled close to the sides of the excavation.
  - Adjacent structures, (e.g. wall, scaffold) undermined by the excavation.
- **Flooding** - from surface water during heavy rain, groundwater or a ruptured water main.
- **Hazardous substances** - in particular, gases and vapours. Considerations include:
  - Excavations will fill with any gas that is heavier than air, such as LPG and carbon dioxide. Adjacent combustion engines (such as generators and compressors) can act as a source of exhaust fumes.
  - The ground surrounding the excavation may contain methane or hydrogen sulphide (both produced by microbial decay) that can leach out of the soil and into the excavation.
  - Excavations might need to be classified as confined spaces for these reasons.
  - Contaminated ground can also present a significant hazard, e.g. the ground may be contaminated with heavy metals or chemicals from previous use of the site.
  - It is not unheard of for unexploded ordinance such as hand grenades to be found during excavation works.
- **Collapse of adjacent structures** - in digging an excavation, the foundations of nearby buildings may be disturbed, resulting in the destabilising or collapse of the structure.

Excavation Control Measures

All excavations must be carefully planned. Before digging, it is essential to confirm the presence of underground services, and this will include the use of service plans, ground scanning equipment to detect cables and pipes and then establishing a safe method of work. Initially, the work may commence with a trial dig by hand before using heavy plant where appropriate.

To prevent injury when working in and around excavations, work must be managed under the supervision of a competent person to ensure the following have been adhered to:

- Use of excavation supports to prevent the collapse of the side walls of an excavated area using:
  - Battering, which relies on the properties of the earth to form a stable sloping pile (i.e. angle of repose).



Angle of repose

- Shoring, which uses artificial support for the side walls of an excavation where the angle of repose in the excavation is greater than the natural angle for the type of material.

Shoring the sides of an excavation by 'close sheeting'

- Barriers may be required to protect the edge of an excavation to prevent falls of people, materials and vehicles. Fencing and hoarding may also be required to protect both employees and members of the public.
- Ladders provide the main means of access to and egress from an excavation.
- Ladders must be suitably secured to prevent undue movement and extend five rungs above the excavation to give a secure stepping off point.
- Crossing points in an excavation should be at designated points and be of sound construction to support all types of vehicles and equipment. Gangways across excavations should have guardrails and toe boards.
- Lighting and warning signs warn of the presence of an excavation and of any special measures to be taken on entering a site. Signs should be clearly visible and there should be a good level of lighting.
- The need for personal protective equipment is determined by the nature of the work being carried out (i.e. breathing equipment in tunnels and shafts; face shields for welding work; hearing protection where there is excessive noise) but hard hats are required at all times.

- Identification and marking of buried services and all cables by checking with local service providers, and safe digging methods, particularly when exposing cables and pipes, and using spades and shovels instead of excavators. Damage to cables should be reported immediately to the appropriate services.
- Positioning and routeing of vehicles, plant and equipment should be carefully considered to prevent objects falling into excavations.

Inspection Requirements

Excavations, like scaffolds, can become unstable and unsafe if not maintained in good order. They can deteriorate rapidly as a result of environmental conditions and are liable to catastrophic failure. It is essential that they are inspected routinely to ensure they are in a safe condition.

Excavations should be inspected by a competent person:

- Before the start of every work shift.
- After any accidental fall of material.
- After any event likely to affect strength and stability.

Records of these inspections should be kept on site and remedial work must be undertaken as soon as possible to repair any defects noted.

Demolition Hazards

Demolition involves the knocking down of buildings to clear ground, but it also includes smaller works in maintenance and renovation, such as the dismantling of parts of structures, (e.g. one part of a steel-framed building) or the removal of walls, (e.g. to create open-plan rooms). The hazards associated with demolition are very similar to those encountered in other types of building work, with a few additions.

Demolition hazards vary depending on the nature of the work, but typical hazards include:

- Premature collapse of structures.
- Work at height.
- Plant and machinery.
- Contact with live overheads.
- Contact with buried services.
- Asbestos.
- Dust.
- Movement of vehicles.
- Explosives.
- Noise and vibration.
- Hazardous substances from previous use of the building.
- Biological hazards from vermin or stagnant water.
- Sharp objects, including glass and nails from the demolition, or syringes left by trespassers.
- Manual handling.

Demolition Controls

Control measures include:

- Careful assessment and planning of the work to eliminate hazards where possible, e.g. selecting a demolition method that keeps workers away from the immediate area, such as a long-reach machine or a crane and ball.
- Elimination or control of work at height.
- Structural surveys to assess strength and stability of the structure and adjacent structures; propping and supporting may be necessary to prevent collapse.
- Assessing the strength and stability of floors to ensure that plant, machinery and debris put on those floors do not exceed their tolerance.
- Disconnection of services, (e.g. gas, electricity, water).
- Removal and disposal of any hazardous materials, such as asbestos, prior to demolition.
- Securing the site with fencing or hoardings to create a buffer zone and exclude unauthorised people.
- Damping down with water spray to reduce dust creation.

National General Certificate Legal Standards	International General Certificate Standards
• Construction (Design and Management) Regulations 2015. • Construction (Design and Management) Regulations (Northern Ireland) 2016.	• ILO C167 - Safety and Health in Construction Convention, 1988 (No. 167). • R175 - Safety and Health in Construction Recommendation, 1988 (No. 175).

STUDY QUESTIONS

18. Identify some of the hazards that might be associated with temporary works.
19. Identify five management controls that should be considered for the control of risks created by temporary works.

(Suggested Answers are at the end.)

Summary

This element has dealt with some of the hazards and controls relevant to the workplace environment.

In particular, this element has:

- Outlined minimum welfare provision as: access to drinking water, sanitary conveniences, washing facilities, changing rooms and accommodation for clothing, and places to rest and eat food.
- Identified basic workplace environment standards for seating, ventilation, heating and lighting.
- Outlined the effects of working in extreme temperatures and relevant control measures.
- Discussed risk factors for work-related violence and control measures.
- Outlined types of substances misused at work, and risks to health and safety of drugs and alcohol misuse and the control measures available.
- Outlined the various hazards that pedestrians are exposed to as they move around the workplace and categorised them as: slips, trips and falls; falls from height; collisions with moving vehicles; striking by moving, flying or falling objects; striking against fixed or stationary objects.
- Noted how these hazards can be controlled by the risk assessment process and by careful design and construction of the workplace. Key controls such as:
  - the use of non-slip surfaces,
  - spill control and good drainage,
  - designating pedestrian walkways,
  - fencing and guarding,
  - signs and PPE,
  - information, instruction, training and supervision, and
  - routine inspection and maintenance routines,

  were identified.
- Described the main risks associated with work at height as falls and falling objects, created by hazards such as fragile roofs, sloping roofs, deteriorating materials, unprotected edges, unstable access equipment and adverse weather conditions.
- Outlined how work at height should be avoided, engineering measures (e.g. edge protection) used to prevent falls, and measures taken to minimise the distance and consequences of a fall (e.g. safety nets).
- Discussed the hazards and precautions relevant to scaffolds, mobile tower scaffolds, Mobile Elevating Work Platforms (MEWPs) and ladders, as well as the inspection requirements for such equipment.
- Discussed the prevention of falling materials through safe stacking and storage.
- Outlined some of the impacts associated with temporary works, such as building maintenance, renovation and demolition work.
- Described hazards of excavations as collapse, striking buried services, falls, falling objects, flooding, and hazardous substances.
- Outlined the control measures for management of temporary works, including risk assessment, communication and co-operation, competent people, segregation of work areas, emergency procedures and welfare provision.

Exam Skills

Introduction

To pass the NEBOSH Certificate you need to perform well during the exams. You only have two hours and your performance will be related to two key factors:

- the amount that you can remember about the elements you've studied; and
- your success in applying that knowledge to an exam situation.

Being good at both aspects is essential. Being calm under exam pressure is pointless if you do not have a good knowledge of the information required to answer the exam questions.

Here we will consider some practical guidelines that can be used to increase success in the exam. Then you will find Exam Skills questions for you to answer at the end of each element, starting with this one.

Exam Requirements

The GC2 exam consists of two sections:

- Section 1 contains one question which is likely to consist of two or more sub-parts. This question in total is worth 20 marks.
- Section 2 contains ten questions with each question being worth eight marks.

There is no choice of questions in the exam - all questions are compulsory. The exam in total lasts two hours and NEBOSH recommends that you spend:

- about half an hour on Section 1; and
- about one and a half hours on Section 2.

Exam Technique

In the exam, candidates can often struggle because they have not understood the question that is being asked. They can interpret questions wrongly and provide an answer for the question they think is in front of them but in reality is not. To try to overcome this issue, let's look at a step-by-step approach that you can adopt when answering exam questions:

Step 1.	**Read the question** - the first step is to read the question carefully. Take care with this as it is very easy to misread words in the rush to get writing.
Step 2.	**Highlight the key words** - the key words include the **command** word that NEBOSH has used in the question (see below) and other important words that direct the question. It is a good idea to underline these words on the exam paper to make them stand out.
Step 3.	**Look at the marks** - each question or part of question will have the maximum number of marks indicated in brackets. For each mark to be awarded, the examiner will expect a piece of information. The marks available give an indication of how much you will need to write and how long you should spend on this part of each question.
Step 4.	**Re-read the question** - to check that you have properly interpreted it and understood it. There are no marks available for answering the question that you *think* you see rather than the one that the examiner asked you.

Step 5.	**Draw up a plan** - this can take the form of a list or a mind map that helps you unload information quickly and make sure you have enough factors (or things) in your answer to win the available marks. Jotting down a plan can help you remember key points. The plan is also your aide-mémoire to keep you on track as you start to write your full answer.

When it comes to the exam, make sure you indicate clearly which is your answer plan and which is your final answer, so that the examiner can be sure to mark the correct one.

When writing your answer, you must ensure that the structure of the question appears in the structure of your answer. So, for example, if the question has a part (a) and a part (b), your answer must follow the same structure. Answer part (a) and label it clearly for the examiner as the answer to part (a). Then leave a gap (one line will do) and answer part (b) and label it clearly. The examiner must be able to see the two separate parts of your answer and it must be clear to them which parts are the answer to which. One long paragraph of text that contains all parts of the answer jumbled up together cannot win full marks, even if all of the relevant information is there.

The above exam technique is tried and tested and is the best way to approach each exam question.

All the way through the exam, you must also remember to **monitor the time**:

- The 20-mark question in the first section should take around 25 minutes to answer, with five minutes' reviewing time.
- Each of the ten eight-mark questions in Section 2 should take around eight minutes to answer. This will leave an accumulated time of ten minutes at the end of Section 2 to review your answers.

When composing your answer, it is essential that you pay proper attention to the **command word** (e.g. outline, describe, identify, explain) that has been used in the question. Candidates lose marks if the wrong approach is taken. The command word informs you about the amount of information the examiner is expecting to see in your answer.

Command Words and Their Meaning

Command word	Definition
Identify	To give reference to an item, which could be its name or title. NB: normally a word or phrase will be sufficient, provided the reference is clear.
Give	To provide short, factual answers. NB: normally a single word, phrase or sentence will be sufficient. Often used in the context of "give an example".
Outline	To indicate the principal features or different parts of. NB: an exhaustive description is not required. What is sought is a brief summary of the major aspects of whatever is stated in the question.
Describe	To give a detailed written account of the distinctive features of a subject. The account should be factual, without any attempt to explain. When describing a subject (or object) a test of sufficient detail would be that another person would be able to visualise what you are describing.
Explain	To provide an understanding. To make an idea or relationship clear. NB: this command word is testing the candidate's ability to know or understand why or how something happens. Is often associated with the words 'how' or 'why'.

Application of Command Words

Below are a few examples of the application of the command words to an everyday situation along with acceptable answers to the questions set:

Identify four kitchen appliances:

- *Toaster.*
- *Microwave.*
- *Washing machine.*
- *Electric kettle.*

Outline four kitchen appliances:

- *Toaster - cooks individual slices of bread.*
- *Microwave - heats food using short length radio waves.*
- *Washing machine - cleans clothes by agitating them in water.*
- *Electric kettle - uses a heating element to boil small quantities of water.*

Describe a washing machine:

A square metal box approximately 1m × 60cm × 60cm with a door that opens in the front which is usually round and made of glass to view the washing. There is space within the machine to place approximately 7kg of laundry. Detergent and fabric softener are placed in a drawer and water is drawn via a pipe into the machine.

Explain how a washing machine cleans laundry:

The laundry is placed inside the machine drum by the operator. Detergent is placed within the drawer together with fabric softener. The correct operating temperature is selected on the control panel and the machine is started. Water is drawn into the drum together with the detergent and the drum moves to agitate the clothes and wash them. When this is complete, dirty water is drained away and the clothes rinsed with clean water before spinning at high speed to remove excess water.

You will find more guidance as you work through the course along with plenty of sample/practice questions. It's really important that you complete these and get in touch with your tutor if you have any queries or there is anything you are struggling with.

Taking into account what we have just covered on exam technique, look at the following question.

Exam Skills Practice

At the end of each element there is an Exam Skills question (or two) for you to attempt, with guidance on how to answer in addition to a suggested answer outline. This includes an Answer Plan - all of the points listed in this would attract marks and you will see most of them developed in the suggested answer itself.

Remember that when answering exam questions, information from additional reading and personal experience may be included. Examining bodies encourage this and it will enhance your answers.

Please feel free to contact your tutor if you have any queries or need any additional guidance.

QUESTION 1

Outline the measures to be taken to prevent slip and trip hazards in an engineering workshop. **(8)**

Approaching Question 1

Think about the steps you would take to answer this question:

Step 1. The first step is to **read** the question carefully. Note that this question asks for measures to be taken to prevent slip and trip hazards in an engineering workshop.

Step 2. Now highlight the **key words**. In this case, they might look like this:

Outline the **measures** to be taken to **prevent slip and trip hazards** in an **engineering workshop**. **(8)**

Step 3. Next, consider the **marks** available. In this question, there are eight marks, so it is expected that around eight or nine different pieces of information should be provided. The question should take around eight minutes in total.

Step 4. **Read** the question again to make sure you understand it (re-read your notes if you need to).

Step 5. The next stage is to develop a **plan** - there are various ways to do this. Remind yourself, first of all, that you need to be thinking about 'engineering workshops'. When you see the command word 'outline', you need to select and name the preventive measures, but you must do more than list the measures that can be taken.

Your answer must be based on the key words you have highlighted. So, in this case, we need to outline measures to prevent slips and trips in an engineering workshop.

Now have a go at the question. Draw up an answer plan, and then use it as the basis to write out an answer as you would in the exam.

Key hint: think about a range of prevention measures.

Remember, you can always contact your tutor if you have any queries or need any further guidance on how to answer this question.

When you have finished, compare your plan and full answer with those that follow.

Suggested Answer Outline

Preventive Measures for Slips and Trips	
• Initial design and layout of the workshop. • Designated walkways. • Non-slip floors or floor covering materials. • Maintenance of the floor in good condition. • Handrails on stairs. • Procedures to avoid and deal with spillages. • Adequate lighting.	• Highlighting difference in levels or where steps are. • Good housekeeping standards. • Procedures for reporting defects in floors or incidents that may cause slips and trips. • Avoidance of trailing cables. • Maintain clear walkways without objects left on the floor. • Provide non-slip footwear.

Now have a go at the question yourself.

Example of How the Question Could be Answered

To prevent slips and trips in an engineering workshop, the initial design and layout of the workshop must allow for non-slip flooring materials which are designed for use with oils, and designated walkways. Stairways and stairwells must have handrails. Careful layout of machinery and electrical connections will eliminate the requirement for cables crossing gangways. The workshop will need a system which ensures the immediate repair of floor defects, such as holes or bumps. Procedures and systems must also be in place that will prevent spills of fluids arising and will deal with them if they do arise, either as a result of filling machines with cutting fluids or oils or draining sump tanks for maintenance. The workplace needs to be adequately illuminated with additional strip lighting in areas of differing levels. A good standard of housekeeping should ensure gangways are kept clear. The workshop should also have good procedures for reporting incidents that may lead to slips and trips. In addition, the provision of non-slip safety footwear to employees may further reduce the risk.

Reasons for Poor Marks Achieved by Candidates in Exam

- Providing a list instead of outlining measures.
- Focusing purely on housekeeping or providing a description of methods of housekeeping, avoiding many of the broader measures.
- Identifying hazards in an engineering workshop not related to slips and trips.
- Not providing sufficient breadth in the answer.

QUESTION 2

A roofing contractor is required to carry out extensive repair work on a fragile roof on a large manufacturing building.

(a) **Outline** the factors that should be considered in the selection process for hiring the roofing contractor. **(8)**

(b) **Identify** the main risks to the contractors from working at height. **(4)**

(c) **Identify** possible control measures for the erection of an independent tied scaffold. **(8)**

Approaching Question 2

In GC2, the first section is a longer, 20-mark question, which is typically broken down into smaller parts. NEBOSH advise that you allow yourself half an hour for this question - here you can allow yourself a little longer to work through the process, but be aware that on exam day you will be under greater time pressure.

This question may look daunting, consisting of three sub-sections, but you should approach it in the same way that you would a simpler, eight-mark question. Command words are used to indicate the level of depth that you are required to provide. Note, however, that it is possible that a 20-mark question may cover topics from more than one element.

Think now about the steps you would take to answer the question:

Step 1. The first step is to **read** the question carefully. This question requires you to outline and identify - as always, be careful that you understand the correct level of depth required, as many good candidates lose marks for giving a list rather than an outline.

Step 2. Now highlight the **key words**. In this case, they might look like this:

A **roofing** contractor is required to carry out extensive repair work on a **fragile roof** on a large manufacturing building.

(a) **Outline** the **factors** that should be **considered** in the **selection process** for hiring the roofing **contractor**. **(8)**

(b) **Identify** the **main risks** to the contractors from **working at height**. **(4)**

(c) **Identify** possible **control measures** for the erection of an **independent tied scaffold**. **(8)**

Step 3. Next, consider the **marks** available. It would be sensible to assume that you need to outline eight factors for part a (though adding a couple of additional factors may maximise your chances of getting full marks here). In part b, you should identify at least four main risks from working at height. In part c, you should identify at least eight controls for erection of the scaffold.

Step 4. **Re-read** the question again to make sure you understand about roof work, contractor selection and scaffolds. (Re-read your notes if you have to.)

Step 5. The next stage is to develop a **plan**. Here, your answer plan is likely to take the form of a bullet-pointed list that you need to develop into a full answer based on the key words that you have highlighted.

Now have a go at the question. Draw up an answer plan, and then use it as the basis to write out an answer as you would in the exam.

When you have finished, compare your plan and full answer to those that follow.

Suggested Answer Outline

Factors to Consider in Contractor Selection	Risks to Contractors from Work at Height	Controls for Erection of Independent Tied Scaffold
• References. • Insurance. • Trade association memberships. • Maintenance of equipment. • Experience of similar works. • Training of staff. • Method statement suitability. • Risk assessment quality. • Accident history. • Enforcement actions. • Health and safety policy. • Equipment to be used. • Maintenance of equipment. • Control of sub-contractors.	• Falls from height. • Falling objects. • Falls through fragile roof. • Contact with live services/cables. • Injuries due to tools in use. • Effects of weather (from sunburn to slips on ice).	• Correctly designed for use and load. • Designed for weather. • Equipment to be used. • Stable ground. • Base plates and sole plates. • Scaffold not damaged and in good condition. • Erected by competent persons. • Inspected before use. • Scaffolders wearing fall-arrest equipment. • Securely tied to structure/building. • Protected from vehicles.

Example of How the Question Could be Answered

(a) *The following factors should be considered when selecting a roofing contractor. References should be checked to ensure that previous clients were satisfied with the work carried out, and to ensure that works of a similar nature and size to the proposed project have been delivered successfully. Certificates of insurance should be checked to ensure that adequate public liability and employer's liability cover is carried by the contractor. The level and quality of health and safety training provided to employees should be considered, and preference given to organisations that demonstrate such commitment to employee training. The organisation's health and safety management system should be considered, such as the suitability of the health and safety policy and the process for reporting and recording of accidents, and the processes in place for checking and controlling sub-contractors. With regard to the safety of the project, the suitability and quality of the risk assessments should be assessed, ensuring that the risk assessments are site-specific. Method statements should be sufficiently detailed and demonstrate how control measures will be implemented to reduce the risk to the workers. Finally, consideration should be given to the safety of the equipment to be used on-site, the suitability of the equipment for the environmental conditions and its maintenance.*

(b) *The main risks to the contractors from working at height include falls from height, falls through a fragile roof, contact with live services such as power cables, and the effects of exposure to adverse weather conditions (from sunburn through to slips on ice).*

(c) *Possible control measures to be implemented when erecting an independent tied scaffold include ensuring that the scaffold is designed for the load it is intended to take, and that it is erected by a competent scaffold contractor on firm, level ground with base plates used to spread the load. The scaffold components should be free from damage. The scaffolders should wear fall-arrest equipment during the assembly to prevent falls. The scaffold should be tied securely to the building with the appropriate number of ties to prevent collapse, taking into account possible loads and adverse weather conditions.*

Reasons for Poor Marks Achieved by Candidates in Exam

- In part (a), problems encountered include limiting answers to previous work of a similar nature, and reviewing the health and safety policy.
- In part (b), confusing risks (which were required) with hazards and providing the wrong information.
- In part (c) misreading the question and detailing the components used for the erection of the scaffold rather than the control measures to be used during the erection of the scaffold.

QUESTION 3

Excavation work is being carried out on a construction site. **Identify** the control measures needed to reduce the risk to workers. **(8)**

Approaching Question 3

Think now about the steps you would take to answer the second question:

Step 1. The first step is to **read** the question carefully. This question requires you to identify, so you don't need to give much detail - as we saw earlier, if asked to "identify" you are expected to "select and name", so in this case you should name the control measures needed to reduce risk to workers.

Step 2. Now highlight the **key words**. In this case, they might look like this:

Excavation work is being carried out on a construction site. **Identify** the **control measures** needed to **reduce the risk** to workers. **(8)**

Step 3. Next, consider the **marks** available. In this question, there are eight marks. It would be sensible to assume that you need to identify eight or more controls to gain the eight marks (adding a couple of additional controls may maximise your chances of getting full marks here). However, don't go overboard - watch the time! The question should take around eight minutes in total.

Step 4. **Re-read** the question to make sure you understand it and have a clear understanding of controls to protect workers. (Re-read your notes if you need to.)

Step 5. The next stage is to develop a **plan** - there are various ways to do this. Your answer must be based on the key words you have highlighted. Remind yourself, first of all, that you need to be thinking about "How can excavation work be controlled to reduce the risk to workers?"

Now have a go at the question. Draw up an answer plan, and then use it as the basis to write out an answer as you would in the exam.

Take care to keep an eye on the time when answering - it is very easy to spend too long on a question and there are only eight marks available, no matter how long you spend on it!

When you have finished, compare your plan and full answer to those provided.

Suggested Answer Outline

Excavation Controls
• Shoring or drag boxes to prevent trench collapse. • Stop blocks to prevent vehicles driving into trench. • Provision of safe access into excavation (ladders, etc.). • Pre-dig checks for services (cable scans, checking plans). • Supporting adjacent buildings/checks to ensure foundations aren't undermined. • Barriers to prevent pedestrians falling in. • Gas checks to ensure breathable atmosphere. • PPE to protect against possible contamination (contaminated land). • PPE and training in biological hazards. • Statutory inspections of the excavation.

Example of How the Question Could be Answered

Possible controls to reduce the risk to workers near excavations on a construction site include:

- *Before digging, the excavation site should be checked for underground services, including power and gas mains. This should be carried out by checking site plans and using cable detectors.*
- *Supporting the sides of the excavation to prevent collapse using shoring or drag boxes. An alternative is to batter back the sides of the excavation to a safe angle. All material excavated should be stored a safe distance from the excavation to prevent it from falling in onto workers.*
- *Provision of stop blocks to prevent vehicles driving or reversing into the excavation.*
- *Use of barriers to prevent pedestrians from falling into the excavation.*
- *Provision of safe access means for those entering the excavation (e.g. a ladder) and so that they can exit safely.*
- *Those working in the excavation may need gas detectors to ensure that the atmosphere is breathable, to test for toxic gases but also to ensure an adequate oxygen supply.*
- *PPE may be needed to protect workers from contamination (e.g. chemicals in contaminated land), or biological hazards.*
- *In order to ensure ongoing safety the excavation should be inspected before the start of every shift, after any fall of earth and after any event likely to affect stability.*

Reasons for Poor Marks Achieved by Candidates in Exam

Talking about general controls, such as permits to work and risk assessments, which wouldn't attract marks.

Element 2

Transport Hazards and Risk Control

Learning Outcomes

Once you've read this element, you'll understand how to:

1. Explain the hazards and control measures for the safe movement of vehicles in the workplace.
2. Outline the factors associated with driving at work that increase the risk of an incident and the control measures to reduce work-related driving risks.

Contents

Safe Movement of Vehicles in the Workplace

IN THIS SECTION...

- Vehicle operations create risk for the vehicle driver, as well as pedestrians, other drivers and passengers. Hazards include:
  - Those relating to vehicle movement, which include driving too fast, reversing, quiet machinery and poor visibility.
  - Non-movement-related hazards, which include loading, unloading, securing and sheeting of loads, coupling and maintenance work.
- Common accidents involve vehicle overturn, and collisions with pedestrians, other vehicles or fixed structures.
- These hazards can be controlled through the risk assessment process and by careful management of the workplace environment, the vehicles and the drivers.
- The workplace environment should be designed, constructed and maintained to allow safe vehicle movement and to separate vehicles from pedestrians.
- Vehicles should be suitable for their intended use and workplace environment and maintained in safe working order.
- Drivers should be appropriately qualified, medically fit and given information, instruction, training and supervision.

Risks Associated with Workplace Transport Operations

Typical Risks Relating to Vehicle Movements

When vehicles move around in workplaces, they are a hazard to pedestrians, to other vehicles (and their occupants) and to the driver (and other occupants).

Forklift truck

Loss of Control and Overturning

A driver may lose control of their vehicle for various reasons:

- Driver error, (e.g. driving too fast).
- Environmental conditions, (e.g. mud on the road).
- Mechanical failure, (e.g. brakes fail).

Depending on the type of vehicle being driven, this loss of control may result in a skid, collision or overturn of the vehicle.

Some vehicles, because of their design or environment of use, are more likely to overturn than others. Forklift trucks (with a very short and narrow wheel base) and dumper trucks (with a high centre of gravity and used on rough terrain) are frequently involved in overturn accidents.

TOPIC FOCUS

Factors that can cause a forklift truck to overturn:

- Cornering whilst being driven too fast.
- Uneven loading of the forks.
- Driving over potholes.
- Driving with the load elevated, especially cornering.
- Uneven tyre pressures.
- Driving across a slope (rather than straight up/down the fall line).
- Excessive braking.
- Collisions, especially with kerbs.

When a vehicle overturns, the driver can easily be trapped or crushed between the vehicle and the floor unless precautions are taken to retain the driver in a safe location - this is why seatbelts are so important.

Collisions

Collisions can occur between the vehicle and:

- Other vehicles, e.g. between two lorries manoeuvring at a depot.
- Pedestrians, e.g. between a car in a staff car park and a member of staff leaving work.
- Fixed objects, e.g. between a forklift truck and the support leg of racking in a warehouse.

Areas of particular concern are vehicle entrance and exit points, such as the forklift truck entrance point from an outside yard area into a workshop. These parts of a building tend to have a high incidence of vehicle collisions because of the:

- Bottlenecking of vehicles through these routes.
- Presence of blind spots (places that the driver cannot see).
- Change in light levels that usually occurs (from brightly lit to dark and gloomy, or the reverse) - the driver's eyes take a while to adapt to the new light level.

Remember that some of the highest-risk situations occur when pedestrians have to interact with vehicles. Any collision between a vehicle and a pedestrian is likely to lead to serious or fatal injury.

TOPIC FOCUS

Factors that increase the risk of vehicle collisions are:

- Driving too fast.
- Inadequate lighting.
- Reversing without the help of a banksman (signaller).
- Blind spots, such as corners and entrances.
- Bad weather conditions, (e.g. rain).
- Obstructed visibility, (e.g. overloaded forklift truck driving forwards).
- Poor design of pedestrian walkways and crossing points.
- Lack of vehicle maintenance, (e.g. brake failure).

Vehicle accidents are responsible for many serious and fatal injuries and also cause a significant amount of property and equipment damage. You will find the various risk factors listed below, along with some typical conditions and environments in which each hazard might arise:

- **Driving too fast** - often associated with driver error, is a major cause of vehicle collisions and vehicles overturning. The effects of driving too fast are worsened by movements across uneven ground, sloping surfaces and around bends. Loads may move due to abnormal movements and fall from vehicles. Braking when driving too fast may be ineffective and more hazardous on wet, icy or slippery surfaces.
- **Reversing** - limits a driver's vision and puts the whole length of a vehicle in the direction of travel. Without rear-vision devices (such as cameras) or reversing alarms, drivers and pedestrians may not see or hear the approach of a vehicle.
- **Silent operation of machinery** - not only are vehicle engines more quiet, but auxiliary machinery and equipment such as loaders, cranes, refrigeration plant, etc., are quiet, and may not be heard by pedestrians or other drivers.
- **Poor visibility** - especially around loads, wide or long vehicles or while vehicles reverse, causes many collisions. Vehicle entrance and exit points also create blind spots and changes in light levels.

DEFINITION

BANKSMAN (SIGNALLER)

A person used to guide a vehicle/plant driver/ operator during vehicle/ plant use, e.g. while reversing.

Non-Movement-Related Hazards

Vehicles do not only present a hazard when they are moving. Some vehicle hazards occur when other types of activity are being carried out on the vehicle:

- **Loading** - both manual and mechanical loading of vehicles can create risk. For example, the manual handling risk associated with lifting crates into the back of a lorry, or the risk of collision when loading a flat-bed lorry using a forklift truck.
- **Overloading** - exceeding the safe working limit of the vehicle can result in significant risks. This could be due to driver error, or through a lack of knowledge about the capabilities of the vehicle or the nature of the load. An unbalanced load can also destabilise the vehicle.
- **Unloading** - both manual and mechanical unloading can create risk. For example, tipping operations can result in the vehicle overturning or people being struck by the material being tipped.

- **Securing** - when workers have to climb onto a vehicle in order to secure the load. For example, a driver might have to climb onto the top of a lorry to sheet over the load to prevent it blowing out when moving at speed, or might have to climb onto the top of a road tanker to close hatches. Both of these operations involve work at height.
- **Coupling** - when vehicles are attached to trailers or other towed equipment, there is potential for collision and crushing.
- **Maintenance work** - when mechanics have to access various parts of the vehicle and may have to work at height or under the vehicle.

Workplace Transport Control Measures

The control strategies for managing the risk inherent in vehicle operations are based on the usual basic health and safety management principles:

- Eliminate the hazard.
- Create a safe place.
- Create a safe person.

The starting point is **risk assessment**.

Risk Assessment

A risk assessment covering the vehicle operations in a workplace would:

- Identify the various hazards, by establishing the vehicle operations taking place in or from the workplace and the types of foreseeable accident that might occur.
- Identify the groups at risk (pedestrians, the driver, other drivers, etc.) and those who might be especially vulnerable (young children, the elderly, people with certain disabilities, such as the visually impaired, etc.).
- Evaluate the risk by considering the existing controls, the adequacy of those controls and any further controls required to reduce the risks to an acceptable level.
- Be recorded and implemented.
- Be subject to review as the workplace changes, in response to incidents, and perhaps periodically.

The measures necessary to control the risks created by vehicle operations can be grouped under three main categories:

- **Workplace environment**.
- **Vehicle**.
- **Driver**.

The Workplace Environment

Careful design and construction of the workplace can eliminate or reduce the risks created by vehicle operations:

Pedestrian direction sign

- Vehicle-free zones - it may be possible to eliminate the hazard by creating pedestrian-only areas.
- Pedestrian-free zones - since pedestrians are usually the group at greatest risk during vehicle manoeuvring operations, it may be possible to eliminate them from certain parts of the workplace.
- Vehicle traffic route layout - good design of roads and routes can be used to keep vehicles at a distance from pedestrian walkways and other vehicles, and this should include separate access doors for pedestrians and vehicles. One-way systems are an effective method of reducing the risk of vehicle-to-vehicle collisions.
- Segregation of vehicles and pedestrians - wherever possible, pedestrians should be provided with a separate walkway. It may be necessary to barrier this route to provide additional physical protection. In some situations (such as in loading bays), areas of safety should be provided that pedestrians can retreat into during vehicle movements.
- Where barriers cannot be used, segregation might be achieved by marking pedestrian walkways on the floor.
- Separate site and building entrances should be provided for vehicles and pedestrians so that they are not forced into close proximity at these bottlenecks.
- Speed limits should be set for traffic routes and then clearly indicated by signage, and enforced. Traffic-calming measures, such as speed bumps, might be used where experience shows there is a problem with vehicles speeding.
- Vehicle movements on site should be managed. This may include implementing vehicle restrictions to reduce the number of vehicles on site, allocating booking slots for deliveries, etc. Banksmen (signallers) may be used to ensure that vehicle manoeuvres in the vicinity of pedestrians are carried out safely.
- Crossing points may be implemented to allow pedestrians to cross traffic routes safely.
- Good visibility is essential, so that drivers have unobstructed views from their vehicles. Blind spots should be eliminated by careful traffic route design; where this is not possible, aids such as mirrors, CCTV and transparent doors should be provided.
- Good standards of lighting should be present on traffic routes.
- Appropriate signage should be used to alert vehicle drivers to hazards on their route (such as lower overheads). Signage should also be used to warn pedestrians that there could be vehicles operating in the area.
- Whilst barriers can protect pedestrians from vehicles, they can also be used to protect structures that might be at risk of damage or collapse in the event of a collision, e.g. in a warehouse, racking may be protected with barriers at vulnerable locations.
- Wherever there are changes in level, e.g. at loading docks, physical barriers should also be used to prevent a vehicle driving off the dock and falling.
- The surface of the traffic route must be suitable for the vehicles using it, with attention paid to its strength and stability, grip characteristics and drainage.
- Gradients should be avoided, but if this is not possible, they must not exceed the capabilities of the vehicle using the traffic route.

The above controls must also be reinforced by the implementation of **site rules** for drivers and pedestrians (strictly enforced and adhered to) and driver training, with information provided on the rules to visiting drivers, such as delivery drivers.

TOPIC FOCUS

Typical rules for parking a forklift truck are:

- Apply the handbrake.
- Lower the forks and tip the mast forwards.
- Remove the key.
- Do not obstruct a traffic route.
- Do not obstruct a pedestrian route.
- Do not obstruct emergency escape routes.

All these control measures should be **maintained** in good order. This may require routine inspection regimes, cleaning regimes and repair/replacement as necessary.

It will usually be necessary to develop **safe systems of work** for vehicle operations. These safe systems should identify the site procedures and rules that must be followed. For example, many workplaces prohibit vehicles from reversing without the aid of a banksman.

TOPIC FOCUS

Control measures that can reduce the risk of accident from reversing vehicles include:

- Avoidance of reversing by implementing one-way traffic systems.
- Segregation of pedestrians and vehicles or the provision of refuges.
- Good vehicle selection so that drivers have adequate visibility.
- Provision of audible reversing alarms and flashing beacons.
- Provision of mirrors at blind spots to see approaching pedestrians.
- Use of high-visibility clothing.
- Ensuring that the area is well lit.
- Provision of banksmen.
- Training for drivers and pedestrians working in the area.

These workplace design, construction and layout matters may be subject to legal standards. For example, the UK **Workplace (Health, Safety and Welfare) Regulations 1992** set out the basic legal framework for traffic route construction and layout with an emphasis on the separation end segregation of vehicle and pedestrians. On the public highway, other legislation exists that dictates some of the standards to be achieved.

MORE...

More detailed information on workplace traffic route layout and safety can be found at:

www.hse.gov.uk/workplacetransport/index.htm

Safe Vehicles

The range of vehicles that might be used for work purposes is enormous - from cars, vans and lorries used on public roads to 200-tonne quarry trucks. In spite of this great variety of vehicles, there are some basic principles that can be applied.

TOPIC FOCUS

Vehicles should be:

- Suitable for their intended use.
- Suitable for the environment and conditions in which they are used.
- Maintained in safe working order.
- Only driven by suitably trained, qualified staff.
- Inspected routinely before use.

And, where necessary, vehicles should be fitted with a:

- Seat for the driver (and any passengers).
- Seat belt.
- Roll bar or roll cage to protect the driver in the event of overturn.
- Guard to protect the driver in the event of falling objects (Falling Object Protective Structure (FOPS)).
- Horn.
- Set of visibility aids, such as cameras and mirrors.
- Audible reversing alarm to warn pedestrians.
- Beacon or flashing light to warn of an approaching vehicle.

DEFINITION

ROLL BAR OR ROLL CAGE (ROLL-OVER PROTECTIVE STRUCTURE)

This is part of the structure of the vehicle that prevents the driver from being crushed, should the vehicle roll over onto its side or top; also known as a Roll-Over Protective Structure (ROPS).

Vehicles used on **public roads** have to comply with the relevant local legislation, such as the **Road Traffic Act 1991** in the UK, (e.g. requirements for road tax, appropriate insurance, working headlights, etc.). Vehicles used on **private land** (as with most workplaces) do not usually have to comply with the same public highway laws, but do have to meet specific legal standards relating to workplaces in general or a workplace in particular, e.g. vehicles used in a quarry should always be fitted with a yellow beacon (flashing light) and that light should always be working when the vehicle is operational.

For example, in a UK workplace, the **Health and Safety at Work, etc. Act 1974** will apply, as will the **Management of Health and Safety at Work Regulations 1999**. A vehicle is an item of work equipment and therefore subject to the **Provision and Use of Work Equipment Regulations 1998 (PUWER)**, most notably part 3 of **PUWER**, which applies specifically to mobile work equipment. The vehicle may also be an item of lifting equipment, (e.g. a forklift truck) and so subject to the **Lifting Operations and Lifting Equipment Regulations 1998 (LOLER)** as well. Relevant Approved Codes of Practice and guidance will also apply.

A risk assessment may have to be completed to decide exactly which safety features a vehicle should have in a particular workplace in order to meet legal standards.

Safe Drivers

Since there are very few instances where automated vehicles can be used in a workplace, vehicles are usually under the control of a driver. It is essential that the driver is carefully selected, trained and supervised.

Drivers should be:

- **Competent to drive the vehicle**: proof of qualification, (e.g. driving licence) may be necessary or the driver may have to be trained and assessed to achieve qualification. Refresher training and re-certification may be required. In certain situations, the driver's licence may have to be checked periodically to ensure that the driver does not have undisclosed penalties or disqualification for road traffic offences.
- **Medically fit to drive**: a medical examination to assess the driver's health and fitness may be required. This should take place at selection and may have to be repeated periodically.
- **Provided with specific information, instruction and training** appropriate to the workplace and site where they will be driving; driver-specific site induction training may have to be provided.
- **Supervised**: to ensure that they follow safe systems of work, obey site rules and do not lapse into bad practices.


Supervisor with forklift truck driver

The employer must make sure that an appropriate **management system** is in place to ensure driver competence as set out above. This management system should form a part of the policy arrangements for the organisation.

There are legal standards and approved codes of practice relating to these matters that will vary depending on the location, the nature of the workplace, the vehicle and whether the vehicle is to be driven on private land or on the public highway. For example, in the UK, a forklift truck driver using a forklift on private land should be qualified to drive the relevant type of truck as indicated by the **ACoP L117 Rider-Operated Lift Trucks: Operator Training and Safe Use - Approved Code of Practice and Guidance** (an ACoP to **PUWER**).

MORE...

The UK's Health and Safety Executive website contains more information on vehicle and transport safety at work, at:

www.hse.gov.uk/workplacetransport/index.htm

National General Certificate Legal Standards	International General Certificate Standards
• Health and Safety at Work, etc. Act 1974. • Health and Safety at Work (Northern Ireland) Order 1978. • Management of Health and Safety at Work Regulations 1999. • Management of Health and Safety at Work Regulations (Northern Ireland) 2000. For most workplaces: • Workplace (Health, Safety and Welfare) Regulations 1992. • Workplace (Health, Safety and Welfare) Regulations (Northern Ireland) 1993. For construction sites: • Construction (Design and Management) Regulations 2015. • Construction (Design and Management) Regulations (Northern Ireland) 2016. • Provision and Use of Work Equipment Regulations 1998. • Provision and Use of Work Equipment Regulations (Northern Ireland) 1999. • Lifting Operations and Lifting Equipment Regulations 1998. • Lifting Operations and Lifting Equipment Regulations (Northern Ireland) 1999. • Road Traffic Act (1981 and 1991). • Road Traffic (Northern Ireland) Order (1981, 1995 and 2007).	• ILO C155 - Occupational Safety and Health Convention, 1981 (No. 155). • ILO R164 - Occupational Safety and Health Recommendation, 1981 (No. 164). For construction sites: • ILO C167 - Safety and Health in Construction Convention, 1988 (No. 167). • R175 - Safety and Health in Construction Recommendation, 1988 (No. 175).

STUDY QUESTIONS

1. Identify the main types of risk associated with vehicle operations.
2. Identify the unsafe practices that might cause a forklift truck to overturn.
3. Identify the main safety measures used to manage vehicle operations and movement.
4. Identify special equipment that might be fitted to vehicles to protect drivers.
5. Identify when vehicle warning lights and alarms are particularly useful.
6. Outline the means of separating vehicles and pedestrians.

(Suggested Answers are at the end.)

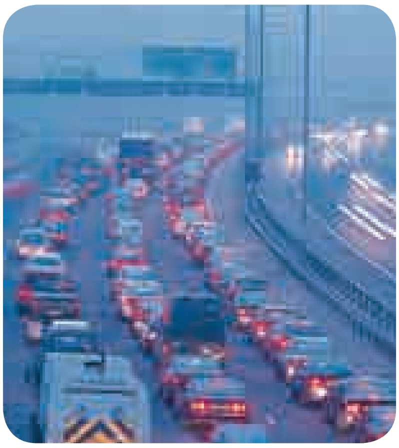
Driving at Work

IN THIS SECTION...

- Organisations should establish clear policies on work-related driving safety and implement management systems and monitoring arrangements.
- Risk assessment of work-related driving should follow the standard five-step approach for risk assessment. Factors to consider include the distance travelled, driving hours, work schedules, stressful situations and weather conditions.
- Evaluation of risk should focus on three things: the driver, the vehicle and the journey.
- Control measures to reduce driving risk include:
  - Elimination of the need to travel.
  - Use of alternative means of transport.
  - The management of the risk factors associated with the driver, vehicle and journey.

Managing Work-Related Road Safety

In this section, we look at the issue of driving a vehicle on the public highway for work; in particular, a company car. This section does not focus specifically on large goods vehicles or passenger service vehicles, where specific legislation applies.



Driving on a public motorway

Managing work-related road safety requires that the employer integrates road safety into their existing safety management system. Road safety should be treated as simply another aspect of their general duty for the health and safety of their staff and third parties. This requires the establishment of several management systems:

- **Policy** - an organisation's policy should cover work-related driving and should recognise that this activity puts a duty on the employer to manage the risk created. Specific arrangements must be made. If the employer has five or more employees then this policy and the arrangements must be recorded.
- **Responsibility** - there must be top-level commitment to the organisation's policy and responsibility must be allocated at a senior level to ensure that necessary authority and resources are available to back that commitment.
- **Organisation** - work-related driving will often involve different groups of workers in different ways. An organisation's policy should be developed with all of those various groups of workers in mind and often involves various interested parties from different parts of the organisation, (e.g. training department, health and safety department, fleet managers, etc.).
- **Systems** - specific arrangements must be made to ensure that vehicles are maintained, inspected and tested in accordance with the manufacturer's recommendations and law. Driver qualifications and fitness may have to be checked. These management systems must be established and checked periodically to ensure that they are still working adequately.

- **Monitoring** - various methods can be used to monitor the effectiveness of arrangements made, e.g. a road traffic accident reporting system should exist.
- **Legal responsibilities** - individuals driving while at work are bound by the national laws governing road safety and road traffic offences. An individual in breach of these laws could face personal penalties, regardless of the fact that they were driving for work-related reasons. For example, a sales representative caught speeding would be personally liable for the offence, not the organisation. However, if offences were committed with the knowledge of the organisation, the company might also face legal action.

Risk Assessment

Work-related driving should be risk assessed in the same way as other work-related activities. This will allow the employer to establish arrangements for controlling the risk. The standard five-step approach to risk assessment can be used:

1. **Identify the hazards** - these can be categorised as the factors associated with driving that increase the risk of being involved in a road traffic incident, namely:
   - **The journey distance** - the longer the journey, the greater the risk. Long journeys should be broken into shorter sections. Sections of a journey should also be of comfortable length.
   - **Driving hours** - it may be tempting to drive for a long period without a break in order to get to the destination faster, but this increases the risk of an accident due to fatigue and lapses of attention.
   - **Work schedules** - poor planning and unreasonable work schedules (which do not allow adequate time between appointments) can cause drivers to speed, take risks, or fail to take breaks.
   - **Stress** due to traffic - times of journeys can place a driver in 'rush-hour' traffic on major and suburban roads, and road works or traffic incidents can cause unscheduled delays.
   - **Weather conditions** - adverse weather conditions can increase the risk to those driving. For example:
     - Snow can cause the roads to be slippery and reduces visibility.
     - Fog affects visibility.
     - High winds are particularly hazardous to drivers of high-sided vehicles.

   (More on these when we consider control measures later in this section.)
2. **Identify the people who might be harmed** - the driver, but they may also include passengers and other road users. Certain groups might be more at risk, such as young drivers.
3. **Evaluate the risks** - the level of risk must be estimated and decisions made about appropriate control measures. A standard hierarchical approach can be adopted:
   - Eliminate the need to travel - e.g. conduct web-based video conference calls rather than meeting face-to-face.
   - Travel by a safer means of transport - e.g. train or aeroplane.
   - If travel by road is the only sensible option then ensure that the vehicle is appropriate and in a safe condition and that the best person is driving. Various arrangements can be made through the company policy to ensure that both the vehicle and the driver meet the required standards (see later).
4. **Record** findings and implement them.
5. **Review** - the risk assessment should be reviewed following incidents, after significant change and periodically.

Evaluating the Risks

Evaluating the risks means looking at what controls are in place already - are they enough to reduce the risks to an acceptable level, or do we need to do more? The risk evaluation should look particularly at the driver, the vehicle and the journey, and consider the risk factors that might exist under each topic as we have seen above:

- **The driver:**
  - Competency.
  - Fitness and health.
  - Training.
- **The vehicle:**
  - Suitability.
  - Condition.
  - Safety equipment.
  - Safety-critical information.
  - Ergonomic considerations.
- **The journey:**
  - Routes.
  - Scheduling.
  - Sufficient time.
  - Weather conditions.

Control Measures

Control measures can then be identified that would be appropriate for each risk factor. Some of these control measures require that specific management arrangements are put in place, while others require that guidelines are prepared and passed on to drivers. In some instances, there may be clear statutory requirements that must be met. In many cases, however, the employer has to base their control measures on good practice.

The Driver

Three main risk factors exist for the driver:

- **Competency** - drivers should hold the relevant driving licence for the vehicle to be driven. They might also be required to demonstrate relevant experience, skill and knowledge:
  - Drivers' licences should be checked on recruitment and re-checked periodically, (e.g. every six months) to ensure validity.
  - Some organisations set minimum standards regarding endorsements on company driving licences.
  - Some organisations take up references for proof of relevant experience and ability.
- **Training** - drivers may have to undertake specific training on safe driving:
  - Some organisations require their drivers to undertake advanced driving or defensive driving training and assessments.

- Some organisations train their drivers on vehicle safety, such as pre-use vehicle inspection, use of anti-lock braking, head restraint adjustment (to prevent whiplash injury), etc.

- **Fitness and health** - drivers may have to undergo a medical examination and be passed as fit to drive:
  - For certain drivers, such as those driving heavy vehicles and buses, this medical examination and certification is a legal requirement.
  - For some organisations, medical examination is a matter of company policy.
  - Drivers' eyesight might need to be checked.
  - Drivers should be reminded about not driving whilst taking certain drugs that cause drowsiness.

The Vehicle

- **Suitability** - the vehicle must be suitable for its intended purpose:
  - Some organisations set a minimum requirement for the safety standards of the vehicle (e.g. as determined by Euro NCAP crash test (see 'More' box)).
  - Some organisations set minimum standards for safety features, such as anti-lock braking, airbags, headrests and seat belts.
  - A personal vehicle should only be used for work if it has a valid regulatory certificate where required (e.g. an MOT certificate in the UK, which checks certain roadworthy features of a vehicle of a certain age) and is insured for work use.

Vehicle testing and maintenance

- **Condition** - the vehicle must be in a roadworthy condition:
  - Vehicles should be maintained in accordance with the manufacturer's recommended service schedule.
  - Vehicles should be routinely inspected prior to use to check the condition of tyres, lights, etc.
  - Vehicle defects should be reported and corrected where safety-critical.
- **Safety equipment** - the vehicle should carry suitable safety equipment:
  - Seat belts, airbags and head restraints are fitted as standard in many vehicles; they should be in good order.
  - Other safety equipment may be specified by the employer, such as emergency triangles, first-aid kit, spare tyre and fire extinguisher.
- **Safety-critical information** - certain information must be understood by the driver:
  - Tyre pressure, headlight adjustment and head restraint adjustments are examples of safety-critical information that the driver should know.
- **Ergonomic considerations** - the adjustability of the seat position and vehicle controls, as well as driver posture, should be considered when selecting vehicles to ensure driver comfort and to minimise the risk of back pain and other musculoskeletal disorders (MSDs).

The Journey

There are also several considerations relating to the journey that need to be taken into account when determining control measures:

Roadworks

- **Routes** - route planning allows for hazards to be avoided and risks minimised:
  - Hazards, such as busy areas, (e.g. a town centre) or high-risk areas, (e.g. accident black-spot) can be avoided.
  - Low-risk roads can be selected. Motorways and dual carriageways (also known as divided highways) are the safest roads.
  - Roadworks can be avoided.
- **Scheduling** - scheduling journeys at the right time of day:
  - Avoid travelling at peak traffic times.
  - Avoid travelling when drivers will feel naturally fatigued (2:00-6:00am and 2:00-4:00pm).
  - Allow flexibility of deadlines.
- **Time** - allowing sufficient time for the journey:
  - Time allowed must be realistic given the route chosen, weather conditions and anticipated breaks.
  - Unrealistic deadlines put pressure on drivers to speed. Rest breaks must be factored into journey times. A fifteen-minute break every two hours is recommended.
  - There are statutory requirements for professional drivers.
- **Distance** - travel distances must be reasonable:
  - It may be possible to minimise travel distances by using other forms of transport for some of the journey.
  - Distance must not be excessive and consideration should be given to the length of the driver's day outside of driving time.
- **Weather conditions** - weather forecasts and adverse weather conditions must be taken into account when journey planning and travelling. Drivers should:
  - Have access to reliable weather forecast information so that they can journey plan accordingly.
  - Be given guidance on adverse weather conditions when they should not travel.
  - Be given advice on additional safety during adverse weather.

MORE...

Browse the following websites to read more on work-related road safety:

www.hse.gov.uk/roadsafety/www.hse.gov.uk/roadsafety/index.htm

www.drivingforbetterbusiness.com

Details about the Euro NCAP crash test can be found at:

www.euroncap.com/enwww.euroncap.com/tests.aspx

National General Certificate Legal Standards	International General Certificate Standards
• Health and Safety at Work, etc. Act 1974. • Health and Safety at Work (Northern Ireland) Order 1978. • Management of Health and Safety at Work Regulations 1999. • Management of Health and Safety at Work Regulations (Northern Ireland) 2000. • Road Traffic Act (1981 and 1991). • Road Traffic (Northern Ireland) Order (1981, 1995 and 2007).	• ILO C155 - Occupational Safety and Health Convention, 1981 (No. 155). • ILO R164 - Occupational Safety and Health Recommendation, 1981 (No. 164). • C153 - Hours of Work and Rest Periods (Road Transport) Convention, 1979 (No. 153). • R161 - Hours of Work and Rest Periods (Road Transport) Recommendation, 1979 (No. 161).

STUDY QUESTIONS

7. Identify the first option to consider when controlling driving risk.
8. Identify the three main areas of concern that can be managed by the risk assessment process.
9. Identify three risk factors associated with the journey.

(Suggested Answers are at the end.)

Summary

This element has dealt with safe movement of vehicles in the workplace and driving at work.

In particular, this element has:

- Identified the hazards presented by vehicle operations and categorised them as vehicle overturn or collisions with pedestrians, other vehicles or fixed structures.
- Explained how these hazards can be controlled through the risk assessment process and by careful management of the workplace environment, vehicles and drivers.
- Outlined how the workplace environment should be designed, constructed and maintained to allow safe vehicle movement and to separate vehicles from pedestrians.
- Identified key requirements for vehicles: they must be suitable for their intended use and workplace environment and maintained in safe working order.
- Noted some key requirements for drivers: they must be appropriately qualified, medically fit and given appropriate information, instruction, training and supervision.
- Outlined the relatively high-risk nature of work-related driving on the roads and the need for organisations to establish clear policies on work-related driving safety and to implement management systems and monitoring arrangements.
- Explained how the risk assessment of work-related driving should focus on three main areas of concern; the driver, the vehicle and the journey, each of which has various risk factors associated with it.
- Described some of the control measures to reduce driving risk, such as the elimination of the need to travel, use of alternative means of transport and the management of the various risk factors associated with the driver, vehicle and journey.

Exam Skills

QUESTION 1

Identify EIGHT ways in which a forklift truck may become unstable during operation. **(8)**

Approaching Question 1

Now think about the steps you would take to answer this question:

Step 1. The first step is to **read** the question carefully. Note that this question asks you to identify the ways in which a forklift truck may become unstable - it doesn't ask for causes of collisions

Step 2. Now highlight the **key words**. In this case, they might look like this:

Identify EIGHT ways in which a **forklift truck** may become **unstable** during operation. **(8)**

Step 3. Next, consider the **marks** available. In this question, you are specifically asked for eight pieces of information, so only eight should be provided. The question should take around eight minutes in total.

Step 4. **Read** the question again to make sure you understand it and have a clear understanding of what causes instability in forklift trucks. (Re-read your notes if you need to.)

Step 5. **Plan** your answer. When you see the command word 'Identify', you need to give a brief answer - so, for each reason for instability, a short phrase would be acceptable.

Your answer must be based on the key words you have highlighted. So, in this case, we need to identify eight ways in which a forklift truck can become unstable.

Now have a go at the question.

Key hint: think about not only the forklift truck but also the driver, the environment and the characteristics of the load.

Remember, you can always contact your tutor if you have any queries or need any further guidance on how to answer this question.

When you have finished, compare your answer with the one that follows.

Suggested Answer Outline

It is unlikely that you would draw up an answer plan to this question since 'identify' does not require you to give any explanation in your answer. You simply need to select and name a way in which a forklift might become unstable.

Example of How the Question Could be Answered

- *Cornering too fast.*
- *Uneven or insecure load on forks.*
- *Uneven road surfaces.*
- *Driving with elevated load.*
- *Uneven tyre pressure.*
- *Driving across a slope/ramp.*
- *Excessive braking.*
- *Collisions with objects.*

Reasons for Poor Marks Achieved by Candidates in Exam

Focusing too much on one aspect of forklift operation, e.g. driver error.

QUESTION 2

(a) **Identify THREE** different control measures that could be used to segregate pedestrians and vehicles in the workplace. **(3)**

(b) **Identify** other control measures that could be used to reduce the risk to pedestrians when segregation is not practicable. **(5)**

Approaching Question 2

Think now about the steps you would take to answer the question:

Step 1. The first step is to **read** the question carefully. You are asked to identify measures, which means that you can 'give without explanation'. Your answers should therefore be quite succinct.

Step 2.

(a) **Identify THREE** different **control measures** that could be used to **segregate pedestrians and vehicles** in the workplace. **(3)**

(b) **Identify other control measures** that could be used to **reduce the risk** to pedestrians when segregation is **not** practicable. **(5)**

Step 3. Next, consider the **marks** available. In this question, there are eight marks, three for part (a) and five for part (b). In part (a), you have been specifically asked for three control measures - if you provide any more, they won't be marked. However, in part (b), there is no such restriction. It would be logical to conclude that NEBOSH would expect five control measures for part (b), as there are five marks available. However, in this case, if you can think of a couple of additional measures, it would increase your likelihood of gaining full marks. The question should take around eight minutes in total.

Step 4. **Read** the question again to make sure you understand it and have a clear understanding of controls to protect pedestrians. (Re-read your notes if you need to.)

Step 5. The next stage is to develop a **plan** - there are various ways to do this. Your answer must be based on the key words you have highlighted. Remind yourself, first of all, that you need to be thinking "How are pedestrians kept separate from vehicles?" and then "How else can we ensure the safety of pedestrians?"

Now have a go at the question. Draw up an answer plan, and then use it as the basis to write out an answer as you would in the exam.

Take care to keep an eye on the time when answering - it is very easy to spend too long on a question, and there are only eight marks available, no matter how long you spend on it!

When you have finished, compare your plan and full answer to those provided.

Suggested Answer Outline

Pedestrian/Vehicle Segregation	Other Pedestrian/Vehicle Controls
• Prevent access to pedestrians altogether. • Barriers around walkways. • Painted/designated walkways and footpaths. • Separate doorways for pedestrians. • Site rules to ensure pedestrians keep to walkways. • Training.	• Good lighting. • Pedestrian crossing points, e.g. zebra crossing. • Pedestrian refuge areas. • Lights and alarms on vehicles. • Use of a banksman when reversing. • Trained drivers. • Speed-limited vehicles. • Mirrors to reduce blind spots. • High-visibility clothing. • Signs to warn of vehicle operations.

Example of How the Question Could be Answered

(a) *Control measures to segregate pedestrians and vehicles include:*

- *The provision of barriers to restrict access to areas where vehicles are in use (perhaps excluding pedestrians altogether from an area with high vehicle activity).*
- *The provision of designated walkways for use by pedestrians, which are clearly marked.*
- *The enforcing of site rules restricting pedestrians to the walkways when moving around the site.*

(b) *Control measures to protect pedestrians when segregation is not practicable include:*

- *Provision of pedestrian crossings, e.g. zebra-crossing points.*
- *Use of flashing beacons on vehicles.*
- *Use of audible reversing alarms on vehicles to warn of reversing operations.*
- *Use of banksmen (reversing assistants) when reversing to ensure pedestrians are not present when vehicles are moving.*
- *Use of trained drivers, e.g. with forklift trucks.*
- *Use of restricted vehicles that operate at reduced speeds, or if not possible speed limits which are enforced.*
- *Ensuring good visibility, with good lighting and mirrors to minimise blind spots.*

Reasons for Poor Marks Achieved by Candidates in Exam

Confusion between what was being asked for in part (a) and part (b). Part (a) asked for methods of segregation whereas part (b) asked for controls if segregation is not practicable.

You will see in the example answer provided above that bullet points were used to structure the answer. Although we warn against producing a bullet-pointed 'list' in an exam answer, bullets can be used to good effect to help show the examiner where each new point is. What you must avoid at all costs is a bullet-pointed list of 'words'; this will not give the examiner enough detail. What you can see here is a series of controls that are in the appropriate depth to be considered as "identify". Compare this with the following:

- Banksmen.
- Alarms.
- Training.
- High visibility.
- Zebra crossings.

This would not be acceptable - there is insufficient depth to meet the question requirements and so the marks would not be awarded. So don't simply list words, but bullet points themselves are not prohibited, if they are used correctly.

Element 3

Musculoskeletal Hazards and Risk Control

Learning Outcomes

Once you've read this element, you'll understand how to:

1. Explain work processes and practices that may give rise to work-related upper limb disorders and appropriate control measures.
2. Explain the hazards and control measures which should be considered when assessing risks from manual handling activities.
3. Explain the hazards and controls to reduce the risk in the use of lifting and moving equipment with specific reference to manually-operated load moving equipment.
4. Explain the hazards and the precautions and procedures to reduce the risk in the use of lifting and moving equipment with specific reference to powered load-handling equipment.

Contents

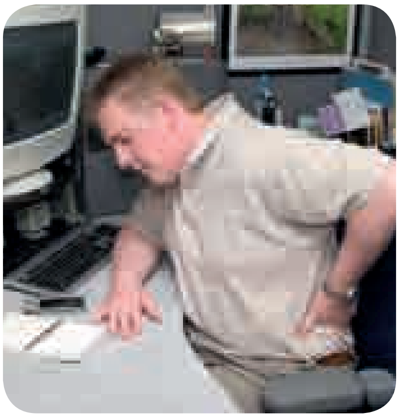
Work-Related Upper Limb Disorders

IN THIS SECTION...

- Musculoskeletal disorders, such as back pain and Work-Related Upper Limb Disorders (WRULDs), can result from repetitive tasks, such as Display Screen Equipment (DSE) use, checkout operation and bricklaying.
- Many factors influence ergonomic risk, such as repetition, force, posture, twisting, rest breaks, equipment design and adjustability, and workplace lighting.
- DSE use can cause WRULDs, back pain and eye strain.
- Precautions for safe use of DSE include: ergonomic assessment of the workstation; provision of basic equipment; short, frequent breaks; eye tests; and the provision of information and training.

Musculoskeletal Disorders and Work-Related Upper Limb Disorders

When workers sit or stand for long periods of time or carry out repetitive activities, or activities that require them to adopt uncomfortable postures, they are subject to stress and strain on their body. This can cause injury to the skeletal system and the soft tissues associated with that system, e.g. muscle sprains and strains, tendon and ligament injuries, joint injuries and nerve damage. Collectively, these chronic soft-tissue injuries are referred to as **Musculoskeletal Disorders (MSDs)**.



Badly designed workstations lead to ill health

Typical **musculoskeletal disorders** associated with poor work design are:

- **Back injuries and back pain** - associated with repetitive handling or poor posture and movement whilst standing or sitting for long periods of time. Injuries such as back muscle strain, ligament strain and disc injury are common and a significant cause of workplace absence.
- **Work-Related Upper Limb Disorders (WRULDs)** - a collection of conditions that affect the arms and hands. Examples include carpal tunnel syndrome (inflammation of a nerve in the wrist that causes tingling sensations, pins and needles, numbness in the fingers and arm pain) and tenosynovitis (inflammation of the tendons in the forearm that makes finger movement difficult and painful).

  Early symptoms of WRULDs often include tingling sensations, numbness and discomfort but then progress to more severe pain and immobility.
- **Other chronic soft-tissue injuries** - associated with sitting, standing or kneeling for long periods of time at work, e.g. painful knee joints as a result of having to kneel down to work under floorboards.

High-Risk Activities - Repetitive Operations

The following repetitive activities all involve significant risk of musculoskeletal disorders:

- Display Screen Equipment (DSE) use.
- Keyboard operation.
- Factory assembly of small components.
- Supermarket checkout operation.
- Bricklaying.

Each of these activities will be explored in more detail after we have looked at the factors that increase the risk of MSDs and considered the need for an assessment of work.

MSD Risk Factors

Various factors influence the risk of MSDs from work activities. These relate to the task the worker is doing, the equipment they are using and the environment they are working in. These factors can be applied to any repetitive work activity, whether it is factory assembly line work or bricklaying on a construction site.

TOPIC FOCUS

Ergonomic factors that influence risk relate to the task, the environment and the equipment.

Task factors include:

- **Repetition** - the need for repetitive movements when carrying out the task, e.g. typing for several hours.
- **Force** - the physical force required to perform the task and the strain this puts on the body (particularly strenuous tasks), e.g. closing stiff catches on a machine.
- **Posture** - any requirement to adopt an awkward posture, e.g. stooping over into a bin to pick out contents.
- **Twisting** - any twisting action required by the task, e.g. twisting the wrist when using a screwdriver.
- **Rest** - the potential for the worker to rest and recover from any fatigue, e.g. a worker on a production line cannot stop the line; they have to keep working even when fatigued.

Equipment factors include:

- **Equipment design** - the shape of the equipment and how this affects ease of use, e.g. a large, shaped handle on a scraper makes it easier to hold and use.
- **Equipment adjustability** - the scope there is for the user to adjust the equipment to suit their personal preferences, e.g. the height of the seat for a computer user.

Environment factors include:

- **Lighting** - the availability of natural and artificial light and the effect on the worker's ability to see the work clearly.
- **Glare** - this can cause headaches or eye strain; can also cause workers to adopt poor postures in order to avoid the discomfort.
- **Other environmental parameters** - in particular, temperature, humidity and ventilation will directly affect the worker's ability to perform the task and their comfort.

If one or a combination of the above factors is inherent in the work, then ergonomic risk exists.

Matching the Workplace to Individual Needs

DEFINITION

ERGONOMICS

The study of the relationship between the worker, the work that they are doing, the tools and equipment that they are using and the environment in which they are working.

The risk of musculoskeletal disorders can be reduced by adapting the workplace to suit the individual needs of workers. This is often referred to as applying an '**ergonomic**' approach.

Ergonomics is concerned with the interaction between people and:

- The tools, equipment or machinery that they are using, e.g. the ease of use of control panels.
- The workplace environment, e.g. suitability of lighting.
- Organisational factors, e.g. shift patterns or hours of work.

The aim of ergonomics is to minimise ill-health effects and optimise efficiency by adapting the workplace to suit the individual. This means taking into account both a person's physical attributes (such as height, shape, muscle strength, etc.) and their mental attributes (processing speed, decision-making ability, etc.). For example, ergonomic principles can be applied to a manual-handling operation to reduce the risk of injury.

An uncomfortable static posture leads to musculoskeletal disorders, such as neck pain and knee pain

This approach can be taken by carrying out an ergonomic risk assessment on work activities where there is a high risk of MSDs, i.e. a risk assessment is carried out with special focus and consideration of the ergonomic issues associated with the work.

Control Measures

Countless activities involve significant ergonomic risk. For example, bricklaying on a construction site involves several of the risk factors noted above:

- The work is repetitive.
- Awkward posture and twisting is necessary.
- Rest periods may be infrequent.
- The work area may be extremely cold and windy or hot, humid and airless.

In general terms, the control of ergonomic risk can be achieved by introducing changes to the:

- task and the way that it is done,
- tools, equipment and machinery, and
- workplace environment,

so as to suit the individuals carrying out the work.

In some cases, it may be appropriate to put restrictions on the individuals doing the work (i.e. restricting those people who have a known WRULD to light duties to avoid further injury). The first step in achieving controls is to undertake a risk assessment.

The following examples illustrate the ill-health effects that can occur due to ergonomic risks and the possible control measures that may be implemented.

Display Screen Equipment: Risks

Use of Display Screen Equipment (DSE), or computers and keyboards, is a common workplace activity that has several associated ill-health issues, including:

- **WRULDs** - associated with repetitive use of the keyboard and mouse for long periods of time.
- **Back pain** - and other MSDs associated with sitting in a fixed position, perhaps with poor posture, for long periods of time.
- **Eye strain** - temporary eye fatigue associated with prolonged use of the screen.
- **Fatigue and stress** - associated with the type of work being done, e.g. call centre staff may be subjected to verbal abuse during telephone calls.

These health effects can occur when using desktop computers but are becoming increasingly common in association with the use of laptops when they are used for long-duration work.

Display Screen Equipment: Control Measures

Control measures appropriate for DSE use are to:

- Carry out a workstation assessment of the user's workstation to ensure that the equipment and environment meet minimum standards and that the workstation can be adjusted to suit the user.
- Provide basic DSE workstation equipment that meets minimum standards in terms of good ergonomic design.
- Plan the user's work routine so that they can take short, frequent breaks from screen and keyboard use.
- Provide DSE users with a free eye test and, if required, spectacles for screen use.
- Provide information and training to users on the potential health risks of DSE use and the preventive measures - in particular, ergonomic use of the workstation.

The portability of laptops allows them to be used in a casual manner that is inappropriate for long-duration use

In many countries and regions, these measures are incorporated into legal standards. For example, in the EU, they are subject to a Directive that in the UK is incorporated into the **Health and Safety (Display Screen Equipment) Regulations 1992**.

Some of the minimum standards for workstation equipment and the good practices with regard to posture and workstation use are illustrated in the following figure.

Good ergonomics at a DSE workstation

The numbered issues are as follows:

1. Adjustable height and angle to seat back.
2. Good lumbar support.
3. Adjustable height seat to bring the hands to a comfortable position on the keyboard. Seat also has a stable five-star base.
4. Correct seat height adjustment and keeping the feet supported prevents excess pressure on underside of thighs and backs of knees.
5. Foot support if user cannot get their feet on the floor.
6. Space for postural change, no obstacles under the desk; this allows the user to fidget and change position as they work.
7. Forearms approximately horizontal when hands are on the keyboard.
8. Minimal extension, flexion or deviation of wrists; wrists should be straight and flat when on the keyboard indicating proper seat height adjustment.
9. Screen height and tilt should be adjustable so as to allow comfortable head position.
10. Space in front of the keyboard to support hands/wrists during pauses in typing; a wrist-rest can provide further support if required.

Additional points:

- The desk should be laid out to minimise the need for twisting or over-reaching, e.g. when reaching for a telephone.
- A document holder may be required.
- If frequent telephone use is necessary when using the keyboard, a headset may be required.
- Workplace lighting should be provided so as to avoid reflections on the screen and glare.

Unfortunately, some of these good ergonomic principles cannot be applied to use of a laptop computer. If laptops are going to be used in the workplace, then:

- Allow short-duration use but not long-duration use.
- When laptops are going to be used for long durations, apply the same management approach of workstation assessment: frequent breaks, eye test, information and training.
- Provide a docking station and/or separate screen, keyboard and mouse as required to allow the user to convert the laptop to a more adjustable configuration.

Factory Assembly Line: Risks

Assembling small components on a factory production line will have many of the same health effects as DSE use, which are:

- **WRULDs** - associated with repetitive handling of parts for long periods of time.
- **Back pain** - and other MSDs associated with sitting or standing in a fixed position for long periods of time, perhaps in association with over-reaching, twisting and stooping to reach parts.
- **Eye strain** - temporary eye fatigue associated with having to focus on small parts.
- **Fatigue and stress** - associated with infrequent rest breaks and a demanding work rate.

Factory Assembly Line: Control Measures

The control measures appropriate for the factory assembly line are very similar to those applied in the case of DSE use, which are to carry out an ergonomic assessment of the workstation to ensure that it is appropriate and can be adjusted to suit the worker's needs. Specific controls might include to:

- Automate the process to eliminate the MSD risk entirely.
- Re-lay out the workstation to allow comfortable posture and to minimise over-reaching, stooping, twisting, etc.
- Provide seating if not already available.
- Provide comfortable shoes and floor mats to relieve foot pressure if sitting is not possible.
- Allow short, frequent breaks from the production line or introduce job rotation to prevent long duration on one task.
- Ensure lighting is appropriate to the task (brightness or lux levels should be relatively high for fine-detail work).
- Introduce ergonomically designed hand tools.
- Provide information and training to workers on the potential MSD health risks and the preventive measures; in particular, ergonomic use of the workstation.

Bricklaying: Risks

Bricklayers are subject to similar risks:

- **WRULDS** - associated with the frequent and repetitive nature of the work. There is also a twisting motion as the mortar is applied to the brick, and the weight of the brick means that force is required to maintain a grip on the brick as it is lifted. Work outside in cold conditions could also exacerbate the symptoms, and there may be few opportunities for rest breaks.
- **Back pain** - bricklayers may have to transport bricks in carriers that are a considerable weight, and this may be repeated many times a day. There may also be a need to adopt awkward postures.

Bricklaying: Control Measures

Control measures could include:

- Provision of suitable gloves and PPE to protect against wet and cold weather and to maintain good circulation.
- Ensuring workers are trained in good handling techniques.
- Provision of lifting aids to improve manual handling.
- Provision of rest breaks or use of job rotation.
- Having assistance to prepare the bricks and bring them to the worksite using manual handling equipment where necessary.

Suitable PPE should be provided for bricklayers

Checkout Operators: Risks

Checkout operators are exposed to some of the same risks as DSE users:

- **WRULDs** - associated with repetitive action of scanning and/or keying at the till. This is exacerbated by the need to twist and turn items to find the barcodes and to present them to the scanner; the weight of the items can also be a factor.
- **Back pain** - and other MSDs associated with sitting or standing in a restricted position for long periods of time. In addition, there may be considerable lifting or pulling of weights as the items are moved from belt to scanner.
- **Eye strain** - temporary eye fatigue associated with the use of small, fixed and non-adjustable displays.
- **Fatigue and stress** - associated with dealing with the public, especially if there are long queues which could add to pressure at busy times. In addition, many operators are also expected to pack bags to assist.

Checkout Operators: Controls

- Make checkouts as adjustable as possible - provide chairs and give operators flexibility.
- Provide hand scanners for large items.
- Mechanise conveyors.
- Provide training in manual handling.
- Provide rest breaks and job rotation.
- Design checkouts so not all operate from the same side and rotate staff.
- Provide staff with training in customer service and management.
- Ensure supervisors are available to help deal with queries/complaints.
- Ensure that the checkouts are well manned.

MORE...

Browse the following website for some more information on MSDs:

www.hse.gov.uk/msd

National General Certificate Legal Standards	International General Certificate Standards
• Health and Safety at Work, etc. Act 1974. • Health and Safety at Work (Northern Ireland) Order 1978. • Management of Health and Safety at Work Regulations 1999. • Management of Health and Safety at Work Regulations (Northern Ireland) 2000. • Health and Safety (Display Screen Equipment) Regulations 1992. • Health and Safety (Display Screen Equipment) Regulations (Northern Ireland)1992. • Workplace (Health, Safety and Welfare) Regulations 1992. • Workplace (Health, Safety and Welfare) Regulations (Northern Ireland) 1993.	• ILO C155 - Occupational Safety and Health Convention, 1981 (No. 155). • ILO R164 - Occupational Safety and Health Recommendation, 1981 (No. 164).

STUDY QUESTIONS

1. Outline the aim of ergonomics in a simple phrase.
2. Identify the categories of health risks arising from poor task and workstation design.
3. Identify the risk factors involved in the physical requirements of the task.
4. Identify the key requirements relating to the following parts of a DSE workstation:
   (a) Work surface/desk.
   (b) Keyboard.
   (c) Chair.
   (d) Space.

(Suggested Answers are at the end.)

Manual Handling Hazards and Control Measures

IN THIS SECTION...

- Manual handling is a common cause of musculoskeletal injury, such as:
  - injury to the back, (e.g. a prolapsed disc), tendons, ligaments, muscles, and
  - work-related upper limb disorder.
- Manual handling can be assessed by looking at four main factors:
  - the task,
  - the load,
  - the environment, and
  - individual capabilities.
- The risk associated with manual handling can be controlled by:
  - automating or mechanising the handling;
  - using handling aids;
  - modifying the task, load or environment; and
  - ensuring individual capabilities are matched to the activity.
- Safe lifting technique involves following simple precautions before and during the lift, and when setting down.

Common Types of Manual Handling Injury

DEFINITION

MANUAL HANDLING

The lifting, carrying, pushing and pulling of a load by bodily force.

Manual handling is an activity that takes place in most workplaces. Often, manual handling is a routine part of day-to-day work activity - workers on a construction site frequently move building materials by hand; factory workers routinely pack boxes by hand; farm labourers spend hours at a time bent double in the fields picking crops. In some workplaces, manual handling occurs infrequently - office workers do not often have to lift or carry loads on a daily basis, but they will do so occasionally.

Manual handling can involve very repetitive movements of relatively small loads, (e.g. handling small components on a production line); in other instances, it can involve one-off movements of very large and heavy items, (e.g. handling structural steels into position in an inaccessible location).

All these manual handling activities generate the possibility of injuries, most of which are musculoskeletal injuries.

Common types of manual handling injury include:

- **Back injury** - the spine is made up of individual bones (vertebrae) separated by tough pads (intervertebral discs). Wear and tear can occur to these discs so that they become distorted - this is called a **prolapsed disc**. This causes extreme pain and discomfort and is often accompanied by nerve pain because the distorted disc traps nerves where they enter the spinal cord. This type of injury is perhaps the most serious of all manual handling injuries since recovery is often slow, incomplete and, in some instances, the casualty will have to undergo surgery to repair the defect or may end up permanently disabled.
- **Tendon and ligament injuries** - (tendons and ligaments are the connective tissues that join muscle to bone, and bone to bone respectively). When tendons and ligaments are overloaded, they tear, causing extremely painful injuries which can take a long time to heal. In some instances, recovery is incomplete and an operation may be required.
- **Muscle injuries** - overloaded muscle tissue can tear. This is painful and likely to lead to short-term impairment.
- **Hernias** - when the sheet muscle that surrounds the gut is overloaded it can distort and tear. This usually happens in the lower abdomen and can be a painful injury that will not repair naturally. In many instances, an operation is required.
- **WRULDs** - chronic soft-tissue injuries to the arms, wrists and hands as a result of repetitive movements.

  This is a generic term for many different medical conditions, such as carpal tunnel syndrome and tennis elbow. WRULDs usually involve inflammation and discomfort through overuse of muscles, tendons or ligaments and, frequently, there is irritation to the nerves that causes additional pain. WRULDs usually start as minor discomfort that gradually worsens to severe pain and immobility. They can result in corrective surgery, and even disability if left untreated.
- **Cuts, burns, dislocation and broken bones** - physical injury may result if the load is hot, sharp or dropped on the feet.


Worker with back injury

Assessing Manual Handling Risks

Manual handling activities have to be risk assessed in order to control the risks of injury to the workers undertaking them. This risk assessment is different from the general risk assessment you are already familiar with from Unit 1 because it focuses exclusively on the hazard of manual handling and ignores all other hazards.

Manual handling risk assessment focuses on four main factors:

- **The task.**
- **The individual.**
- **The load.**
- **The environment.**

HINTS AND TIPS

An easy way to remember the factors in a manual handling risk assessment is by using the acronym 'TILE' for **T**ask, **I**ndividual, **L**oad, **E**nvironment.

In many countries and regions, this risk assessment is subject to legal standards and guidance. For example, in the EU, it is subject to a Directive which has been transposed into UK law as the **Manual Handling Operations Regulations 1992**.

The Task

The focus here is on the movements required of the worker as they handle the load.

The **task** can be assessed by asking questions such as:

- At what height is the load being picked up, carried or put down?
- Is the task very repetitive?
- Is a long carrying distance involved?
- Does the task involve stooping (where the worker has to keep their legs straight and bend their back) to move the load?
- Does the task involve twisting (turning the shoulders while the feet stay still)?
- Can rest breaks be taken as the worker requires them?
- Does the task involve lifting the load through a vertical distance?
- Does the task involve reaching above shoulder height?
- Does the task involve the worker holding the load away from their trunk (torso)?

Holding a load away from your torso when lifting increases risk of injury

Each of these risk factors increases the risk associated with the task. For example, picking up a load at waist height, carrying it a short distance and putting it down at waist height is a simple task that does not complicate the risk associated with the handling. But picking up the same load from floor height (risk factor 1) from the bottom of a box that requires the worker to stoop down into the box (risk factor 2) then carrying the load at arms' length (risk factor 3) for a distance of 15 metres (risk factor 4) and putting it down above head height (risk factor 5) increases the risk associated with the task very significantly.

Individual Capabilities

The focus here is on the worker carrying out the handling activity.

Individual capabilities can be assessed by asking questions, such as:

- Does the activity require unusual ability? Some handling activities require unusual strength, stamina, size or technique.
- Does the activity present significant risk to vulnerable individuals, such as pre existing back injuries?

The Load

Here, the focus is the load that is being handled.

Though the load is usually an inanimate object, in some workplaces it may be an animal or a person, e.g. in a hospital, patients have to be moved from bed to gurney (a wheeled stretcher/trolley), from wheelchair to bath, etc.

How stable is this load?

The **load** can be assessed by asking questions, such as:

- How heavy is the load?
- How large and bulky is the load?
- How stable is the load?
- Where is the centre of gravity of the load?
- Is the load difficult to grip?
- Is the load hot, sharp or otherwise hazardous?

For example, the risk associated with handling a concrete block of 12kg is lower than that associated with handling a bundle of flexible plastic pipes, each three metres long that weighs the same.

The Environment

The focus here is the environment in which the handling takes place.

The **environment** can be assessed by asking questions, such as:

- Are there restrictions on the space available?
- Is the floor surface slippery or uneven?
- Are there changes in floor level (steps, stairs, etc.)?
- What are the light levels like?
- What is the temperature and humidity?

For example, handling activities carried out outdoors on a poorly lit construction site in freezing conditions when there is ice on the ground will be higher risk than similar activities carried out indoors in a warm, well-lit area.

Avoiding or Minimising the Manual Handling Risks

Employers should avoid manual handling where there is a risk of injury wherever possible. If this can't be achieved, the risks must be assessed and controls measures introduced to reduce the risks to an acceptable level.

Control of manual handling risk can be achieved by using a simple hierarchy of controls:

- Eliminate the manual handling.
- Assess the manual handling that cannot be eliminated.
- Use handling aids.
- Modify the task, load or environment.
- Ensure individual capabilities are matched to the activity.

Eliminate the manual handling - by automation or mechanisation of the handling activity. Conveyor belt systems, forklift trucks, electric pallet trucks, cranes, hoists and other types of mechanical moving or lifting equipment provide a way of moving loads without the need for workers to use bodily force.

Electric hoist moving load

Assess the manual handling that cannot be eliminated - by looking at the four factors of: task, load, environment, and individual capabilities.

Use handling aids - consider the use of a piece of equipment that does not completely eliminate the manual handling but does make it much easier. For example, a sack truck does not eliminate the need to push the load, but it does eliminate the need to carry it.

There are many handling aids available, such as: trolleys, barrel lifts, gin wheels, trucks, hoists and lifts that require some manual effort to lift or support the load, but give the worker mechanical advantage.

Modify the task, load or environment - when the appropriate questions we listed earlier are answered, there are usually some simple solutions that present themselves.

Modifications may be possible to reduce the significant risk factors, such as:

- **The task:**
  - Control repetitive handling by introducing frequent rest breaks or job rotation to minimise the length of time that an individual worker has to perform the task.
  - Eliminate stooping and twisting by changing the layout of the workstation.
  - Use a table or lift to bring the load to waist height to eliminate picking up from floor level.
- **The load:**
  - Break down a heavy load into smaller parts.
  - Use several workers to handle a large, bulky load rather than just one.
  - Stabilise an unstable load by securing it or putting it into a container.
  - Mark up a load with an off-centre centre of gravity so that workers can see where the centre of gravity is.
  - Attach handles to a load that is difficult to grasp.
- **The environment:**
  - Re-arrange the workspace to allow more space for the handling activity.
  - Level an uneven floor.
  - Supply additional lighting in a poorly lit location.

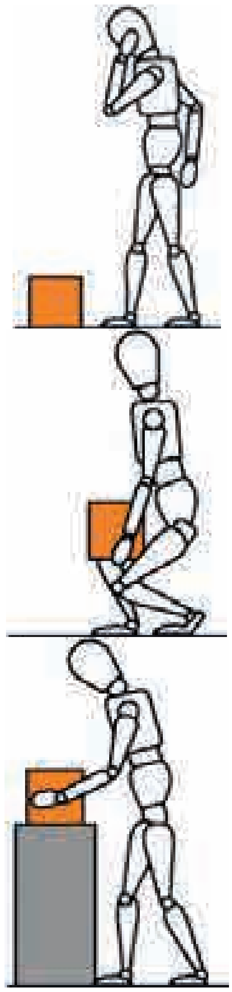
Some manual handling aids

Ensure individual capabilities are matched to the activity - if the activity requires unusual ability, then workers must have that ability. For example, if unusual strength and size are required, then the worker must have those characteristics; if a particular technique is required, the worker must be trained so that they develop that technique.

If the activity presents significant risk to vulnerable individuals, such as pregnant women or people with pre-existing back injuries, those people will have to be prohibited from carrying out the activity.

Efficient Movement Principles

Employees should be trained in efficient movement principles that incorporate basic safe lifting techniques. This technique minimises the risk of musculoskeletal disorders:



- Before Lifting
  - Check the weight, centre of gravity and stability of the load.
  - Plan the route of the carry.
  - Establish a firm grip.
- The Lift
  - Bend the knees and use the leg muscles to lift.
  - Keep the back upright.
  - Keep the load close to the body.
  - Avoid twisting, over-reaching and jerking.
- Setting Down
  - Use the same principles as when lifting.
  - Maintain good balance.
  - Set the load down and then adjust its position using body weight.

MORE...

Browse the following website for some more information on manual handling:

www.hse.gov.uk/msd/manualhandling.htm

National General Certificate Legal Standards	International General Certificate Standards
• Manual Handling Operations Regulations 1992. • Manual Handling Operations Regulations (Northern Ireland) 1992.	• ILO C155 - Occupational Safety and Health Convention, 1981 (No. 155). • ILO R164 - Occupational Safety and Health Recommendation, 1981 (No. 164). • ILO C127 - Maximum Weight Convention, 1967 (No. 127). • ILO R128 - Maximum Weight Recommendation, 1967 (No. 128) (to be revised).

STUDY QUESTIONS

5. Outline the main injuries associated with manual handling.
6. Outline the meaning of the term WRULD and how WRULDs might be brought about.
7. Identify the characteristics of a load which may present a hazard.
8. Identify the main risk factors presented by the working environment in relation to manual handling.
9. Identify the primary means of minimising the hazards of manual handling.
10. Identify the sort of individuals who might be more prone to manual handling injury.

(Suggested Answers are at the end.)

Manually Operated and Powered Load-Handling Equipment

IN THIS SECTION...

- There are many different types of lifting and moving equipment, such as manually-operated trucks and hoists, and powered load-handling forklift trucks, lifts, hoists, conveyors and cranes.
- Typical hazards associated with lifting and moving equipment are:
  - Collapse or toppling of the equipment.
  - Falls from height.
  - Falling objects.
  - Being struck by the equipment or the load during movement.
- General precautions for safe use include ensuring that the equipment is:
  - Suitable in terms of strength and stability.
  - Correctly positioned and installed.
  - Visibly marked with the safe working load.
  - Used by competent operators under appropriate competent supervision.
  - Maintained in a safe working condition.
  - Only used for carrying people if it has been designed for that purpose and all additional safety requirements have been implemented.
- Lifting equipment should be routinely inspected and subjected to a statutory thorough examination by a competent engineer.

Hazards and Safe Use of Manually Operated Load-Handling Equipment

Loads are frequently moved around the workplace using lifting and moving equipment. This equipment may rely on some form of manual effort (such as a trolley, sack truck or pallet truck) or it may be fully powered (such as a forklift truck, hoist, conveyor or crane). Though these devices are useful in minimising the risks associated with manual handling, they do present their own hazards. The hazards and safety precautions of various types of lifting and moving equipment now follow.

Loads are frequently moved around the workplace

Hazards and Controls for Manually Operated Load-Handling Equipment

There are many different types of manually operated load-handling aids and equipment, such as trolleys, sack trucks, pallet trucks and person handling hoists, (e.g. bath hoist).

Hazards associated with this type of equipment include:

- Manual handling risk associated with pushing or pulling the truck.
- Instability of the load causing the load to fall.
- Moving up, down or across slopes causing loss of control.
- Poor parking of the truck causing obstruction in a traffic route.
- Other pedestrians possibly being struck during manoeuvring.
- Trapped feet under the wheels or when lowering the load.
- Entrapment of the person being handled.

Precautions for safe use of manually-operated equipment include:

- Restricting use to trained workers only.
- Following manufacturer's recommendations.
- Avoidance of uneven ground and slopes.
- Use of ramps over steps.
- Observing the safe working load limits of the truck.
- Securing the load if necessary.
- Using the brakes (if fitted) whenever the truck is stationary.
- Care when moving or lowering the load.
- Safe parking and storage to avoid obstruction.
- Routine inspection and maintenance.
- Use of safety shoes or boots to avoid crush injuries.

Lifts and Hoists

A wide variety of items can be included in the phrase 'lifts and hoists': from a simple, manually operated chain hoist to a passenger lift in a multi-storey building. We will look at larger hoists later.

People Hoists and Handling Aids

In some sectors, workers may have to move people, such as hospital patients and those needing assistance with living requirements in the home. There is a variety of moving and handling aids available, which includes:

- **Patient hoists** - these can be manual (where the hoist is lifted by operating a manual crank handle) or powered, and may be mobile or permanently mounted in a ceiling track. Hoists should only be used by trained personnel and the safe working load of the hoist should not be exceeded. The suitability of the equipment for the working environment must also be considered, e.g. pushing a mobile hoist on a carpet or over rugs may be difficult. Lifting equipment of this type should be inspected regularly to ensure it remains in good working order.

A manual, mobile hoist used to lift patients

- **Small handling aids**, such as slide sheets and transfer boards - these are used to assist the transfer of patients, e.g. from bed to trolley in a hospital. The slide sheet is placed beneath the patient and the person is pulled over the slide onto the bed. This allows for the rapid transfer of the patient without lifting them and is again for use by trained persons.
- **Wheelchairs** - a form of handling aid, wheelchairs help in the movement of people. Though they can be powered, most wheelchairs used to transfer patients are simply pushed.

In order to make sure that workers are competent to use mobility assistance equipment, training in handling techniques should include instruction in the:

- Different types of equipment available, and their appropriate use.
- Safe use of hoists and their slings.
- Re-charging of electric hoists.
- Safe use of the smaller aids, such as handling belts and transfer boards.
- Identification of possible faults and safety checks that should be made each time before use.
- Procedures to follow when equipment is damaged and unsafe to use, or if it fails during use.

Powered Load-Handling Equipment

Forklift Trucks

There are many different types of forklift truck, but they share a range of common hazards and safety precautions.

The hazards associated with forklift trucks are:

- **Overturn of the truck** - the narrow and short wheelbase of the truck makes it unstable, so it can fall over sideways or tip forwards or backwards very easily. (We covered some of the poor practices that might cause a forklift truck to fall over in Element 2.)
- **Fall of the load** - the load may fall from the forks of the truck onto the driver or others standing nearby during a lifting operation.
- **Striking of pedestrians** - like all vehicles, a forklift will cause serious injury if it hits a pedestrian.
- **Fall or entrapment of a person riding on the forks** - workers often use the forks of a forklift as a working platform. This practice may result in a fall from height or the worker becoming trapped between the mast of the forklift and fixed structures.

Counterbalance forklift truck

- **Fall from loading dock** - another common accident, where the forklift truck either falls through or off the loading dock that it was driving over to access the back of a lorry.

The engine type and fuel of the forklift truck are also a source of concern:

- **Battery-powered trucks** are commonly used in indoor workplaces. Batteries present several hazards in their own right:
  - Charging batteries emit hydrogen gas which is explosive.
  - Batteries contain dilute sulphuric acid which is corrosive.
  - Batteries are extremely heavy and present a manual handling risk if they have to be changed for charging purposes.

- The electricity can cause arcing, shock, burns or fire.
- Battery contents are an environmental hazard requiring appropriate disposal.

- **Diesel-powered trucks** are commonly used outdoors. Hazards include:
  - Dermatitis, caused by contact of diesel with the skin.
  - Diesel spills, a significant slip hazard.
  - Large spills which might pollute the environment.
  - Exhaust fumes which are toxic.
  - Those hazards associated with the bulk storage of diesel.
- **Liquid Petroleum Gas (LPG)-powered trucks** have the following hazards:
  - LPG is an explosive gas.
  - Exhaust fumes are toxic.
  - LPG cylinders are heavy and present a manual handling risk during changing.
  - Those hazards associated with the storage of replacement cylinders or bulk storage of LPG.

TOPIC FOCUS

The precautions for safe use of forklift trucks include:

- Restricting use to trained operators only.
- Routine visual inspection of the truck before use.
- Routine maintenance of the truck in accordance with the manufacturer's recommendations.
- Never using the forklift to lift people unless a proper working platform is attached.
- Ensuring that the load on the forks is secure and stable.
- Ensuring that the safe working load limits of the truck are not exceeded.
- Observing site speed limits.
- Never travelling with the forks raised.
- Never travelling with obstructed vision.

Forklift trucks powered by different types of fuel require different precautions:

- **Battery-powered trucks:**
  - Batteries must be charged in well-ventilated areas only, away from ignition sources.
  - Sulphuric acid should only be handled when wearing appropriate PPE (gloves, apron and eye/face protection).
  - Battery handling should be mechanised.
  - The electrical risk may require the use of insulated tools and gloves.

- **Diesel-powered trucks:**
  - These should only be used in a well-ventilated area.
  - Spill kits should be available.
  - Gloves should be worn when handling diesel.
- **LPG-powered trucks:**
  - These should only be used in a well-ventilated area.
  - LPG cylinder handling should be mechanised.
  - Spare cylinders must be stored in a secure, safe, well-ventilated location.

TOPIC FOCUS

Pre-use checks should be carried out on forklift trucks at the beginning of each shift; these checks must cover:

- Tyre pressures.
- Parking brakes and service brakes.
- Steering.
- Fuel, oil and water systems for levels and leaks (in a combustion engine truck).
- Batteries, to ensure they are charged, are leak-free, chargers are off and leads are stored, and that the battery retention device is secured.
- Lifting and tilting systems (including hydraulics) are working, are leak-free and hydraulic fluid levels are correct.
- Audible warning.
- Lights.
- Mirrors.

Any defects should be reported to the supervisor for immediate rectification.

Lifts and Hoists

We looked at smaller, manually-operated 'people hoists' earlier; here we consider larger powered hoists in use, from passenger lifts to construction site hoists.

The main hazards associated with hoists are:

- Falling objects, such as the load falling from the hoist, or the hoist itself falling due to structural failure.
- Being struck by the load during a lifting operation.
- Becoming entangled in moving parts.

Additional hazards exist when the equipment is used to carry people, such as with a passenger lift, including:

- Falls from height - from a landing level or from the platform of the lift itself.

A material hoist for moving materials up and down a scaffold during roof work

- Being struck by landing levels, parts of any enclosure or other projections while riding on the platform of the lift.

Precautions for safe use of hoists and lifts include:

- Ensuring that the hoist or lift is suitable for its intended use - in particular, people should only be carried on equipment specifically designed for that purpose.
- Preventing people from getting underneath the hoist or lift platform or the load during a lifting operation - by enclosing the base of the lift or hoist with a fence.
- Preventing people from gaining access to an unprotected landing edge - with a passenger lift, having safety interlocks fitted on the doors at each landing.
- Preventing people being carried on the lift platform from being struck by landings or other obstructions as the lift moves - by constructing an enclosure around the lift platform.
- Observing the maximum safe working load of the lift or hoist - which should be clearly displayed.
- Ensuring that all safety devices, such as brakes, freefall brakes and interlocks, are in full working order.
- Restricting the use of the hoist or lift where necessary to trained, competent people only.
- Providing information, instruction and training as required.
- Routine maintenance by competent engineers.
- Routine inspection and thorough examination as required.

Conveyors

Conveyors use belts, rollers or screws to move articles or material around and are frequently used in manufacturing and distribution.


A belt conveyor used to move aggregate at a quarry

The main hazards associated with conveyors are:

- **Drawing-in hazards** - or 'in-running nip points' where fingers might be drawn into moving parts.
- **Entanglement** - where loose clothing might become entangled with rotating parts.
- **Falling objects** - from overhead conveyor systems.

The precautions for safe use of conveyors include:

- Warning alarms or sirens to warn people that the belt is about to start moving.
- Guarding of moving parts to prevent drawing in and entanglement as far as is possible.
- Ensuring that emergency stop buttons or pull-cords are fitted and available for use.
- Barriers to exclude people from the area (protects also from falling objects).
- Fitting guards underneath overhead conveyors to catch falling objects.
- Information, instruction and training for operators.
- Controlling loose clothing and long hair, e.g. by the use of overalls and hairnets in the workplace.
- Maintenance by authorised persons to ensure safe running.
- Provision of a defect reporting system.

Cranes

Many different types of crane are used in workplaces, from small derricks bolted to the floor at the edge of a loading bay, to large tower cranes positioned at the top of skyscrapers during construction. We will use a mobile crane as a typical example.

The main hazards associated with a mobile crane are:

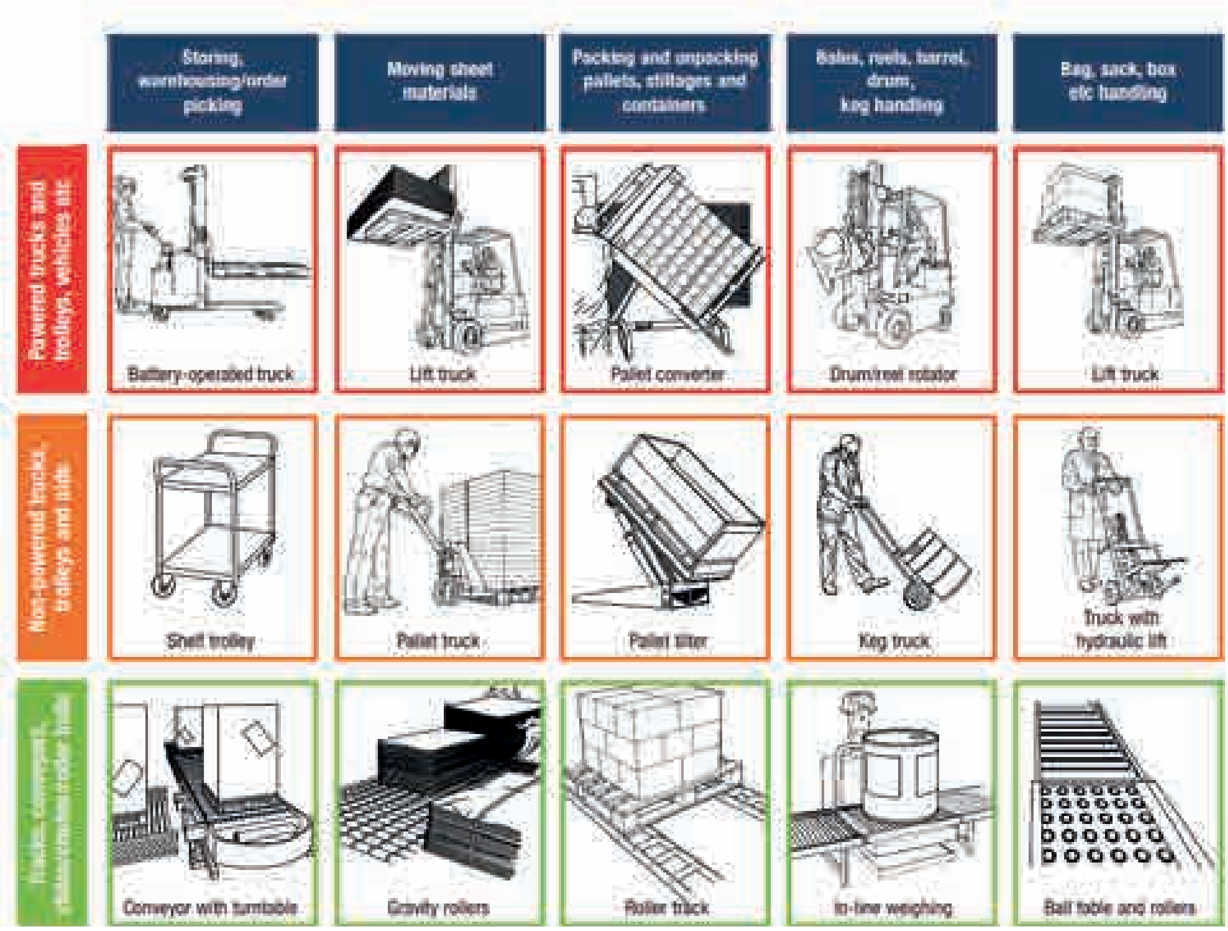
- The crane collapsing or toppling over.
- The boom or jib (arm) of the crane striking against other structures during movement.
- The load (or part of it) falling.
- The load striking against objects or people while being manoeuvred.
- Contact with live overhead cables.

Mobile crane

TOPIC FOCUS

Factors that might make a mobile crane unstable and topple over include:

- Overloading the crane beyond its lifting capacity.
- Siting the crane on uneven or unstable ground.
- Failure to use the outriggers correctly.
- Using the crane in high winds.
- Extending the boom or jib of the crane too far out for the weight being lifted.
- Structural failure of parts (perhaps due to lack of maintenance).



Summary of handling options available
Source: INDG398 (rev1) Making the best use of lifting and handling aids, HSE, 2013 (www.hse.gov.uk/pubns/indg398.pdf)

TOPIC FOCUS

General requirements for safe lifting operations:

- The equipment should be strong enough for the lifting task (rated for the load to be lifted) and suitable for the operation, (e.g. forklift trucks must only carry people if a suitable attachment has been installed, such as a man-rider cage and if the truck has been subjected to any necessary inspections in order to allow the lifting of people).
- The equipment should be stable and secure, e.g. mobile cranes with outriggers (stabilising legs) must be located on firm, level ground to avoid the outriggers sinking and the crane tipping.
- Lifting equipment should be visibly marked with the Safe Working Load (SWL), the maximum load that the device is permitted to lift.
- Lifting operations should be planned, carried out and supervised by competent persons. For example, though it is possible to hire a crane and a driver, the lift should also be planned and supervised throughout - it is common practice to carry out a 'contract lift' whereby the planning and execution of the entire lifting process is contracted out to the hire company.
- Equipment that is used to lift people may be subject to additional regulatory inspections.

Requirements for Safe Lifting Operations

The requirements for safe lifting operations include:

- **Planning and preparation of the lift:**
  - Carrying out a lifting risk assessment by a competent person to determine the correct controls, which will form the basis of the lifting plan for the operation.
  - Checking that the crane has been maintained and has an in-date certificate of thorough examination (see later).
  - Restricting use of the crane to trained and competent operators only.
  - Ensuring the crane or lifting device is of the correct type for the job and terrain; that it is strong and stable.
  - Ensuring that the load to be lifted is within the safe lifting capacity of the crane (and that the safe working load is visibly marked). Safe lifting capacity will vary with the length of the boom or jib and the distance away from the crane that the boom or jib is positioned to (the radius), so capacity can vary from one lift to the next.
- **Carrying out the lift:**
  - Carefully siting the crane on even, stable ground in a safe position away from structures or overheads that might be struck during the lifting operation.
  - Using the outriggers correctly.
  - Ensuring that each lift is planned and supervised by a competent person, and that the operator and slingers are competent.

DEFINITION

SLINGER

The competent person responsible for preparing and slinging a load in readiness for a crane lift, and for attaching or detaching load slings from the crane hook.

  - Providing a banksman (signaller) to give directions to the crane operator with good means of communication between the driver and other operators.
  - Ensuring that safety devices, such as overload indicators, are operational and are used correctly - these devices are frequently disabled or ignored by the crane operator.
  - Checking weather conditions and obeying any manufacturer's recommendations about maximum wind speed. For a mobile crane, typical maximum safe wind speeds would be 14 metres per second (31 miles per hour).
  - Using PPE, such as hard hats, steel toe-cap boots and high-visibility clothing.
  - Using signs to warn of the operations and exclusion of personnel from the area.
  - Special requirements for lifting equipment used for lifting people - equipment which may be used to lift people will be subject to more stringent examination requirements than equipment used to move goods.

It is also important to consider the **lifting accessories** that are used to attach the load to the crane: items such as chains, wire ropes, nylon slings or eye-bolts and shackles. These must be:

- Attached to the correct lifting points.
- Fitted to the load by competent people.
- In good condition.
- Regularly checked by pre-use visual inspection and subjected to thorough examination.

On lifting, a test lift is usually carried out where the load is lifted just off the ground to test the equipment and balancing, before being lifted smoothly into position. Tag lines may also be used in some lifting operations in order to guide the load into position. Loads should never be left suspended or lifted over people.


Crane lift being supervised

Requirements for Statutory Examination of Lifting Equipment

Lifting equipment is placed under a great deal of strain. If it is not maintained in good working order, it can fail catastrophically. This will almost certainly happen under load, when maximum damage will be done.

Fatalities frequently occur as a result of catastrophic lifting equipment failures. There are, therefore, legal requirements about the thorough examination of lifting equipment to ensure strength and stability. For example, in the EU, lifting equipment is subject to the Work Equipment Directive. In the UK, this is transposed as the **Lifting Operations and Lifting Equipment Regulations 1998 (LOLER)**.

Lifting equipment should be thoroughly examined:

- Before it is used for the first time (unless it has an in-date certificate of thorough examination from the manufacturer or previous owner).
- Before it is used for the first time where the way that it has been installed will make a difference to its strength and stability.
- Periodically.
- After an event that may have affected its strength and stability.

The frequency of 'periodic' thorough examination will typically be every:

- Twelve months where it is not used to carry people.
- Six months where it is used to carry people.
- Six months for lifting accessories (lifting chains, slings, etc.).

This thorough examination must be carried out by a competent engineer.

MORE...

Follow the link below for some more information on lifting equipment:

www.hse.gov.uk/work-equipment-machinery/loler.htm

National General Certificate Legal Standards	International General Certificate Standards
• Provision and Use of Work Equipment Regulations 1998. • Provision and Use of Work Equipment Regulations (Northern Ireland) 1999. • Lifting Operations and Lifting Equipment Regulations 1998. • Lifting Operations and Lifting Equipment Regulations (Northern Ireland) 1999.	• ILO C155 - Occupational Safety and Health Convention, 1981 (No. 155). • ILO R164 - Occupational Safety and Health Recommendation, 1981 (No. 164). • For construction sites: • ILO C167 - Safety and Health in Construction Convention, 1988 (No. 167). • R175 - Safety and Health in Construction Recommendation, 1988 (No. 175).

STUDY QUESTIONS

11. What are the most common hazards associated with the following lifting/moving equipment?
    (a) Forklift trucks.
    (b) Sack trucks.
    (c) Lifts and hoists.
    (d) Cranes.
12. What personal protective equipment might be appropriate for working with the following lifting/moving equipment?
    (a) Pallet trucks.
    (b) Cranes.
13. What are the typical safety precautions for safe use of a mobile crane?

(Suggested Answers are at the end.)

Summary

This element has dealt with some of the hazards and controls relevant to repetitive work activities, manual handling and mechanical handling.

In particular, this element has:

- Defined ergonomics, identified the musculoskeletal disorders associated with poor work design and identified factors that influence ergonomic risk, such as repetition, force, posture, twisting, rest breaks, equipment design and adjustability, and workplace lighting.
- Described the application of ergonomic principles to DSE use.
- Outlined the main types of injury associated with manual handling as musculoskeletal disorders, such as injury to the back, tendons, ligaments, muscles and WRULDs.
- Described the four main factors that have to be considered during a manual handling risk assessment: the task, individual capabilities, the load and the environment.
- Explained how risk associated with manual handling can be controlled by automating or mechanising the handling; using handling aids; modifying the task, load or environment; and by ensuring individual capabilities are matched to the activity.
- Noted the basic principles of safe lifting technique before the lift, during the lift and when setting down.
- Considered the hazards and safety precautions associated with different types of lifting and moving equipment, such as manually-operated trucks, mechanically-operated forklift trucks, lifts, hoists, conveyors and cranes.
- Outlined the typical hazards as:
  - Collapse or toppling of the equipment.
  - Falls from height.
  - Falling objects.
  - Being struck by the equipment or the load during movement.
- Outlined the general precautions as:
  - Suitability in terms of strength and stability.
  - Correctly positioned and installed.
  - Marked with the safe working load.
  - Used by competent operators under competent supervision.
  - Maintained in a safe working condition.
  - Only used for carrying people if the equipment has been designed for that purpose and all additional safety requirements have been implemented.
- Explained how lifting equipment should be routinely inspected and subjected to thorough examination by a competent engineer.

Exam Skills

QUESTION 1

Due to the failure of automated handling equipment, workers will be expected to lift boxes weighing 20kg from a conveyor and place them onto pallets ready for distribution.

Outline the factors that should be considered when undertaking a manual handling risk assessment of the activity. **(8)**

Approaching the Question

Now think about the steps you would take to answer this question:

Step 1. The first step is to **read** the question carefully. Note that this question sets the scene by saying automated equipment has failed so the employees are exposed to manually handling 20kg boxes. NEBOSH would not be looking for ideas about alternative automation or planned preventive maintenance schemes, but an acceptance that manual handling is being used as a last resort.

Step 2. Now, highlight the **key words**. In this case, they might look like this:

Due to the failure of automated handling equipment, workers will be expected to lift boxes weighing 20kg from a conveyor and place them onto pallets ready for distribution.

Outline the **factors** that should be considered when undertaking a **manual handling risk assessment** of the activity. **(8)**

Step 3. Next, consider the marks available. In this question, there are eight marks, so it is expected that around eight or nine different pieces of information should be provided. The question should take around eight minutes in total. Try not to overrun that time. Statistically, most marks are picked up in the first five to six minutes of attempting a question. It's better to pick up more marks on other questions than run over time perfecting just one. Remember, if you do not attempt a question because you have run out of time, you will get no marks!

Step 4. **Read** the question again to make sure you understand it. Substitute the word 'things' if you are unsure about the meaning of factors. For manual handling risk assessments, you need to be thinking about task, individual, load and environment. (Re-read your notes if you need to.)

Step 5. The next stage is to develop a **plan**; there are various ways to do this. Remind yourself, first of all, that you need to be thinking about manual handling and 'TILE'. When you see the command word '**Outline**', you need to provide a sentence explaining each factor in the TILE mnemonic that we have identified. So, the answer plan will take the form of a bullet-pointed list that we construct sentences around to aid explanation.

Your answer must be based on the key words you have highlighted. So, in this case, we need to outline factors in a manual handling risk assessment.

Now have a go at the question. Draw up an answer plan, and then use it as the basis to write out an answer as you would in the exam.

HINTS AND TIPS

Read the question with care - you have not been asked to supply control measures; and take a broad view - do not focus simply on the load!

Remember, you can always contact your tutor if you have any queries or need any further guidance on how to answer this question.

When you have finished, compare your plan and full answer with those that follow.

Suggested Answer Outline

Task
• Distance to pallet. • Frequency of lifting. • Vertical height to lift. • Twisting and turning. • Work rate/lack of rest breaks. • Load held away from body.
Individual
• Pre-existing medical condition/pregnancy. • Knowledge of lifting techniques.
Load
• Weight of box. • Dimensions (size) of box. • Stability of load. • Good grip available. • Centre of gravity.
Environment
• Space constraints. • Floor condition. • Temperature. • Lighting.

Example of How the Question Could be Answered

The factors that should be considered in a manual handling risk assessment can be considered under four headings, namely Task, Individual, Load and Environment.

Task-related factors include the distance that employees have to carry the 20kg box from the conveyor to the pallet - the longer the distance, the greater the risk of injury. Employees may have to raise the load from the conveyor onto the pallet, lower the load onto the pallet or hold the load away from the body; these operations will involve risk of injury to the employee. The risk of injury is also increased if the lifting operation is repetitive and rapid, with little opportunity for rest breaks.

The individual moving the load may have a pre-existing medical condition that places them at greater potential for harm when lifting loads. The employee may not have any knowledge of correct lifting techniques and be at risk of injury through not using kinetic lifting methods.

Factors relating to the load include the weight of the box and its physical size, which may make it difficult for the employee to easily grip or manoeuvre it. The load in the box may make it unstable when lifted (the box may contain fluids or may have an unpredictable centre of gravity).

With regard to the environment, the lift may be undertaken in a confined space that does not allow for proper lifting techniques to be adopted. The temperature around the conveyor and pallet may be sufficiently hot to induce perspiration in the employee, making it harder to get a good grip due to hands being moist. There may also be trip hazards, such as damaged flooring which may not be seen if lighting levels are poor.

Reasons for Poor Marks Achieved by Candidates in Exam

- Providing a list without sufficiently outlining the factors.
- Failing to read the question and giving responses on control measures or further automation.
- Taking too narrow a view and providing many factors surrounding the load that are so close in association that the examiners could not award full marks, e.g. once you have mentioned the size of the box, you cannot collect more marks for discussing the width and height!

QUESTION 2

(a) **Give FOUR** specific types of injury that could be caused by the incorrect manual handling of loads. **(4)**

(b) **Identify** factors in relation to the load that will affect the risk of injury. **(4)**

Approaching the Question

Now think about the steps you would take to answer this question:

Step 1. The first step is to **read** the question carefully. Note that part (a) just asks for four injuries caused by manual handling, so you don't need any more detail than that, and only the first four items in your list will be marked. Part (b) asks you to identify factors, which means that you can 'give without explanation'. Your answers will therefore be quite short.

Step 2. Now, **highlight** the key words. In this case, they might look like this:

(a) **Give FOUR specific** types of **injury** that could be caused by the incorrect **manual handling** of loads. **(4)**

(b) **Identify factors** in relation to the **load** that will affect the risk of injury. **(4)**

Step 3. Next, consider the **marks** available. In this question, there are eight marks split equally between parts (a) and (b). In part (a), you are asked specifically for only four facts, but in part (b), we can deduce that the examiner would be looking for four factors, as there are four marks available. However, in this case, if you can think of a couple of additional factors, it would increase your likelihood of gaining full marks. The question should take around eight minutes in total in an exam.

Step 4. **Read** the question again to make sure you understand it. Substitute the word 'things' if you are unsure about the meaning of factors. For manual handling risk assessments, you need to be thinking about task, individual, load and environment. (Re-read your notes if you need to.)

Step 5. The next stage is to develop a **plan**; there are various ways to do this. Your answer must be based on the key words you have highlighted. Remind yourself, first of all, that you need to be thinking about 'What types of injury are caused by manual handling?' and then 'What is it about the load that can cause injuries?'

Now have a go at the question. Draw up an answer plan, and then use it as the basis to write out an answer as you would in the exam.

Suggested Answer Outline

Manual Handling Injuries	Load
• Strains. • Sprains. • Cuts and lacerations. • Crushes, e.g. fingers and toes. • Prolapsed discs. • Hernias.	• Weight. • Size. • Centre of gravity. • Whether static or shifting load. • Sharp edges. • Hot surfaces. • Absence of hand-holds and grip difficulties.

Example of How the Question Could be Answered

(a) *Common manual handling injuries include:*

- *Strained muscles.*
- *Strained ligaments and tendons.*
- *Prolapsed discs.*
- *Hernias.*

(b) *There are many factors relating to the load that affect the risk of manual handling injury. Firstly, the weight of the load being lifted is important, together with the size of the object (a bulky item may be harder to lift than a small item). If the load's centre of gravity is off-centre, this can cause the load to tip. The load may have intrinsic hazards, such as hot or sharp surfaces that can cause injury when touched. A load which moves during lifting, e.g. a container of liquid, may have a moving centre of gravity, causing it to tip.*

Reasons for Poor Marks Achieved by Candidates in Exam

- Failing to list specific types of injury - general terms such as 'back pain' or 'musculoskeletal injuries' would not be sufficient to be awarded marks.
- Not reading the question and giving factors relating to the individual, task or environment, which wouldn't be awarded marks.

Element 4

Work Equipment Hazards and Risk Control

Learning Outcomes

Once you've read this element, you'll understand how to:

1. Outline general requirements for work equipment.
2. Explain the hazards and controls for hand-held tools.
3. Describe the main mechanical and non-mechanical hazards of machinery.
4. Explain the main control measures for reducing risk from machinery hazards.

Contents

General Requirements for Work Equipment

IN THIS SECTION...

- Work equipment covers a wide range of hand-held tools, power tools and machinery.
- Work equipment should be suitable for the task it is being used for and the environment it is used in.
- Access to dangerous parts of machinery should be prevented and safeguards applied according to a hierarchy of control measures.
- It is often necessary to restrict the use of work equipment to competent operators.
- Information, instruction and training should be provided for equipment users, managers and maintenance staff.
- Equipment controls should be clearly labelled and accessible; this is particularly important for stop controls and emergency stops.
- Work equipment should be maintained in safe working order and maintenance activities carried out safely.
- Routine inspection of equipment is sometimes necessary to ensure its safe condition.
- Work equipment should be stable, adequately marked with appropriate warning signs and devices, and environmental factors, such as lighting and space, should be managed.
- Operators must obey rules for safe use of work equipment.

Types of Work Equipment

Note that in this element we will use the phrase '**work equipment**' in a very wide sense to include:

- Simple hand tools, e.g. a hammer, screwdriver or chisel.
- Hand-held power tools, e.g. a portable electric drill or circular saw.
- Single machines, e.g. a bench-mounted abrasive wheel, photocopier, lathe or compactor.
- Mobile work equipment, e.g. a tractor or mobile crane.
- Machine assemblies, where several machines are linked together to form a more complex plant, such as a bottling plant.

This broad use of the phrase 'work equipment' is in keeping with the definition used in EU Directives and, in the UK, the **Provision and Use of Work Equipment Regulations 1998 (PUWER)**, perhaps the most important set of regulations relevant to this particular topic.

Hand-held power tool

Suitability

When an employer provides work equipment for use at work, that equipment must be **suitable**. This means it must be suitable for the:

- **Task** it is going to be used to perform, e.g. a chisel is not appropriate for prising lids off tins.
- **Environment and conditions** in which it is to be used, e.g. a standard halogen spotlight is not suitable for use in a flammable atmosphere.

Equipment must be carefully selected to ensure that it is suitable for the task and environment on the basis of manufacturers' information.

In many regions of the world, there are regulations that require **manufacturers** to ensure that the equipment they produce meets basic safety standards. For example, in the European Union, the **'Machinery Directive' (2006/42/EC)** establishes the basic safety standards that manufacturers are legally obliged to meet. Manufacturers are required to:

- design and manufacture machinery so that it meets 'essential health and safety requirements'.
- create a **technical file** which should contain the information required to show that the product properly complies with the requirements of the directives that apply to it.
- fix a Conformité Européenne (CE) mark to the equipment; and
- provide a written **Declaration of Conformity** for the purchaser.

Employers in the European Union have to ensure that any equipment they purchase for work use has this CE mark and written declaration.

In the UK, this directive is implemented through the **Supply of Machinery (Safety) Regulations 2008**.

Employers in the European Union have to ensure that any equipment they purchase for work use has this CE mark and written declaration.

CE mark

Preventing Access to Dangerous Parts of Machinery

Access to dangerous parts of machinery should be prevented. The safeguards that are used to prevent access to dangerous machine parts should be applied using a hierarchy of control measures. (We will look at practical machinery safeguarding later in this element.)

The hierarchy of control measures is best understood by looking at a specific hierarchy created by the UK **Provision and Use of Work Equipment Regulations 1998 (PUWER)**. Regulation 11 sets out the methods by which this must be achieved, through provision of:

- Fixed, enclosed guards that encase or surround the dangerous part.
- Other guards and protection devices, such as interlocked guards, self-adjusting guards, adjustable guards, pressure mats, trip devices and two-hand controls.
- Protection appliances, such as jigs, holders and push-sticks.
- Information, instruction, training and supervision.

Each of these precautions has to be used where, and to the extent that is, **practicable**. 'Practicable' in this context means that if it can be done (i.e. it is possible) then it must be done.

Restricting Use

Use of work equipment should, where necessary, be restricted to competent operators only. This relates to all equipment where risk of serious injury to the operator or to others exists. For example, forklift truck use must be restricted to trained, competent drivers. In addition, repair, modification or maintenance of equipment should similarly be restricted to designated competent people. For example, routine planned preventive maintenance of a forklift truck should be carried out by a competent vehicle mechanic.

Information, Instruction and Training

Work equipment users should be provided with appropriate information, instruction and training:

- Where the equipment is **low risk**, this requirement is simple to fulfil. For example, an office paper shredder can be used by staff who have read the instructions supplied by the manufacturer.
- With **high-risk** machinery, more has to be done to fulfil this requirement to an acceptable standard. For example, an employer operating an industrial shredder capable of shredding wooden pallets should ensure that all operators receive specific training in the safe use of the equipment, as well as written information. They should also check to ensure understanding of that training and information.

Those involved in the **management of operators** should be given adequate information, instruction and training to allow them to effectively manage.

As a minimum, they should understand the basic principles of safe use of the equipment.

Maintenance staff should be given specific information, instruction and training so that they:

- Can undertake any maintenance activities with a minimum of risk to themselves and others.
- Understand the maintenance requirements of the equipment and are able to keep the equipment in safe working order.

Maintenance Requirements

Work equipment should be maintained in a safe working condition, according to relevant legal standards (such as **PUWER**) and manufacturers' recommendations.

Maintenance can be carried out according to various regimes, such as:

- **Planned preventive maintenance** - where servicing work is carried out at prescribed intervals and parts are replaced or changed, irrespective of their condition. For example, oil in an engine might be changed every year regardless of the amount of use that the engine has received.
- **Condition-based maintenance** - where servicing is carried out and parts changed only where inspection indicates that use has caused deterioration. For example, the brake pads on a car might be inspected every 6,000 miles but only changed when they show signs of heavy wear.

Engineer carrying out condition-based maintenance

- **Breakdown maintenance** - where maintenance is only carried out during repair.

Whatever type of maintenance regime is used for an item of work equipment, maintenance staff must not be exposed to unacceptable risk during maintenance work.

Maintenance work often creates greater risk for the staff involved because:

- Guards and enclosures have to be removed to allow access.
- Safety devices have to be removed or disabled.
- Equipment has to be partially or completely dismantled.
- Power sources may be exposed, (e.g. an electrical supply).
- Stored power may be accidentally released, (e.g. a compressed spring).

- Access may be awkward, (e.g. space constraints or work at height).
- Handling of parts may be difficult, (e.g. heavy parts).
- Additional hazards may be introduced, (e.g. power tools).
- Workers may be under pressure to complete the job, especially in the case of breakdown maintenance.

A safe system of work should be developed for when maintenance work is carried out, and this may require the use of a permit to work and adequate levels of supervision (remember your Unit 1 studies).

For some items of work equipment, it is foreseeable that deterioration of safety-critical parts might occur and it is possible for these parts to be inspected without dismantling the equipment. It may be necessary to introduce some form of inspection regime. For example, the tyres on a vehicle might go flat or become excessively worn and it is an easy matter for the driver of the vehicle to carry out a pre-use inspection to check their condition.

TOPIC FOCUS

Additional precautions may be required during maintenance work:

- Maintenance should only be carried out by competent staff.
- Power sources should be isolated and physically locked off (secured).
- Stored power should be released or secured to prevent accidental discharge.
- Where power cannot be isolated, additional precautions are required, for example:
  - Covering live parts with insulating material.
  - Using additional PPE, such as insulating rubber gloves.
- If dangerous moving parts have to be accessed, additional precautions required are to:
  - Run at very slow speed rather than normal operating speed.
  - Fit maintenance guards that have been made specifically to allow minimum access to required areas only.
- Precautions should be taken to allow safe access, especially when working at height.
- Handling aids and equipment should be used to reduce manual handling risk.

In certain instances, this routine inspection should be combined with a more detailed periodic examination and testing. For example, pressure systems, such as boilers and air receivers, must be thoroughly examined and tested because they are subject to very heavy stresses, and if parts were to fail they would fail catastrophically, leading to explosion. Periodic examination and testing of pressure systems should be carried out by a competent engineer and, in some cases, 'competence' and the standard of examination required is defined in legislation and approved codes of practice.

Equipment Controls and Environmental Factors

Equipment controls, such as 'stop' and 'start' buttons, should be:

- Well designed so they are easy to use.
- Placed at suitable locations on the equipment.
- Easily identifiable.
- Kept in good working order.
- Compliant with relevant standards.

It is particularly important that 'stop' controls are easy to see and reach and that they override all other controls. By comparison, 'start' controls are usually recessed and harder to operate accidentally.

Emergency stop button

Many machines should also have emergency stops fitted. These are controls that bring the equipment to a safe stop as quickly as possible. Emergency stops can be buttons or pull cords and should be positioned on or by the equipment, within easy reach of operators. For large machines, this means that several emergency stop buttons may be fitted at various locations around the machine.

In addition to the requirements we outlined earlier, there are some other basic physical requirements that work equipment should meet.

It should:

- Be stable - this may mean bolting it to the floor or fitting outriggers, jacks or stabilisers.
- Be appropriately marked - with labels on control panels, safe working loads, maximum speeds, etc.
- Have appropriate warnings - such as warning signs by dangerous parts and, in some cases, visible and audible warnings, such as flashing beacons and klaxons to warn of the start-up or movement of machinery.

The physical environment around work equipment must also be considered; in particular, lighting and space.

Lighting Considerations

When working with equipment, consider the following:

- Adequate general workplace lighting should be provided around equipment for the safety of both operators and others in the vicinity.
- Local lighting, such as spotlights positioned above machinery, might be required to give higher levels of light on critical areas.
- Lighting should be suitable for the type of equipment in use; avoid lights that flicker when illuminating rotating machinery because of the 'stroboscopic effect' where the rate of flicker coincides with the rotation rate of the machinery, giving the impression that the machinery is rotating very slowly when in reality it is rotating quickly.
- Lighting should be suitable for the environment, (e.g. intrinsically safe lighting used in a flammable atmosphere).

Markings

All work equipment has to be marked in a clearly visible manner, giving any relevant health and safety information, such as:

- 'Stop' and 'start' controls.
- Abrasive wheel rotation speeds.
- Safe working loads.
- Colour-coding of gas cylinders for recognition of contents.
- Contents of storage vessels and nature of hazardous contents.
- Pipework colour-coding.

Warnings

All work equipment should incorporate any warnings or warning devices that are appropriate for health and safety. These can be in the form of notices, requirements within permit-to-work systems and safety signs. The presence of a safety sign warning, e.g. of moving parts, does not remove the need for guarding. Warnings are a useful indication but not a replacement for physical protection.

Space Considerations

These considerations include:

- Operators should have adequate space to move around work equipment safely.
- Other people should be able to move around safely without coming into close proximity to dangerous parts or presenting a hazard to the operator.

Responsibilities of Users

You may remember from your studies of Unit 1 that employees have a duty to take reasonable care of their own health and safety and that of others who might be affected by their acts or omissions. This is particularly relevant with regard to the operation of work equipment.

TOPIC FOCUS

Users of work equipment should:

- Only operate equipment they are authorised to use.
- Operate equipment in accordance with instruction and training.
- Only use equipment for its intended purpose.
- Carry out all necessary safety checks before using equipment.
- Not use the equipment if it is unsafe.
- Report defects immediately.
- Not use equipment under the influence of drugs or alcohol (this includes some medication which causes drowsiness).
- Keep equipment clean and maintained in safe working order.

MORE...

The HSE website contains more information on workplace equipment and machinery at:

www.hse.gov.uk/work-equipment-machinery/index.htm

National General Certificate Legal Standards	International General Certificate Standards
• Provision and Use of Work Equipment Regulations 1998. • Provision and Use of Work Equipment Regulations (Northern Ireland) 1999. • Supply of Machinery (Safety) Regulations 2008.	• ILO C155 - Occupational Safety and Health Convention, 1981 (No. 155). • ILO R164 - Occupational Safety and Health Recommendation, 1981 (No. 164). • ILO C119 - Guarding of Machinery Convention, 1963 (No. 119). • ILO R118 - Guarding of Machinery Recommendation, 1963 (No. 118) (to be revised).

STUDY QUESTIONS

1. Why are maintenance workers sometimes at greater risk than operators when working on machinery?
2. What are the general health and safety responsibilities of machine operators?

(Suggested Answers are at the end.)

Hand Tools and Portable Power Tools

IN THIS SECTION...

- Simple hand tools can cause injury through user error, misuse or mechanical failure.
- Safe use of hand tools requires user training, compliance with safety rules, and routine inspection and maintenance of the tools.
- Portable power tools present greater risks because of the severity of injury that might be caused and the additional hazards presented by each tool.
- Safe use of power tools requires the same basic approach as that for hand tools, but with greater emphasis on user competence, supervision and maintenance, with additional precautions being introduced to combat each of the hazards associated with a tool and its power source.

Hazards and Controls for Hand Tools

Simple hand tools (or hand-held tools), such as a hammer, chisel or screwdriver, present relatively simple hazards:

- The tool may shatter during use, throwing off sharp metal fragments, (e.g. a hammer head or chisel blade).
- The handle may come loose during use, (e.g. the axe head comes off the handle).
- The tool may be blunt, leading to use of excessive force which causes loss of control, (e.g. a blunt knife).
- Simple human error, where the user misjudges a movement, (e.g. they hit their own thumb with a hammer).
- The tool may be misused, i.e. used in an inappropriate way or for an inappropriate task, (e.g. a screwdriver used as a crowbar).

Some relatively simple precautions can therefore be applied to ensure safe use of hand tools:

There are hazards associated with simple tools such as hammers

- Tools must be **suitable** for the **task** that they are going to perform and for the **environment** in which they are to be used, e.g. non-sparking tools (which do not produce sparks when struck) are suitable for use in a potentially flammable atmosphere.
- Users should be given appropriate **information**, **instruction** and **training**. Many workers serve some form of apprenticeship or spend several years in training where they acquire an understanding of safety in the use of the tools for their trade, but not all workers come to the workplace with this knowledge (which may seem like common knowledge to others).
- Tools should be **visually inspected** routinely before use to ensure they are in an acceptable condition. This should be done by the user. Spot checks by line management will ensure that users comply.
- Substandard tools should be maintained or discarded.
- Tools should be **maintained** in a safe condition, e.g. blades should be kept sharp and handles firmly attached.
- **Supervision** is important to ensure that safe working practices are adhered to and misuse does not become commonplace.

Hazards and Controls for Portable Power Tools

Portable power tools include items such as drills, sanders, portable grinding wheels and portable power saws, and are commonly used in the construction and maintenance sectors.


Construction worker using portable power tool

Portable power tools create greater risk than simple hand tools because:

- The forces generated by the tool are far greater, so the potential for very severe injury or death exists (a ruptured disc from a disc cutter will cut an arm off, which would not happen with use of a handsaw).
- Power tools have additional hazards not present with simple hand tools.

Additional hazards from portable power tools are:

- Electricity - that may result in electric shock, burns, arcing or fire.
- Fuel - usually petrol, which creates a fire and explosion risk.
- Noise - which may cause hearing loss.
- Vibration - which may cause hand-arm vibration syndrome (see Element 8).
- Dust - which is harmful if inhaled.
- Ejection - of material, (e.g. brick fragments) or tool parts, (e.g. cutting disc fragments).
- Trip hazards - from power cables.

Because the risks created by portable power tools are greater than those associated with simple hand tools, the safety precautions are more stringent. Management should ensure that:

- Tools are carefully selected to ensure **suitability** for **task** and **environment**.
- **Instructions** and safety rules are available in the form of manufacturers' handbooks or in-house safe working procedures.
- Operators are **trained** and given **information** on safe use of the tool. Operator competence is a key control that should be verified.
- Operators are **supervised** to ensure safe use.
- Tools are routinely **inspected** by the operator before use. Additional formal inspections should be carried out by the supervisor or maintenance staff.
- Substandard tools are **repaired** or **discarded**.
- Tools are **maintained** in safe working order. This might be done according to a maintenance schedule.
- Maintenance is carried out by **competent personnel** only and records should be kept. The tool might be labelled to indicate the date of next maintenance.

In practice, safe use of a portable power tool requires that:

- Tools and parts are only used for their intended purpose, within their design specification, (e.g. the maximum speed of a cutting disc should not be exceeded) and in an environment that they are suitable for.
- Necessary guards and safety devices are always used, (e.g. the self-adjusting guard fitted to a portable circular saw).
- Necessary personal protective equipment is always used, (e.g. eye protection when using a chainsaw).

- Trailing power cables or pipes are carefully positioned so that they do not present a trip hazard and will not be damaged by the tool or passing vehicles, etc.
- Care is taken to ensure that ejected parts do not present a risk to others nearby. This may require that the area is fenced or cordoned off or that the tool is only used at specific times.
- Dust exposure is controlled, either by damping down or by the use of respiratory protective equipment by the operator and others nearby.
- Noise exposure is controlled, e.g. by using hearing protection (see Element 8).
- Vibration exposure is controlled, e.g. by job rotation or limiting the duration of tool use (see Element 8).

Additional precautions are necessary when storing and handling petrol. It should be **stored** in an appropriate, labelled metal container in a well-ventilated, secure area away from ignition sources. It should be **handled** with care in a well-ventilated area (preferably outside) away from ignition sources. Any spillages should be dealt with immediately (see Element 6).

Additional precautions must be taken when using electrical equipment. Battery-operated tools might be used, or a low-voltage supply, (e.g. 110v rather than 240v). Damage to the electrical flex must be avoided.

The tool, flex and plug should be routinely inspected by the operator prior to use. It should also be given a formal electrical safety inspection, and thorough examination and test (see Element 5).

National General Certificate Legal Standards	International General Certificate Standards
• Provision and Use of Work Equipment Regulations 1998. • Provision and Use of Work Equipment Regulations (Northern Ireland) 1999.	• ILO C155 - Occupational Safety and Health Convention, 1981 (No. 155). • ILO R164 - Occupational Safety and Health Recommendation, 1981 (No. 164). • ILO C119 - Guarding of Machinery Convention, 1963 (No. 119). • ILO R118 - Guarding of Machinery Recommendation, 1963 (No. 118) (to be revised).

STUDY QUESTIONS

3. (a) Identify three likely causes of accidents involving simple hand tools.
   (b) Identify why greater risk arises from the use of portable power tools.
4. Why might each power tool be marked?

(Suggested Answers are at the end.)

Machinery Hazards

IN THIS SECTION...

- The mechanical hazards of machinery are: crushing, shearing, cutting or severing, entanglement, drawing in or trapping, impact, stabbing or puncture, friction or abrasion, and high-pressure fluid injection.
- The non-mechanical hazards of machinery are: electricity; noise; vibration; hazardous substances; radiation (ionising and non-ionising); extreme temperatures; ergonomics; slips, trips and falls; and fire and explosion.
- All machinery, from simple office machinery (such as a photocopier or document shredder) to construction machinery (such as a cement mixer or bench-mounted circular saw), present a range of both mechanical and non-mechanical hazards.

Mechanical and Non-Mechanical Hazards

The hazards of machinery can be divided into:

- **Mechanical hazards** - mainly from contact with or being caught by dangerous moving parts.
- **Non-mechanical hazards** - mainly from the power source or things emitted by the machine.

This follows **BS EN ISO 12100:2010** - Safety of machinery.

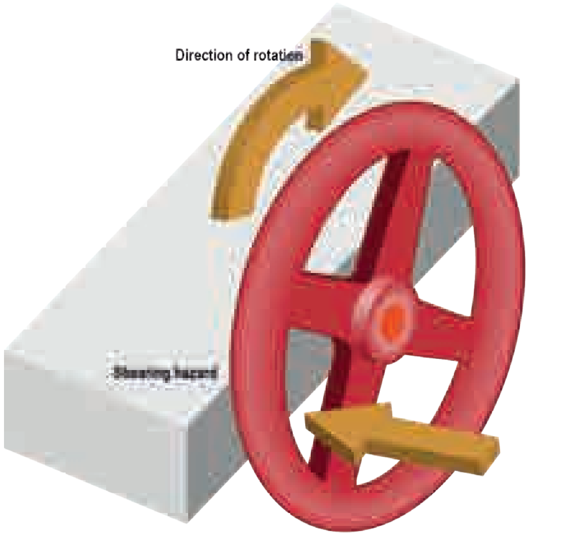
Mechanical Hazards

The mechanical hazards of machinery can be further subdivided into the following classes:

- **Crushing** - the body is trapped between two moving parts or one moving part and a fixed object, (e.g. a hydraulic lift collapses crushing a person underneath it).

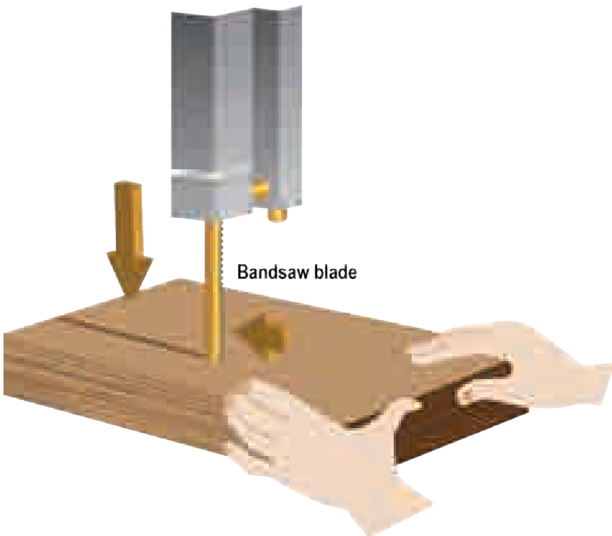
Crushing - the person is crushed between the moving object and the wall

- **Shearing** - a part of the body (usually fingers) is trapped between two parts of the machine, one moving past the other with some speed. The effect is like a guillotine, shearing off the trapped body part.



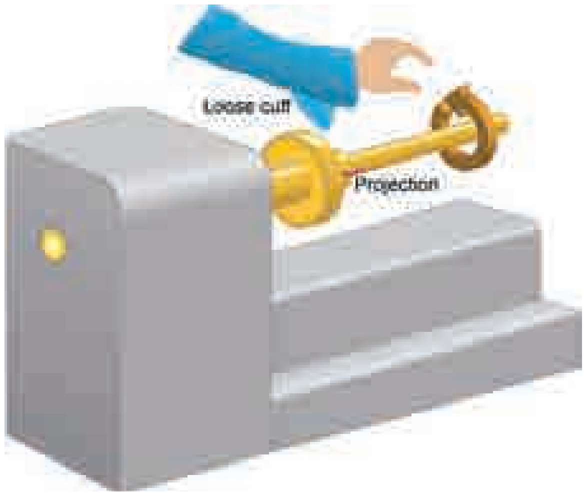
Shearing - a finger put through the spokes of this wheel will be sheared off

- **Cutting or severing** - contact is made with a moving sharp-edged part such as a blade, (e.g. the blade of a bandsaw).



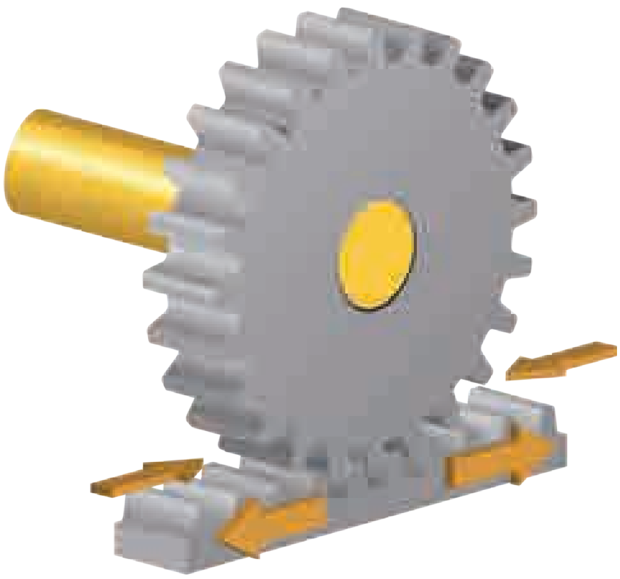
Cutting or severing - if the hands come into contact with the moving blade, severe laceration or amputation will occur

- **Entanglement** - loose items such as clothing or hair get caught on a rotating machine part and the person is wound up onto the machine.



Entanglement - a loose sleeve cuff becomes entangled with the chuck of a lathe

- **Drawing in or trapping** - a part of the body is caught between two moving parts and drawn into the machine, e.g. at 'in-running nips' where two counter-rotating rollers meet.

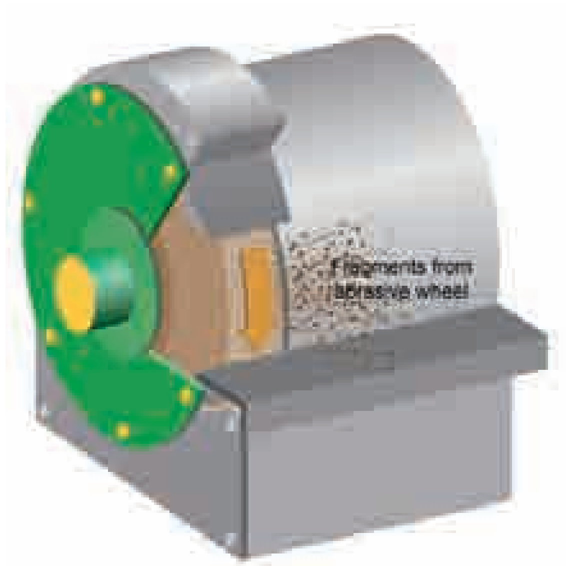


Drawing in or trapping - if the rollers are touched at the in-running nip point then the hand will be drawn in by the two rollers

- **Impact** - the body is struck by a powered part of a machine (this is similar to crushing, but there is no fixed structure to trap the person; the speed and weight of the object does the damage).

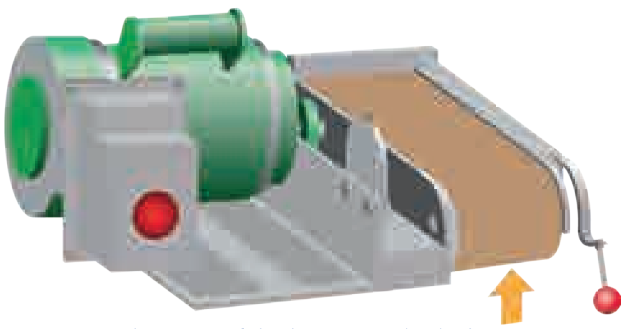
Impact - the person is struck hard by the heavy and fast-moving industrial robot

- **Stabbing or puncture** - sharp parts of the machine, or parts or material ejected from the machine, penetrate the body, (e.g. swarf, sewing machine needle, abrasive wheel fragments, nails from a nail gun, etc.).



Stabbing or puncture - small fragments of the abrasive wheel are ejected at high speed and can cause penetration injury, particularly to the eyes

- **Friction or abrasion** - contact is made with a fast-moving surface which may be smooth, (e.g. touching a spin dryer) or rough, (e.g. touching a belt sander).



Friction or abrasion - if the belt is touched whilst in motion then abrasion occurs

- **High-pressure fluid injection** - fluid at very high pressure is ejected from the machine and penetrates the skin, (e.g. hydraulic fluid escaping from a burst hydraulic hose).

Non-Mechanical Hazards

The non-mechanical hazards of machinery are all of the **other hazards** that do not arise directly from contact with dangerous moving parts. They are mainly associated with the power source of the machine or are things that it emits. In other words, they are all the hazards that remain once the mechanical hazards have been listed.

TOPIC FOCUS

The non-mechanical hazards of machinery are:

- Electricity.
- Noise.
- Vibration.
- Hazardous substances.
- Ionising radiation.
- Non-ionising radiation.
- Extreme temperatures.
- Ergonomics.
- Slips, trips and falls.
- Fire and explosion.

We cover these hazards in other Unit GC2 elements, so here we will just clarify two issues:

- **Hazardous substances** are often contained or used by machinery as an integral part of the process, e.g. a metal-cutting lathe uses cutting fluid to cool and lubricate the cutting bit. In other instances, hazardous substances are produced as a by-product of machine operation, e.g. a robot welder produces welding fumes.
- **Ergonomic hazards** result from the interaction of the machine operator and the machine - from the posture that the operator has to adopt during machine use and the stresses put on the body. For example, a construction worker using a concrete breaker may have to support the weight, (e.g. 8kg) of the breaker in order to cut a hole for a door lintel.

Specific examples of the mechanical and non-mechanical hazards of typical machines will be covered at the end of this element after the next section on control measures.

STUDY QUESTIONS

5. Identify the non-mechanical hazards arising from the use of machinery.
6. Outline how drawing-in injuries are caused.

(Suggested Answers are at the end.)

Control Measures for Machinery Hazards

IN THIS SECTION...

- Guards and other protection methods have to be used to control the risk associated with all such types of machinery.
- Protection from machinery hazards can be achieved by using guards that physically enclose the hazard and prevent contact. Fixed guards are most effective at preventing contact, but interlocked guards, adjustable guards and self-adjusting guards may be required.
- If it is not possible to completely guard in a hazard then other forms of protection will have to be used, such as sensitive protective equipment, two-hand controls, protective appliances, emergency stops, PPE, or information, instruction, training and supervision.
- Guards and safety devices must meet relevant standards: be strong and robust, compatible with machine operation, not easy to defeat, allow visibility and ventilation, take maintenance into account, and not increase overall risk.

Machinery Safeguarding Methods

It may be possible to eliminate the risk created by a piece of machinery by getting rid of the machine that creates the risk. However, this is not an option in most circumstances.

It is also possible that the hazards associated with a piece of machinery can be eliminated by good design. This is the job of the manufacturer and statute law exists to ensure that this approach is taken. But even when this is done, hazards will still remain.

It is, therefore, essential that further safeguards are used to control the remaining hazards. The best approach is to create a safe machine using engineering controls (such as fixed guards). In some situations, it is not possible to guard in a machine hazard, so then other devices and appliances have to be applied.

Some hazards cannot be controlled by engineering means at all, so safety depends solely on operator behaviour. This is, of course, the least preferred option because operators are prone to human error and commit violations.

Guards reduce the risks from machinery hazards

The hierarchy of control measures for dangerous moving parts of machinery is best understood by looking at a specific hierarchy created by the UK **Provision and Use of Work Equipment Regulations 1998 (PUWER)**. **PUWER** Regulation 11 sets out the methods by which this must be achieved, through provision of:

- Fixed, enclosed guards that encase or surround the dangerous part.
- Other guards and protection devices, such as interlocked guards, self-adjusting guards, adjustable guards, pressure mats, trip devices and two-hand controls.
- Protection appliances, such as jigs, holders and push-sticks.
- Information, instruction, training and supervision.

Each of these precautions has to be used where and to the extent that is **practicable**. 'Practicable' means that if it can be done (i.e. it is possible) then it must be done.

Here, we look at each of the safeguards that might be used, in order of preference. Usually, a combination of the various safeguards is used to reduce risk to an acceptable level.

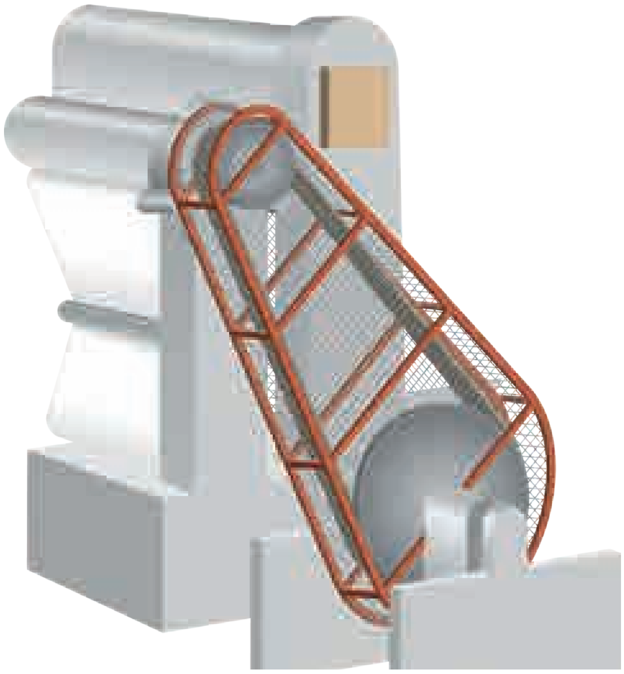
Fixed Guards

A **fixed** guard is a physical barrier that prevents a person from coming into contact with dangerous moving parts. The guard may be shaped to fit the machine quite closely (enclosing guard), or it may be more like a fence around the machine (perimeter guard). It may have openings in it, (e.g. to allow raw material to be fed into a machine), but these must be designed in such a way that it is not possible to reach in and contact dangerous parts (distance guard).

Basic principles of a fixed guard:

- It completely prevents access to dangerous parts.
- It is fixed in place.
- Fixings require a tool for removal - the guard must not be removable by finger force alone.

Fixed guards are often made of sheet metal. If ventilation, (e.g. to prevent overheating of machine parts) or visibility into the machine is required, then a mesh guard or Perspex guard might be used instead. If a mesh guard is used, then care must be taken to ensure that the mesh size is not so large as to allow access to dangerous parts.



A fixed enclosed guard on a belt drive mechanism - this guard is made of mesh to allow ventilation and visibility

Fixed guards can also offer some protection against non-mechanical hazards, such as preventing access to electrical conductors, containing radiation sources, preventing access to hot surfaces or hot parts, noise and also containment of dust, swarf or other hazardous materials ejected from the machine.

The main **disadvantage** of a fixed guard is also its main strength - it totally prevents easy access into the machine. There are many situations where easy access into a machine is necessary for machine operation, setting or cleaning. When routine access inside a guard is required, a fixed guard should not be used. If it is, then the operator is very likely to leave the guard off because it is interfering with machine operation.

Interlocked Guards

An **interlocked** guard is designed to be removed or opened as a normal part of routine machine operation. When the guard is removed, a safety interlock system prevents machine operation. For example, a microwave oven has a hinged door on the front to allow easy access; this door is interlocked so that power to the microwave generator is shut off when it is open.

Basic principles of an interlocked guard:

- Power to the machine is disabled and the machine will not operate until the guard is in place.
- Either the guard is locked shut until it is safe for the guard to open, or the act of opening the guard stops the dangerous parts and disables power.

Many machines are fitted with interlocked doors which, when opened, bring the moving parts to an immediate stop, (e.g. photocopier). However, some machines cannot be stopped in this way and it is then preferable to use an interlocked guard that locks shut and can only be opened once the danger has passed, (e.g. domestic washing machine).

Interlocked guards:

- stop the machine immediately when the guard is opened, or
- will not allow the guard to be opened until the machine has fully stopped, and
- will not allow the machine to re-start until the guard has been properly closed.

The main **limitation** of an interlocked guard is that it is possible to bypass the system so that the machine can be operated with the guard open. With simple interlock systems this is easily done, but even complex interlock systems can be defeated by a determined person. For example, a person may gain access to the inside of a machine enclosure during operation by climbing over the guard, or by the equipment being re-started by a second operator once the first person is inside the enclosure.

It is, therefore, important that:

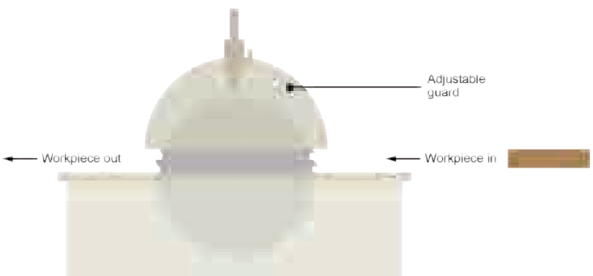
- The appropriate type of interlock system is fitted to the machine.
- Strict rules are imposed about safe use of interlocking guards.
- Regular maintenance is carried out.

Adjustable and Self-Adjusting Guards

Adjustable and self-adjusting guards are used when it is not possible to completely prevent access to dangerous parts. They are commonly used to safeguard woodworking and metalworking machinery where a workpiece has to be fed into the machine or manipulated during machine use.

An **adjustable guard** can be set to a range of positions by the operator, depending on the nature of the workpiece and the operation being carried out. For example, the top guard on a bench-mounted circular saw (table saw) can be set at a range of heights depending on the size of wood being cut.

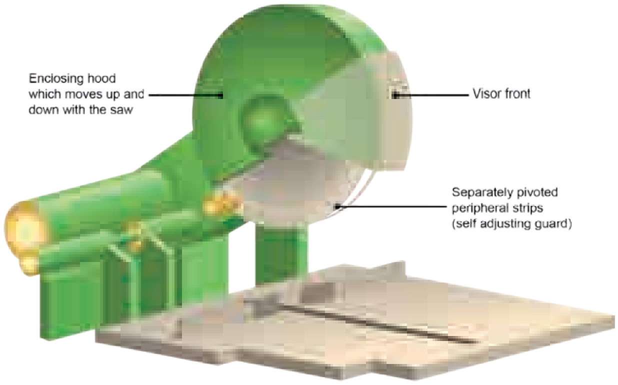
A **self-adjusting guard** does the same thing but is spring-loaded or linked to other machine parts. As the machine operates, the guard adjusts automatically to fit the workpiece. It does not require the operator to set it to the right position.



Adjustable guard over blade of bench-mounted circular saw; the guard covers most of the blade, but a section remains exposed so that wood can be fed through

Main **limitations** with adjustable and self-adjusting guards are that they:

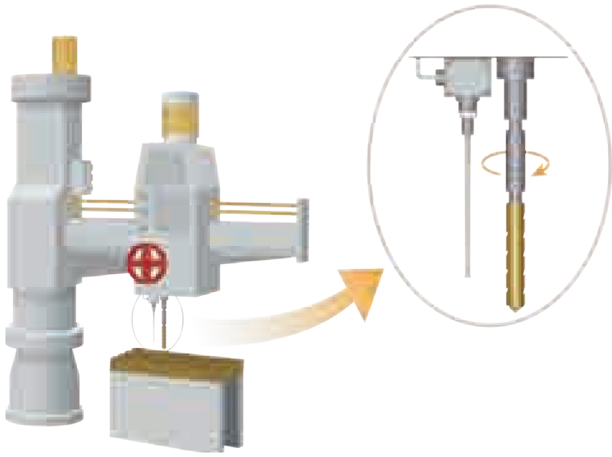
- Do not completely prevent access to dangerous parts.
- Are very easy to defeat.
- Rely entirely on operator competence.



Self-adjusting guard on a crosscut mitre saw; as the saw moves down, the guard retracts to expose the blade

Sensitive Protective Equipment (Trip Devices)

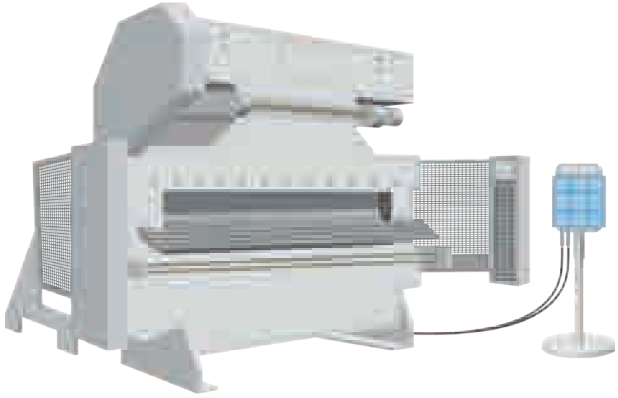
The terms 'sensitive protective equipment' or 'trip devices' cover a range of **protective devices** that do not put a physical barrier between the operator and the dangerous part of machinery. Instead, some form of sensor is used to detect the presence of the operator and stop the machine. The use of sensitive protective equipment is intended to minimise the severity of an injury and is often used as an additional control measure. For example, a pressure safety mat could be used inside an industrial robot enclosure combination with an interlocked access gate in the perimeter guard. This ensures that if an operator does gain access by climbing over a perimeter guard or is locked inside the enclosure by a colleague, then the pressure safety mat will be activated and the robot will not operate.



Trip bar fitted to a drilling machine; if the bar is hit, the drill emergency stops. Note that the bar does not prevent entanglement, but simply reduces the severity of injury

There are different types of sensitive protective equipment:

- **Pressure safety mats** - mats placed on the floor around an item of machinery such as an industrial robot. If a person stands on the mat, their weight activates the trip and the robot stops moving.
- **Trip bars** - wands or rods placed close to dangerous parts which, when touched, will stop machine movement.



A photoelectric device fitted to a press brake; the device forms a curtain of beams across the front of the machine. (Based on original source L22 Safe use of work equipment (4th ed.) HSE, 2014 (www.hse.gov.uk/pubns/priced/l22.pdf))

- **Photoelectric devices** - devices which shine beams of light across an access point. If the beams are broken then the machine is stopped.

Main **limitations** of sensitive protective equipment are that they:

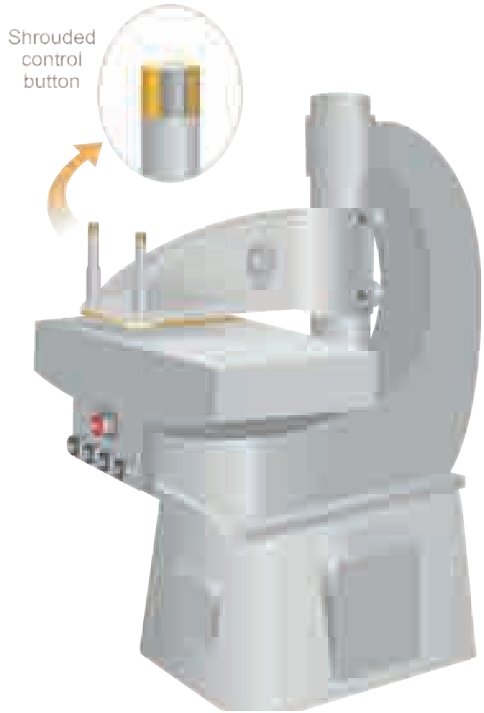
- Do not provide a physical barrier to prevent access.
- Can be overridden, e.g. using platforms to span a pressure mat.
- May not operate fast enough to prevent harm (but may reduce the severity), e.g. the person may still make contact with the machine before it stops, but it will be slowing down.
- May be overly sensitive, leading to frequent trips which will encourage the operator to bypass or disable them.
- Are more complicated than simple physical guards and may therefore fail more frequently, which encourages misuse.

Two-Hand Controls

These are a way of protecting the machine operator's hands where operation of the machine can only be achieved when two 'start' buttons are pressed at the same time. They are often used when routine machine use requires the operator to put their hands inside or under a machine where they are at risk from machine operation.

The idea is that the machine will only operate when the operator has both hands on the controls. There are important principles of two-hand controls:

- Controls must be more than one hand span apart (to prevent one-handed operation).
- Controls must have to be activated simultaneously (to prevent the operator jamming one button down permanently).
- Releasing the controls must stop the machine immediately.



Two-hand controls on a click press; the operator is at risk of a crushing injury if the press operates when their hand is between the top and bottom plates

Main **limitations** of two-hand controls are that they:

- Do not protect other parts of the body.
- Are relatively easy for two operators working together to bypass the system.

Hold-to-Run Controls

Hold-to-run controls, as they suggest, require the operator to hold the control at all times while the equipment or machine is in operation. Releasing the control for whatever reason will disconnect power from the machine and it will cease to function. On some equipment, this may be in the form of either a handle or foot-pedal, and is often referred to as a 'dead-man's handle'.

Important principles of hold-to-run controls are:

- The handle (or pedal) must be held (or beneath the foot) at all times while the machine operates.
- Releasing the control must stop the machine immediately.

Main **limitations** of hold-to-run controls are that they:

- Do not protect any parts of the operator's body.
- Can be held or operated by a person other than the operator.
- Can be easily defeated by an operator.

Emergency Stop Controls

We described emergency stops earlier in this element.

They can be buttons or pull cords and should be positioned at easily reached positions on the machine and associated control panels.

Key principles of emergency stops are that:

- They should bring the machine to a safe stop as quickly as possible.
- They should latch or lock in so that the machine can only be re-started by going to the location of the button to re-set it.
- Release of the button should not re-start the machine.

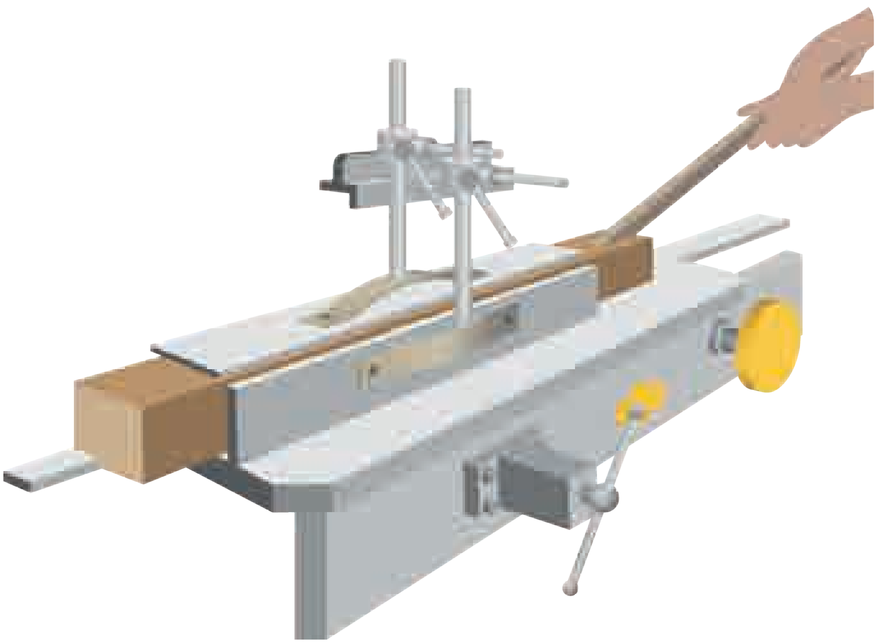
Emergency stop buttons should **never** be used as a substitute for machine guarding or protection devices. They are intended to provide an additional level of protection in case other safeguards fail.

Main **limitations** of emergency stops are that:

- They are only used once danger has been sensed by the operator and by then it may be too late.
- Despite good design, a person trapped by a machine may not be able to reach the emergency stop.
- It may not be possible to emergency brake the machine quickly enough to prevent injury.

Protective Appliances

Protective appliances are pieces of equipment that allow an operator to keep their hands away from dangerous parts. They include clamps, jigs and push-sticks. Clamps and jigs are designed to hold the workpiece in place; a push-stick is used to push a workpiece through a woodworking machine. The push-stick is simply a piece of wood with a V-shaped notch cut in one end.



A push-stick (based on original source L22 Safe use of work equipment (4th ed.) HSE, 2014 (www.hse.gov.uk/pubns/priced/l22.pdf))

Personal Protective Equipment (PPE)

Personal Protective Equipment (PPE) should only be used as a last resort after other, more reliable, protection options have been exhausted.

Inevitably, though, some of the hazards associated with machinery cannot be designed out or safeguarded by any other means; then PPE becomes appropriate.

A wide range of PPE is available to protect machine operators from one or more hazards associated with the machine that they are operating, e.g. respiratory protective equipment may be used to prevent inhalation of hazardous fumes, dust or mist emitted by the machine.

One item of PPE commonly used by machine operators is eye protection. Safety spectacles, goggles or face visors may be used to prevent impact injury to the eye. Such eye protection must always be selected with reference to the relevant standards.

Worker wearing PPE

You will have studied the general limitations of PPE in Unit 1; however, one particular issue worth noting here is that sometimes the use of gloves is inappropriate because it increases the risk of entanglement or drawing in and may increase the severity of injury that results.

Information, Instruction, Training and Supervision

Appropriate information, instruction, training and supervision must be provided to machine operators. The question of how much information, instruction, training and supervision is appropriate can be answered by considering the level of risk associated with the machinery and by reference to legal standards, approved codes of practice and guidance.

In particular, information, instruction, training and supervision become important where the level of risk is high and it has not been possible to use other controls to safeguard the machinery. So, for example, very little information, instruction, training and supervision is needed when introducing a document shredder into an office because the machine will be very well safeguarded already; simply asking users to read the instruction manual and then checking to ensure that they do not misuse the machine should be sufficient. But with an item of woodworking machinery, where there is the risk of serious injury and safe use of the machinery is less reliant on fixed and interlocked guards and far more reliant on safe operating procedures, then far more information, instruction, training and supervision has to be provided.

Specific Machinery Examples - Hazards and Control Measures

The following examples illustrate the hazards and protection methods associated with typical machines found in different types of workplaces.

Office Machinery

Photocopier: Hazards

- Drawing in and entanglement from contact with moving parts.
- Electricity.
- Contact with hot parts.
- Health hazard from ozone (irritant gas).


A typical photocopier

Photocopier: Protection

- Fixed and interlocked guards enclosing all mechanical hazards.
- Routine inspection and portable appliance testing.
- Use in a ventilated room.

Paper Shredder: Hazards

- Cutting and drawing in (in-running nip between cutter blades).
- Electricity.
- Ergonomic from handling of waste.


A typical paper shredder

Paper Shredder: Protection

- Fixed and interlocked guards enclosing all mechanical hazards.
- Routine inspection and portable appliance testing.

Manufacturing and Maintenance Machinery

Bench-Top Grinder: Hazards

- Abrasion on contact with rotating abrasive wheel.
- Drawing in at nip point between wheel and tool rest.
- Puncture by ejected parts of the wheel during normal use or if it bursts.
- Entanglement with the spindle on which the wheel is mounted.
- Electricity.
- Hot parts caused by friction (especially the workpiece being ground).
- Health hazard from dust.
- Noise and vibration.

Bench-Top Grinder: Protection

- Fixed, enclosing guards around the motor and part of the abrasive wheel.
- Adjustable polycarbonate eye guards over the exposed part of wheel.
- Tool rest adjusted to minimise the nip point between the rest and wheel.
- Use and setting restricted to trained operators only.
- Eye protection (impact-resistant).

- Hearing protection may be necessary.
- Routine inspection and portable appliance testing.

Pedestal Drill: Hazards

- Entanglement with the rotating drill bit or chuck.
- Stabbing or puncture by the drill bit during normal use or if the bit breaks.
- Puncture by swarf ejected during metal cutting.
- Impact if struck by the workpiece if the bit jams and the workpiece rotates.
- Drawing in at nip points between motor and drive belts.
- Electricity.
- Noise.
- Hot parts (especially the drill bit).
- Health hazard from cutting fluid, (e.g. dermatitis).

Pedestal drill

Pedestal Drill: Protection

- Fixed guards over motor and drive mechanisms.
- Adjustable (possibly interlocked) guard over the chuck and drill bit.
- Clamp to secure the workpiece to the base.
- Eye protection (impact-resistant).
- Hearing protection may be necessary.
- Routine inspection and portable appliance testing.
- Use restricted to trained operators only.

Agricultural and Horticultural Machinery

Cylinder Mower (Petrol-Driven, Ride-On Type): Hazards

- Cutting on contact with moving blades.
- Impact or crushing if struck by the mower.
- Entanglement with various rotating parts.
- Drawing in at various nip points.
- Noise.
- Vibration.
- Fire and explosion from petrol (fuel).
- Health hazard from sensitisation to grass sap, pollen, etc.

Cylinder Mower (Petrol-Driven Ride-On Type): Protection

- Fixed guards over the drive mechanism.
- Safety switch under the seat to ensure that the driver is in the seat before the machine will operate.
- Use restricted to trained operators only.
- Hearing protection.
- Refuelling carried out in a well-ventilated area.
- Job rotation may be necessary to limit vibration exposure.
- Use restricted for workers with sensitisation.

Strimmer or Brush-Cutter (Petrol-Driven): Hazards

- Cutting on contact with the moving cutting head.
- Entanglement with the rotating cutting head.
- Puncture by objects ejected by the cutting head, (e.g. stones).
- Noise.
- Vibration (into hands).
- Fire and explosion from petrol (fuel).
- Ergonomic from repetitive movement, such as twisting or carrying.
- Health hazards from sensitisation to grass sap, pollen, etc.
- Health hazard from ejected/atomised animal faeces.

Strimmer (Petrol-Driven Brush Cutter): Protection

- Fixed enclosing guards over motor and drive mechanisms.
- Partial side guards fitted around the cutter head.
- Safety interlocked throttle trigger to prevent accidental operation of the throttle.
- Face and eye protection (impact-resistant).
- Hearing protection.
- Stout gloves, boots (steel toe-cap), trousers and shirt.
- Job rotation may be necessary to limit vibration exposure.
- Harness to support and balance weight of machine.
- Refuelling carried out in well-ventilated area.
- Use restricted to trained operators only.
- Use restricted for workers with sensitisation.

Chainsaw (Petrol-Driven): Hazards

- Cutting on contact with the moving blade.
- Entanglement with the moving blade.
- Drawing in at nip point between the blade and casing.
- Puncture by ejected parts (especially broken blade fragments).
- Noise.
- Vibration (into hands).
- Fire and explosion from petrol (fuel).
- Ergonomic from handling.
- Health hazards from dust and sap.

Worker wearing appropriate PPE while using a chainsaw

Chainsaw (Petrol-Driven): Protection

- Appropriate PPE (see Topic Focus box).
- Fixed enclosing guards over motor and drive mechanisms.
- Hand guard for front-hand grip.
- Chain brake to stop the chain in the event of kick-back.
- Safety interlocked throttle trigger to prevent accidental operation of the throttle.
- Job rotation may be necessary to limit vibration exposure.
- Refuelling carried out in a well-ventilated area.
- Use restricted to trained operators only.

TOPIC FOCUS

Personal protective equipment when using a chainsaw includes:

- Face (visor) and eye protection (impact-resistant).
- Hearing protection.
- Head protection (hard hat) - may be necessary.
- Stout gloves.
- Boots with good grip and steel-toe caps.
- Cut-resistant trousers or chaps.
- Stout shirt.

Retail Machinery

Compactor: Hazards

- Crushing if inside during operation.
- Shearing between moving arms during operation.
- Crushing or impact by ejected bale or container lorry.
- Electricity.
- High-pressure fluid ejection from the hydraulic system.
- Ergonomic from handling material during loading.

Compactor: Protection

- Fixed perimeter guard around the loading area and mechanism.
- Interlocked guard to allow access to the loading area.
- Routine inspection and portable appliance testing.
- Use restricted to trained operators only.

Checkout Conveyor System: Hazards

- Drawing in at nip points on the belt system, (e.g. where the belt meets the counter top).
- Entanglement with the motor or rollers driving the belt.
- Friction on contact with the moving belt.
- Electricity (motor).
- Ergonomic from handling items whilst seated.
- Non-ionising radiation from the laser barcode scanner.

Checkout Conveyor System: Protection

- Fixed and interlocked guards to motor and drive mechanisms.
- Trip fitted to the conveyor to prevent drawing in.
- Routine inspection and portable appliance testing.
- Use restricted to trained operators only.

Construction Machinery

Cement Mixer: Hazards

- Entanglement with the rotating drum or drive motor.
- Drawing in at nip point between the motor and drive mechanism.
- Crushing between the drum and drum stop when tipping.
- Friction or abrasion on contact with the moving drum.
- Electricity.
- Ergonomic from handling during loading.
- Health hazard from cement dust inhalation and contact with wet cement (corrosive).

Cement Mixer: Protection

- Fixed guards to motor and drive mechanisms.
- Routine inspection and portable appliance testing.
- Use restricted to trained operators only.
- Hand protection and eye protection (splash-resistant).

Bench-Mounted Circular Saw (Table Saw): Hazards

- Cutting on contact with the blade.
- Entanglement with the drive motor.
- Drawing in at nip points between the motor and drive belt.
- Ejection of the workpiece during cutting.
- Electricity.
- Noise and vibration.
- Health hazard from inhalation of wood dust.

Bench-Mounted Circular Saw (Table Saw): Protection

- Fixed guard fitted to the motor and bottom of the cutting blade.
- Adjustable top guard fitted above the blade.
- Riving knife fitted behind the blade (this prevents the timber from pinching shut on the saw blade after it has been cut, which can lead to the timber being kicked back towards the operator).
- Hearing protection.
- Eye protection (impact-resistant).
- Extraction ventilation or respirator may be necessary.
- Routine inspection and portable appliance testing.
- Use restricted to trained operators only.

Requirements for Guards and Safety Devices

Guards and safety devices must be **suitable**. If they are not, they will not fulfil their function, the machine may not operate correctly, or the operator may come under pressure to remove or defeat them.

TOPIC FOCUS

Basic characteristics of a guard or safety device include the following:

- It meets relevant standards - with regards to preventing contact with dangerous parts.
- It is strong and robust - to withstand the forces it may be subjected to.
- It is compatible - must not interfere with machine operation or the process.
- It is not easy to defeat or bypass.
- Vision - it must not interfere with any need to see in.
- Ventilation - it must not interfere with any ventilation required.
- Ease of maintenance - it should be easy to maintain and maintained in good condition.
- Removal for maintenance - ideally, the guard should not have to be removed to allow maintenance on the machine to take place.
- It does not increase overall risk.

National General Certificate Legal Standards	International General Certificate Standards
• Provision and Use of Work Equipment Regulations 1998. • Provision and Use of Work Equipment Regulations (Northern Ireland) 1999.	• ILO C155 - Occupational Safety and Health Convention, 1981 (No. 155). • ILO R164 - Occupational Safety and Health Recommendation, 1981 (No. 164). • ILO C119 - Guarding of Machinery Convention, 1963 (No. 119). • ILO R118 - Guarding of Machinery Recommendation, 1963 (No. 118) (to be revised).

STUDY QUESTIONS

7. Identify the hierarchy of protective measures.
8. Describe the principles of an interlocking guard system.
9. Outline what a trip device is.
10. Identify the limitations of adjustable guards.
11. Outline the meaning of the phrase 'protective appliance'.
12. Identify when operators are required to be trained in the use of safety equipment.
13. Identify how two-handed controls might be overridden.
14. Identify five requirements for any guarding system.
15. Identify the hazards that arise from the use of the following machines:
    (a) Bench-top grinder.
    (b) Chainsaw.
    (c) Bench-mounted saw.
16. Identify the PPE that should be worn when using a chainsaw.

(Suggested Answers are at the end.)

Summary

This element has dealt with some of the hazards and controls relevant to work equipment. In particular, this element has:

- Described some of the basic management issues that must be considered when introducing work equipment, such as:
  - Suitability for task and environment.
  - Restriction of use to competent operators.
  - Information, instruction and training.
  - Inspection and maintenance requirements.
  - Marking and positioning of controls.
  - Stability, lighting and space requirements.
  - Operator behaviour.
- Outlined the hazards and precautions associated with simple hand tools, such as hammers and chisels.
- Outlined the hazards and precautions associated with portable power tools, such as a portable electric drill or disc cutter.
- Explained the mechanical hazards of machinery as: crushing, shearing, cutting or severing, entanglement, drawing in or trapping, impact, stabbing or puncture, friction or abrasion, and high-pressure fluid injection.
- Identified the non-mechanical hazards of machinery as: electricity; noise; vibration; hazardous substances; radiation (ionising and non-ionising); extreme temperatures; ergonomics; slips, trips and falls; and fire and explosion.
- Explained the basic characteristics of fixed guards, adjustable and self-adjusting guards, and interlocked guards as well as the characteristics of trip devices, two-hand controls, protective appliances and emergency stops.
- Outlined the basic requirements of guards and safety devices, where they: must meet relevant standards, be strong and robust, compatible with machine operation, not be easy to defeat, allow visibility and ventilation, take maintenance into account, and not increase overall risk.
- Described the hazards associated with photocopiers, shredders, bench grinders, pedestal drills, cylinder mowers, strimmers, chainsaws, compactors, checkout conveyors, cement mixers and bench-mounted circular saws.
- Identified the types of guard and other protection measures to ensure safety in the use of photocopiers, shredders, bench grinders, pedestal drills, cylinder mowers, strimmers, chainsaws, compactors, checkout conveyors, cement mixers and bench-mounted circular saws.

Exam Skills

QUESTION 1

With respect to the safe use of work equipment, employers are required to provide adequate information, instruction and training.

(a) **Identify THREE** categories of employees that should receive information, instruction and training on the safe use of work equipment. **(3)**

(b) **Outline** the issues that could be included in such information, instruction and training. **(5)**

Approaching Question 1

Now think about the steps you would take to answer this question:

Step 1. The first step is to **read** the question carefully. Note that the first part of this question asks you to identify three categories of employees. So, you need to select and name them. The second part asks you to outline issues to include in information, instruction and training related to work equipment. This example was chosen because students struggling to think of something to write will often use 'information, instruction and training'. But this will seldom score marks unless you specify what information, what instruction and what training!

Step 2. Now, highlight the **key words**. In this case, they might look like this:

With respect to the safe use of work equipment, employers are required to provide adequate information, instruction and training.

(a) **Identify THREE categories** of employees that should receive information, instruction and training on the safe use of **work equipment**. **(3)**

(b) **Outline** the **issues** that could be **included** in such information, instruction and training. **(5)**

Step 3. Next, consider the **marks** available. In this question, there are eight marks, so it is expected that around eight or nine different pieces of information should be provided. Questions that are split into parts (this one is split into two parts worth three and five marks respectively) are often easier to pick up marks on, because the signposts NEBOSH use are so much easier to see. The question should take around eight minutes in total.

Step 4. **Read** the question again to make sure you understand it and have a clear understanding of safe use of work equipment. (Re-read your notes if you need to.)

Step 5. The next stage is to develop a **plan** - there are various ways to do this. Remind yourself, first of all, that you need to be thinking about 'safe use of work equipment'. It might help you to think of a piece of work equipment, such as a photocopier or power press. When you see the command word 'Identify', you need to select and name - this is a little more than just a list. When you see the command word 'Outline', you need to give the most important features within an explanatory sentence. So, the answer plan will take the form of a bullet-pointed list that you need to develop into a full answer.

Your answer must be based on the key words you have highlighted. So, in this case, we need to identify three categories of employees and outline issues to include in information, instruction and training on safe use of work equipment.

Now have a go at the question. Draw up an answer plan, and then use it as the basis to write out an answer as you would in the exam.

Key hints: think 'people', not 'occupations', for part (a); and for part (b), think about what might be included in the manufacturer's guide to the equipment.

Remember, you can always contact your tutor if you have any queries or need any further guidance on how to answer this question.

When you have finished, compare your plan and full answer with those that follow.

Suggested Answer Outline

(a)	Categories of employee (three needed) - operator, supervisor, maintenance staff, vulnerable persons.
(b)	**Information**
	• Operating instructions. • Maintenance manual. • Risk assessments carried out.
	Instruction
	• Written operating procedures. • Correct use of the equipment and stop and start controls. • Hazards arising from the use of the equipment such as moving parts or hot surfaces.
	Training
	• How to adjust guards. • PPE to be worn. • Method of isolation. • Pre-use inspections. • Procedure to be followed in the event of fire.

Example of How the Question Could be Answered

(a) *Three categories of employees who should be provided with information, instruction and training include the operators who have to use the machinery; the supervisors to whom the operator reports and who are usually responsible for output; and maintenance staff who may have to repair the machine, should it break.*

(b) *Issues that could be included in giving information, instruction and training would be the contents of the manufacturer's operating manual to ensure the machine was being operated and maintained correctly and within its design parameters. Any risk assessments that had been carried out would also be a relevant issue for information supplied. Issues on instructions would include any operating procedures that had been developed for the safe use of the machine, together with instruction on how to use the machine, especially the 'stop' and 'start' controls. Instruction would also cover any special hazards present, such as hot surfaces or moving parts that may cause injury. Training issues would include how to use and adjust machine guarding, the type of personal protective equipment to be used and any pre-use inspections (such as checking oil levels) that the operator was required to understand and do. Operators carrying out maintenance would also need to be trained in how to isolate the equipment.*

Reasons for Poor Marks Achieved by Candidates in Exam

- Focusing on occupations (toolmaker, maintenance fitter) for part (a) rather than what was asked for, which was 'categories' of employees.
- An over-simplified approach to part (b) providing more of a list than an outline.
- Not answering the question at all - if you make no attempt at an answer you will receive no marks.
- A narrow range of issues identified for part (b), focusing mostly on operating the machine.

QUESTION 2

(a) **Identify** hazards associated with the use of a cement mixer. **(4)**

(b) For the hazards identified above, **outline** control measures that can be used to reduce the risks. **(4)**

Approaching Question 2

Now, think about the steps you would take to answer this question:

Step 1. The first step is to **read** the question carefully. Note that part (b) of this question asks you to outline control measures. An outline is defined as "give the key features of". You need to give a brief description of something, or a brief explanation of reasons why. This requires less depth than "explain" or "describe" but more depth than "list". A great amount of depth and detail is not required.

Step 2. Now, highlight the **key words**. In this case, they might look like this:

(a) **Identify hazards** associated with the use of a **cement mixer**. **(4)**

(b) For the hazards identified above, **outline control measures** that can be used to reduce the risks. **(4)**

Step 3. Next, consider the **marks** available. In this question, there are eight marks, so it is expected that around eight or nine different pieces of information should be provided. Note the marks split - 4 and 4. The question should take around eight minutes in total.

Step 4. **Read** the question again to make sure you understand it and have a clear understanding of the hazards associated with the use of cement mixers and their control measures. (Re-read your notes if you need to.)

Step 5. The next stage is to develop a **plan** - there are various ways to do this. Remind yourself, first of all, that you need to be thinking about 'hazards' for the first part; and 'controls' for the second part. The answer plan will take the form of a bullet-pointed list that you need to develop into a full answer, based on the key words that you have highlighted. So, in this case, we need to identify at least four hazards associated with cement mixers, and outline corresponding control measures to control each one.

Now have a go at the question. Draw up an answer plan, and then use it as the basis to write out an answer as you would in the exam.

HINTS AND TIPS

Don't just think of mechanical (machinery) hazards - there are lots of potential hazards associated with the use of a cement mixer.

When you have finished, compare your plan and full answer to those that follow.

Suggested Answer Outline

Cement-Mixer Hazards	Corresponding Controls
• Ejection of materials.	• Guards to contain contents.
• Entanglement in moving parts.	• Guards to prevent access.
• Chemical hazards (irritant and corrosive).	• PPE including gloves, goggles, overalls.
• Inhalation of dusts.	• Use of RPE to prevent inhalation.
• Noise.	• Use of ear defenders.
• Electrocution (if electrically-powered).	• Maintenance and use of RCD.
• Contact with diesel/fumes if diesel-powered.	• Adequate ventilation, safe storage of fuels.
• Manual handling.	• Mechanical lifting aids, reduction in cement bag size, training.

Example of How the Question Could be Answered

(a) *Hazards associated with the use of a cement mixer include:*

- *The ejection of materials from the moving drum.*
- *Contact with moving parts resulting in entanglement or abrasion.*
- *Contact with the corrosive cement and inhalation of irritant dusts.*
- *Noise during the operation of the mixer.*
- *Electrocution from an electrically-powered mixer.*
- *Manual handling of the cement bags.*

(b) *Corresponding controls to reduce the risk could include the following: guards could be installed in order to contain debris and prevent ejection of materials, while also preventing access to moving parts of the mixer. PPE, including gloves, eye protection and overalls, could be used to protect from the corrosive cement, while dust masks could be used to prevent inhalation of cement dusts. Maintenance may reduce the noise levels; however, hearing protection, e.g. ear plugs, could be used to further reduce the risk. The risk of electric shock could be reduced by using reduced-voltage (110V) power supplies, or, if this is not possible, an RCD could be used. Finally, manual handling could be reduced by using mechanical lifting aids, reducing bag sizes, using team lifting and providing training in safe lifting techniques.*

Reasons for Poor Marks Achieved by Candidates in Exam

As before, bullet points have been used with care in the above example answer - this is not a list, and the correct level of detail for an 'identify' question has been used.

In part (b), marks would be lost for not providing sufficient detail for an 'outline', as required.

Element 5

Electrical Safety

Learning Outcomes

Once you've read this element, you'll understand how to:

1. Outline the principles, hazards and risks associated with the use of electricity in the workplace.
2. Outline the control measures that should be taken when working with electrical systems or using electrical equipment in all workplace conditions.

Contents

Principles, Hazards and Risks of Electricity

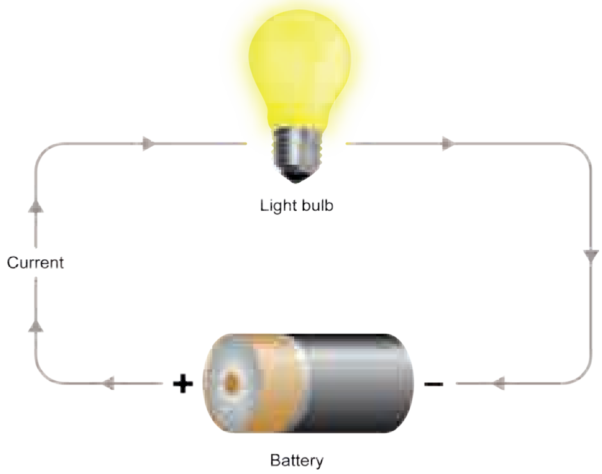
IN THIS SECTION...

- A simple electrical circuit can be described by reference to three parameters: voltage, current and resistance. These three parameters are linked by a simple relationship called Ohm's law: voltage = current × resistance.
- The hazards of electricity are electric shock, burns (both direct and indirect), fire and explosion, arcing and secondary effects.
- When a person receives an electric shock they can suffer a range of effects, from mild discomfort and muscle tremor, through uncontrollable muscle contractions and respiratory failure, to ventricular fibrillation, cardiac arrest and severe burns.
- The severity of injury is influenced by several factors, such as system voltage, duration of contact, pathway through the body, body resistance, contact surface area, environmental factors and frequency.
- Care must be taken when treating an electric shock victim to minimise risk to the first aider.
- Portable electrical equipment is often involved in electrical accidents because it is frequently unsuitable for the job being done, misused, and not inspected or maintained.
- High-risk work activities include the use of poorly maintained electrical equipment, work near overhead power lines, contact with underground power cables, work on live supplies and the use of electrical equipment in wet environments.

Principles of Electricity

Electricity is the flow of electrons through a conductor. A commonly used conductor is copper wire. For electricity to flow, the conductor must be arranged with a power source to make a **circuit**. A very simple circuit is shown in the figure where a battery and a light bulb have been connected together using copper wire to form a loop. Electricity flows in one direction around the circuit, from one terminal of the battery to the other. As it passes through the bulb, the filament in the bulb resists the flow of electricity, heats up and emits light. If the wire is disconnected from the battery or bulb, the circuit is broken, flow stops and the bulb goes out.

The basic parameters of an electrical system, such as the circuit shown, are:



A simple electrical circuit

- **Voltage** - a measure of the potential difference or electrical driving force/pressure that is forcing electricity through the conductor (unit: volt; symbol: V).
- **Current** - a measure of the rate of flow of electricity through a conductor (unit: amp; symbol: I).
- **Resistance** - a measure of how much a component in the circuit resists the passage of electricity (unit: ohm; symbol: R).

These three parameters are linked by a simple relationship called **Ohm's law**:

Voltage = Current × Resistance

Volts = Amps × Ohms

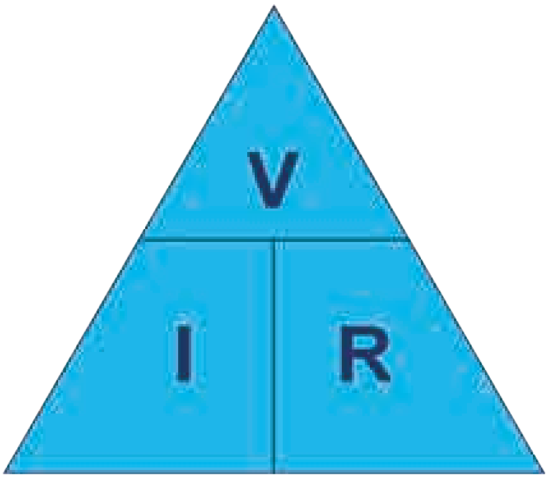
V = I × R

This can also be represented simply in the diagram opposite:

If you know any two parameters, you can determine the missing one.

If you cover the parameter you want to calculate, the equation is indicated for you.

So, if you know two of the parameters of an electrical circuit, you can calculate the third. For example, in our circuit diagram, if the battery is 1.5 volts and the bulb has a resistance of 5 ohms, then the current flow through the circuit will be 0.3 amps (1.5 = 0.3 × 5).



Ohm's law

One final characteristic of electrical systems worth considering is the nature of the current flow. In our basic circuit, the current flows in one direction only - from one terminal of the battery to the other. This is referred to as **Direct Current** (DC) and is usual for battery-supplied electrical systems. The mains supply, however, in domestic houses and workplaces, flows forwards and backwards through the circuit and is known as **Alternating Current** (AC). The rate at which AC current switches backwards and forwards is called the frequency - the number of cycles per second (unit: hertz).

For example, in the UK, the mains electricity supply is 230 volts, 50 hertz. In the USA, it is 120 volts, 60 Hz.

Hazards and Risks

The Hazards of Electricity

The hazards of electricity are:

- Electric shock.
- Burns.
- Fire and explosion.
- Arcing.
- Secondary effects.

Accidents involving electricity frequently involve two or more of these hazards at the same time. We will look at each in turn.

Electric Shock

DEFINITION

LIVE AND DEAD

When a system is connected to an electrical power source, it is described as 'live' (in some countries, the expression 'hot' is used instead). Once it has been disconnected from its power source, it might be described as 'dead'.

Electric shock occurs when a person touches a live surface and electrical current passes through their body. (Note that the electrical current uses the body as a conductor.) The current will, therefore, have a pathway through the body, from the point of contact with the live surface (where the current enters the body) to another point of contact with the ground or earthed surfaces (where the electrical current leaves the body). Put simply, the human body can be thought of as replacing the light bulb component in our simple circuit.

When a person receives an electric shock, it can have a range of effects. The most important factor that determines what the effects will be is the amount of current (amps) that flows through the body. The following table indicates the range of effects that might be experienced at different current flows.

Current (mA) flowing through the body	Effect
0.5-2	Threshold of sensation.
2-10	Tingling sensations, muscle tremor, painful sensations.
10-60	Muscle contractions, inability to let go, inability to breathe.
60 and above	Ventricular fibrillation, cardiac arrest, extreme muscle contractions, burns at contact points and deep tissues.

(**Note**: in the table above, the current is measured in milliamps (mA). One milliamp is one thousandth of an amp (1 mA = 0.001A). The current is AC.)

The effects of current flow on the body during an electric shock. Note that the current is the current flowing through the body:

- At very low current flow (less than 0.5-2mA), **no sensation** is felt by the person receiving the shock.
- Between 2 and 10mA, current starts to flow through the body and stimulates muscles to contract. This can be felt, it causes muscles to **tremble** and it may **hurt**. But the person receiving the shock is able to control their muscles and can let go of the live object.
- Between 10 and 60mA, current starts to cause more **severe muscle contractions** and these may become so strong that the person cannot control their muscles and they grip onto the live object. When this occurs, the muscles of the rib cage and abdomen may contract so that the person **cannot breathe** (which means that they cannot call for help) and they may asphyxiate. Alternatively, the shock may cause a **massive contraction** of big muscle groups so that the person is thrown violently off their feet (hopefully away from the live object).

- At current flows above 60mA, there is the possibility of **Ventricular Fibrillation** (VF), where the heart is no longer beating in a synchronised, rhythmic manner, but spasmodically (writhing like a can of worms). This usually leads to **cardiac arrest**. As the current increases above 80mA, the possibility of VF becomes greater. Muscle contractions can become so extreme that bones are broken, **burns** will occur at the entry and exit points and in the tissues that the current has passed through. **Death** becomes more likely as current increases.

TOPIC FOCUS

Several factors influence the severity of injury associated with receiving an electric shock:

- **Voltage** - as Ohm's law shows, there is a simple relationship between voltage and current: the higher the voltage, the greater the shock current through the body.
- **Duration** - the length of time that a person is exposed to the flow of electricity is critical. For example, a current flow of 60mA for 30 milliseconds (30 thousandths of a second) is unlikely to cause a severe injury, whereas the same current flow over a period of two seconds can induce VF and prove fatal.
- **Current path** - the route that the electricity takes as it flows through the body is also critical. If it runs through the chest, it is likely to affect the heart.
- **Resistance** - as Ohm's law shows, there is a simple inverse relationship between current and resistance - the higher the resistance, the lower the current. Most of the body's resistance to the passage of electricity is because of the skin. A person with dry skin has a high resistance, but if their skin is wet or damaged, this reduces dramatically. The resistance of the person will be influenced by various factors, such as:
  - **Contact surface area** - the more skin that is in contact with the live surface, the lower the resistance, the greater the current flow and the more severe the injury.
  - **Environment** - any environmental factors that reduce resistance will cause an increase in current flow and therefore increase the severity of the shock, e.g. wet surfaces, humid air, metal surfaces, etc.
  - **Clothing and footwear** - worn by the person will similarly affect resistance and hence block or reduce current flow.
- **AC or DC** - alternating current is capable of causing more severe effects at lower shock current than the equivalent direct current shock.

To illustrate the effect of the factors listed in the Topic Focus, consider two separate scenarios.

Scenario 1

A person has one hand on a live part (voltage = 230v) and is standing in a puddle of water with socks on. Their hand-to-ground resistance is 1,000 ohms.

Using Ohm's law:

$$V = I \times R$$

$$230 = 0.230 \times 1{,}000$$

So, the current that flows through them will be 0.23 amps or 230mA.

Using the table given earlier, you can see that this current flow will be associated with VF, cardiac arrest and severe burns. This will probably be a fatal electric shock (unless the power is disconnected very quickly).

Scenario 2

A person has one hand on a live part (voltage = 110v), is fully clothed and booted and is standing on a dry floor. Their hand-to-earth resistance is 100,000 ohms.

Using Ohm's law:

$$V = I \times R$$

$$110 = 0.0011 \times 100{,}000$$

So, the current that flows through them will be 0.0011 amps or 1.1mA. Using the table again, you can see that this current flow will be associated with just the threshold of sensation.

The main differences between these two scenarios are the voltage and the resistance (which has been influenced by clothing and environment) which make an enormous difference to the severity of outcome.

Electrical Burns

People receive burns in two different ways during electrical accidents:

- **Direct electrical burns** - where current causes overheating as it passes through the skin and the internal tissues of the body. There may be entry and exit skin burns and these will be full skin thickness (third degree burns). The internal tissue burns can be very severe and may prove fatal.
- **Indirect electrical burns** - which do not occur as a result of current passing through the body, but when an electrical accident causes something to overheat and explode. For example, dropping a spanner onto a high-voltage cable can cause a short circuit which results in a flash of radiant heat and an explosion of molten metal.

Electrical Fires

Electricity can cause fires in several different ways:

- Electrical equipment may be faulty and overheat as a result, leading to a fire.
- The system may be overloaded; as too much current passes through, it overheats.
- Equipment may be misused, e.g. it may be connected into the mains supply by pushing bare wires into the socket rather than using the proper plug.
- A flammable atmosphere may be present which electricity ignites. This can happen in two different sets of circumstance:
  - The wrong type of electrical equipment is brought into an already known existing flammable atmosphere.
  - A flammable atmosphere is accidentally created in an area where it would not be expected, (e.g. due to spillage). (This is covered in more detail in Element 6.)
- Electrical equipment may produce heat or sparks as part of its normal operation, e.g. a fan heater gets hot during use. If it is poorly positioned next to a full waste paper bin, it may start a fire.

One common cause of overheating electrical equipment is poor internal connections. When two electrical components are joined together, the connection between them must be well made and secure. A poor connection causes an increased resistance which, in turn, leads to overheating at the connection point. Poor connections can occur because the connection was not properly made when the equipment was being manufactured or installed, but they can also occur as a result of loosening of parts over time. Fixed installation, such as distribution boards, can suffer this type of failure.

Arcing

Arcing is where electricity jumps across an air gap. It occurs in a very limited way inside some low-voltage electrical equipment, (e.g. a portable electric drill). The dangers associated with arcing increase at higher voltages because the distance that electricity can arc through air is determined primarily by voltage: the higher the voltage, the greater the distance. High-voltage power lines can arc across distances of over 10 metres through air.

The main risks associated with arcing are:

- Electric shock as a result of being struck by the arc.
- Direct burns as a result of being struck by the arc.
- Indirect burns from the radiant heat given off by the arc and from the melting of any equipment struck.
- Damage to the eye as a result of the ultraviolet (UV) light that is emitted by the arc.

Secondary Effects

Put simply, the secondary effects are any sort of injury that results indirectly from receiving an electric shock. Common secondary effect injuries occur when people undergo violent muscle contractions during an electric shock accident. They may be thrown across a room and receive cuts, bruises and broken bones as a result. If they happen to be working at height off a ladder, then even a relatively minor shock can cause enough of a reaction to cause a fall.

Dangerous Activities

Fixed and Portable Electrical Equipment

A wide variety of workplace equipment is operated by electricity, some being **fixed systems** 'hard-wired' directly into the distribution system (such as wall sockets and ceiling lights), others being portable appliances. The same hazards apply to all of these, but the risks can be different, especially with portable appliances.

Hard-wired equipment still needs to be inspected and tested (see later) to ensure connections and system components remain secure and operational, particularly cables that may be exposed to pedestrian and vehicle traffic, but it is less likely to undergo the rigours of being unplugged and moved around the workplace.

Portable electrical equipment can be defined as equipment with a flex and plug on it that can be moved from one location to another for use. (Whether it actually is moved is irrelevant; a photocopier may never be moved but it has a flex and plug and is, therefore, portable.)

A high proportion of electric shock accidents involve portable electrical equipment.

As an example of vulnerable portable electrical equipment, consider a small concrete breaker used on a construction site. It is:

- Subject to frequent heavy use in an outdoor environment.
- Often handled and transported.
- Used by a variety of users who may not own the item and therefore have little interest in taking care of it.

TOPIC FOCUS

Conditions and practices likely to lead to accidents:

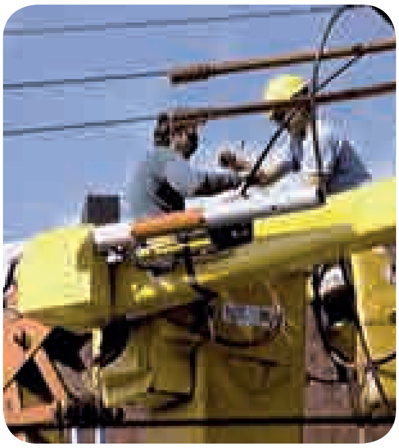
- Using unsuitable equipment, e.g. the use of non-intrinsically safe equipment in a flammable atmosphere.
- Using equipment in wet, damp or humid conditions.
- Misuse, e.g. sticking wires directly into a socket rather than using a plug.
- Physical abuse, e.g. pulling the plug out by tugging at the flex; carrying the tool by the flex; allowing the flex to be pinched, trapped or crushed.
- Repairs carried out by unauthorised personnel or carried out badly, e.g. split flex taped up with insulating tape.
- Continued use of faulty, defective equipment.
- Chemical damage to the flex, e.g. by corrosive wet cement.
- Lack of routine inspection, testing or maintenance.

Use of Electrical Equipment in Wet Environments

Because water decreases the resistance of objects and environments to the passage of electricity, any work using electrical equipment in wet environments increases risk. Not only are electric-shock accidents more likely to happen in wet environments (because normally-insulating materials will start to conduct), but the severity of injury received can be greater (because lower resistance means higher current flow).

Work Near Overhead Power Lines

Most overhead power lines are uninsulated (bare conductors). As a consequence, any work conducted near to these power lines has a risk of electrical arcing. The distance that the arc can jump will depend on the voltage of the electrical system and environmental factors (such as air humidity). A typical high-voltage overhead power line in the UK will be at 11000 V (11 kV).


Working near overhead power lines

Contact with Underground Power Cables

Both low-voltage (<1000 V) and high-voltage (>1000 V) power cables are routinely buried in the ground. When electrical cables are struck during excavation work, this can lead to electric arcing, shock, burns and fire, not to mention major business disruption to service users. Cables can be struck using hand tools such as spades and pneumatic drills, and by mechanical excavators. Note that it is not necessary to sever a cable or cut completely through the insulation to the cores inside to cause damage. Crushing the cores of an armoured cable can be enough to cause catastrophic arcing and explosion.

Work on Mains Electricity Supplies

Any work on or near any exposed **live** mains supply (in many countries, 230 volts; 50 Hz), conductors are inherently high risk because of the severity of injury that might result in the event of an accident. Work on any part of the main supply distribution network is doubly dangerous because of the high voltages of the distribution network (up to 400 kV) and the fact that most overhead cables are uninsulated bare conductors.

MORE...

The HSE website contains more information on the hazards and risk of electricity at:

www.hse.gov.uk/electricity/index.htm

STUDY QUESTIONS

1. Identify the relationship between current, resistance and voltage in a simple circuit.
2. Outline the main effects of electric shock on the body.
3. If a person receives a shock for one second which passes through the body along a path with a resistance 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:
   (a) 230 volts?
   (b) 110 volts?
   (c) 50 volts?
4. Explain what arcing is and what risks it poses.

(Suggested Answers are at the end.)

Control Measures

IN THIS SECTION...

- Electrical equipment must be carefully selected to ensure that it is suitable for the electrical system, purpose and environment of use.
- Various protective systems can be used for electrical equipment, such as:
  - Fuses - a weak link in the circuit.
  - Earthing - a low-resistance path to earth for fault current.
  - Isolation - cutting the power.
  - Double insulation - separating people from the conductors using two layers of insulation.
  - Residual current devices - sensitive and fast acting trips.
  - Reduced and low voltage - so that less current flows during an electric shock accident.
- Each of these protective systems has advantages and limitations.
- Work on electrical systems should be restricted to competent persons only.
- Safe systems of work should be used when risk is created by work on, or near, electrical systems.
- All electrical installations, equipment and appliances should be subject to user checks, formal visual inspections and combined inspection and testing to ensure electrical safety.

Introduction to Control Measures

Electricity is subject to a range of regional and local legislation, codes of practice, guidance and standards. For the purposes of this course, the following control measures are based on UK legislation and standards. In the UK, the principal piece of legislation is the **Electricity at Work Regulations 1989**, supported by guidance such as HSR25 *The Electricity at Work Regulations 1989 - Guidance on Regulations*, and HSG85 *Electricity at Work - Safe Working Practices*.

Protection of Conductors

Electrical conductors should be protected by insulation so that a person is not exposed to a live conductor. For example, cables should be insulated by an unbroken, undamaged sheath so that the live copper conductors are never exposed, and the casing on a drill should be intact so that the user cannot make contact with the live components within. It is essential that equipment is inspected and maintained to ensure that the insulation and protective layers are not damaged, and that where access may be possible, e.g. via an electrical panel or switchgear, the access doors are locked and controlled.

Cables should be insulated by an unbroken, undamaged sheath

Strength and Capability of Equipment

Electrical equipment must be carefully selected to ensure that it is suitable for the:

- electrical system that it will become a part of,
- task that it will perform, and
- environment in which it will be used.

No electrical equipment should be put into use where its electrical **strength and capability** may be exceeded and give rise to danger. It 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. This may require reference to electrical specifications and tests undertaken by the manufacturer and accredited testing organisations, based on international and national standards.

If the equipment might be exposed to hazardous environments, then it should be constructed and protected to prevent danger. The following hazardous environments should be taken into account:

- **Weather** - equipment and cables may need to withstand exposure to rain, snow, ice, wind, dust and lightning.
- **Natural hazards**, e.g. solar radiation, plants and animals, (e.g. gnawing of cables by rats).
- **Extremes of temperature and pressure**, e.g. heat from motors.
- **Dirty conditions** - contamination by liquids or solids.
- **Corrosive conditions** - caused by chemicals.
- **Liquids and vapours** - immersion, splashing or spraying with water and solvent vapours, etc.
- **Flammable substances**, e.g. flammable gases, dusts and vapours.

Foreseeable mechanical damage must also be considered, both in terms of the environment within which the equipment is to be used, and the natural operation of the equipment itself. For example, abrasion may be caused by mechanical movement leading to damage of the flex; this might be prevented by using an armoured flex.

Protective Systems and Devices

A range of protective systems and devices are used to control the risks associated with electricity. Most of these systems and devices can be found in the domestic home as well as at work. In the next section, we will overview the range of control measures and look at the advantages and limitations of each.

Fuses and Miniature Circuit Breakers

A **fuse** is a device used to prevent **current overload** (sometimes called **overcurrent** protection). A simple fuse is made up of two metal caps joined by a thin piece of fuse wire. When this fuse is incorporated into an electrical circuit, current flows through the wire. If the current is too great for the fuse wire rating, the wire becomes hot and melts. This breaks the circuit. In effect, the fuse is the weak link in the circuit.

Advantages of fuses are that they:

- Are very cheap and reliable.
- Offer a good level of protection for the electrical equipment against current overload that might damage the equipment or cause overheating, fire or explosion.

Limitations of fuses are that they:

- Primarily protect equipment and not people. It is possible to receive a severe, even fatal, electrical shock from equipment that is protected by a fuse for two reasons:
  - A fuse does not stop current flow quickly enough to prevent ventricular fibrillation.
  - The current flow must be above the fuse rating for the fuse to operate and this may be above the 60mA capable of causing fatal injury.
- Are very easy to bypass, e.g. by wrapping the fuse in tin foil.

Miniature Circuit Breakers (MCBs) are electromechanical devices that work in a similar way to fuses to protect equipment from current overload (they provide overcurrent protection). One significant difference is that an MCB does not melt in response to current overload; it simply trips out and can be re-set by pressing a button. This gives one of the main advantages of MCBs - they do not have to be removed in order to be re-set and so they are more tamper-proof than fuses. The limitations of MCBs are similar to those for fuses.

Earthing

Earthing is a way of protecting equipment so that, in the event of an electrical fault, current flows safely to earth rather than flowing through a person who might be touching the equipment.

The earth wire of an item of electrical equipment is usually connected to the outer metal casing or chassis of the equipment. If a fault develops and the casing or chassis becomes live, then a fault current will flow down this earth wire. Electricity always takes the **path of least resistance**, and since the earth wire will have very low resistance, the majority of fault current will flow safely to earth through the wire. Any person touching the casing will receive a minor shock.

Advantages of earthing are that it:

- Protects the person from fatal electric shock.
- Often provides secondary protection to the equipment because a large fault current flowing to earth will over-rate and trip the fuse or MCB.

Limitations of earthing are that:

- A poor or broken earth connection will prevent the earth from working properly, but since the earth wire does not take part in the normal functioning of the equipment, this fault can go completely undetected.
- It is easy to disconnect and disable.

Isolation of Supply

Isolation is the removal of electrical power from a circuit or system. This might be achieved using a switch (isolator) or by pulling the plug out. This makes the system or circuit dead and safe to work on (unless electrical energy is stored in the system).

To ensure safety, isolation should always be physically **secured** before people work on the dead system. This is often achieved by padlocking isolators in the 'off' position (the lock-out/tag-out system). As an additional precaution, the system should then be tested to prove that it is dead (and the test meter used should itself be tested both before and after this proof has been carried out).

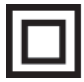
The **advantage** of isolation as a form of protection is that it is a very effective method of ensuring that people cannot be injured by electrical energy when working on an electrical system.

The lock-out/tag-out system

The **limitation** of isolation is that, by definition, the electrical system is dead. Certain types of testing, fault-finding and electrical installation and repair work have to be carried out with the electrical system on and live. In these circumstances, isolation cannot be used.

Double Insulation

The principle behind **double insulated (or Class II equipment)** is that there are two layers of insulation between any potentially live conducting surface that the user might touch (such as the metal casing of the equipment) and any live conductors, or the equipment has a non-conducting plastic casing. This eliminates the need to provide earth protection, so double-insulated equipment will have a two-core flex: live and neutral only.



This symbol is displayed on double-insulated equipment

Double insulation is commonly used as the means of protection for hand-held portable electrical equipment, such as hedge trimmers.

The **advantage** of double insulation is that it relies on insulation rather than the electrical system itself for safety.

The **limitation** of double insulation is that the insulation must be routinely visually inspected because there is no earth protection.

Residual Current Devices

A **Residual Current Device (RCD)** is specifically designed to protect human life in the event of electric shock. It does so, on the basis that it is very sensitive to small current imbalance (30mA) in a circuit and is able to break the circuit very quickly (40ms).

The principle of an RCD is that it constantly compares the amount of current flowing down the live and neutral lines and, if an imbalance is detected, it trips the circuit. RCDs (and earth leakage circuit breakers which work on a similar basis) can be:

- Incorporated into electrical equipment (as part of the plug).
- Standalone devices placed between a portable appliance plug and the power socket.
- Hard-wired into distribution systems, such as the 'consumer unit' of a domestic house (which, in many countries, has become standard practice for new or re-wired houses).

The **advantage** of RCDs is that they provide excellent protection for people in the event of electric shock.

Limitations of RCDs are that they:

- Do not provide overcurrent protection (they are not a fuse and work on a completely different principle).
- Have to be tested periodically, to ensure that they are still working effectively, and this is often not done.
- Can cause repeated circuit tripping if there is a fault and this can encourage people to not use them or to disable them.

Reduced and Low Voltage Systems

In the UK (where mains supply is 230v), it is possible to use a transformer to step the voltage down to 110v for portable power tools. 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 tap earth 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, i.e. 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' are those in which the voltage does not exceed 50 volts AC between conductors in a circuit that 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.

TOPIC FOCUS

Control measures to be considered when selecting portable electrical equipment for use on **construction sites** are to:

- Consider the use of battery-powered equipment.
- Consider the use of reduced- and low-voltage (110v) equipment centre-tapped to earth.
- Provide increased protection through the use of an RCD.
- Locate cables carefully, away from hazards, e.g. vehicles which may drive over them.
- Consider the use of double-insulated equipment.
- Carry out pre-use checks of the equipment for signs of damage.
- Train operators in safe use of the equipment.
- Avoid using in wet conditions (unless the equipment and supply cables are suitable for this).
- Implement a programme of routine visual inspection and thorough testing of electrical equipment and cables.

Competent Persons

Where work on electrical systems creates danger or risk of personal injury, then the employer must restrict that work to those people who have the necessary technical knowledge or experience to be able to carry out that work safely. In this context, a competent person has:

- Knowledge of electricity.
- Experience of electrical work.
- An understanding of the system to be worked on.
- An understanding of the hazards and the precautions needed.
- The ability to recognise whether it is safe for work to continue.

The extent of personal knowledge and experience needed will have to be decided by the employer. It may be that these requirements can be relaxed, provided an adequate level of supervision is being applied (for example, an apprentice electrician can gain experience provided they are appropriately supervised).

Use of Safe Systems of Work

Safe Systems of Work (SSW) must be developed when work on, or near, electrical systems creates risk. There are several issues that might be considered here:

Work On or Near Live Electrical Systems

Work must not be carried out on, or near, live electrical systems except in very particular circumstances (Regulation 14 of the **Electricity at Work Regulations 1989**). Live work should be prohibited in most instances. Where live work is justified (because there is no alternative) then there must be an SSW in place to ensure that the live work can be carried out safely. This SSW is likely to make use of the following controls:

- Permit-to-work system.
- Competent persons.
- Insulating PPE (such as gauntlets and boots).
- Insulated tools and equipment (such as screwdrivers).
- Designated work areas (such as 'earth-free zones').

Isolation

Most work on electrical systems should be carried out with the system dead. This requires that the system is isolated from its source of electrical power. As previously stated, this isolation usually requires:

- The breaking of the circuit.
- Physical securing of the break in the circuit.
- Some form of label (or tag).

So, for example, the isolator switch for an item of equipment might be switched to the 'off' position, a padlock introduced to secure the isolation and a tag added to identify the worker and nature of work activity.

Preventing Buried Cable Strikes

Prevention of striking buried services can be achieved by the use of SSWs, in combination with detection equipment:

1. Plans of the area of the excavation should be obtained.
2. Plans do not necessarily show the exact position of buried services, but can give an indication of the existence of services and an approximate position.
3. The buried services should be located using surface clues and detection equipment. A commonly used device for detecting the location of buried cables is the Cable Avoidance Tool ('CAT scanner').
4. The buried services should be uncovered by careful digging by hand.
5. The exposed services should be identified to ensure that they are those that were expected and be clearly labelled so that their position is easily seen. It may be necessary to support cables where ground underneath is being removed.

Digging with mechanical equipment can commence once the above points have been addressed.

Work Near Overhead Power Lines

Since most overhead power lines are uninsulated, danger is created if the power line is touched, or if any conducting material is positioned close enough for electricity to arc across. This might be the case during routine work in any workplace, but is a particular issue associated with construction work. Prevention of accidents associated with proximity to live overhead power cables can be achieved by:

- **Isolating** the power supply when working in the vicinity of power lines. If power cannot be isolated, it may be possible to **sleeve** low-voltage power lines.
- Using **SSW and permit systems** to control access into danger areas.
- Using **barriers, signage and goal-posts** to keep plant and vehicles a safe distance from power lines.
- Using **banksmen** when plant is manoeuvring near power lines.
- Using **non-conducting equipment**, such as fibreglass ladders.

Diagram showing use of barriers, bunting and goal-posts to control proximity of plant to overhead power lines (Based on original source HSG144 The safe use of vehicles on construction sites (2nd ed.), HSE, 2009 (www.hse.gov.uk/pubns/priced/hsg144.pdf))

Emergency Procedures Following an Electrical Incident

If, in spite of all the precautions, an electrical incident occurs in the workplace, all workers should be aware of the following method for dealing with an electric shock casualty:

Careful assessment of the situation when approaching the casualty is important for two reasons:

- The casualty may still be receiving an electric shock, in which case touching them will involve their potential helper in the shock as well.
- High-voltage conductors can arc electric current through the air over large distances (metres) (as discussed earlier).

In order to provide appropriate casualty care:

- Do not touch them.
- Call for help and an ambulance.
- Turn off the power supply.
- If the power supply cannot be switched off, then carefully push or pull the casualty away from the live part using non-conducting material, such as timber or dry clothing.
- Check breathing:
  - If the casualty is breathing, place them in the recovery position.
  - If they are not breathing, apply cardiopulmonary resuscitation.
- Treat any obvious burns.
- Treat for physiological shock.
- Make sure they get professional medical treatment (heart problems and internal burns may not be apparent to the casualty or first aider).

Inspection and Maintenance Strategies

Electrical installations and equipment should be routinely inspected to ensure electrical safety - this includes:

- The electrical equipment installed in the buildings, such as power distribution circuits and lighting.
- Large items of electrical equipment that are not moved.
- Smaller, portable appliances.

There are standards governing the inspection of fixed electrical installations, or requirements imposed by insurance companies. In many cases, tests should also be carried out to verify the safety of the systems, equipment or appliances in use.

There are several types of inspection and test that might be appropriate for **portable electrical appliances**. The HSE guidance note HSG107 *Maintaining portable electrical equipment* has information on this topic area.

User Checks

Some items of electrical equipment should be visually inspected by the user routinely before use. This is particularly important for portable electrical equipment that is used in environments where damage can easily occur (such as a power tool used on a construction site).

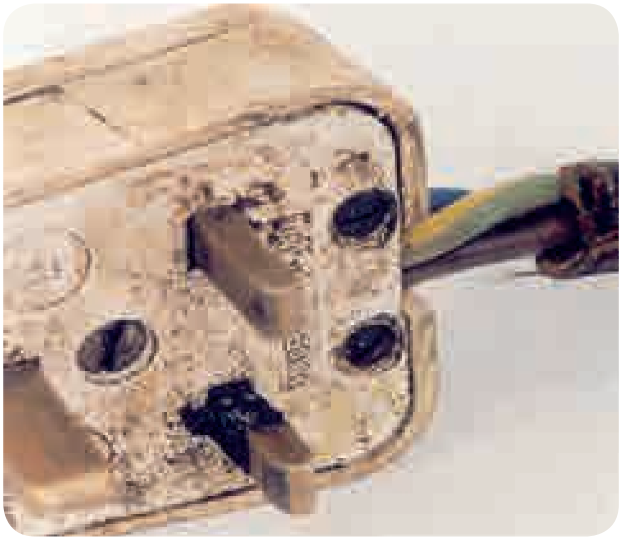
This user check does not involve any form of dismantling, but just careful visual inspection of the equipment. If visual inspection or tests show that the equipment is unsafe, then it must be taken out of service and repaired or discarded.

Initially, the equipment should be checked for suitability to ensure that it is appropriate for the task in hand, and that the equipment conforms to CE marking and EU conformity requirements.

TOPIC FOCUS

Things to check during routine visual inspection of a portable appliance include ensuring:

- The body of plug is intact and secure.
- The outer sheath of flex covers inner cores into body of plug.
- The plug cable clamp appears to be tight.
- The flex appears fully insulated, with no splits or severe kinks/pinches.
- The body of appliance is intact.
- The outer sheath of flex covers inner cores into body of appliance.
- The appliance cable clamp appears to be tight.
- No obvious scorch marks to plug or appliance body.
- The plug and appliance are not excessively soiled.
- The plug and appliance are not wet.

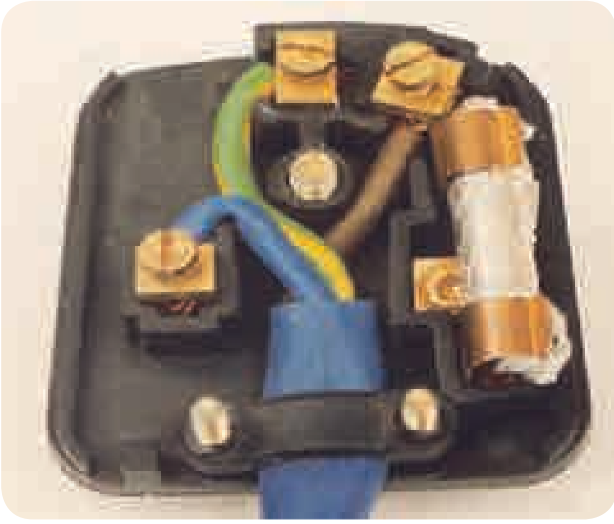


A user check will identify this unsafe condition; the outer sheath of the flex should be securely clamped by the cable clamp inside the body of the plug. (Source: HSG107 Maintaining portable and transportable electrical equipment (2nd ed.), HSE, 2004)

Formal Visual Inspection

Routine user checks should be backed up with less frequent formal visual inspections in some instances. These formal checks verify that the equipment appears to be in a safe condition. Formal visual inspection often requires dismantling of the equipment, usually the plug, to check that connections are still secure and that the correct fuse is fitted.

Formal visual inspection should be carried out by a competent person, i.e. someone with the appropriate training, knowledge and experience.



Formal inspection should uncover unsafe conditions, such as this fuse, which has been disabled by wrapping it in aluminium foil
(Source: HSG107 Maintaining portable and transportable electrical equipment (2nd ed.), HSE, 2004)

Combined Inspection and Testing

The main limitation of visual inspection is that there are certain unsafe conditions that can arise with electrical equipment that cannot be detected visually.

Deterioration of the insulation and defective earth pathway are two of these unsafe conditions.

In many instances it is, therefore, appropriate to carry out routine combined inspection and testing to verify the safe condition of electrical equipment. The visual inspection element of this combined inspection and testing is usually the same as the formal visual inspection we have already outlined. The testing element often consists of plugging a portable electrical appliance into a portable appliance test meter which runs the tests automatically.

A portable appliance test meter
(Source: HSG107 Maintaining portable and transportable electrical equipment (2nd ed.), HSE, 2004)

On other occasions, testing requires a detailed technical understanding of the equipment. In any event, this must be carried out by a competent person (with appropriate knowledge, training and experience).

Frequency of Inspection and Testing

The frequency at which user checks, formal visual inspections and combined inspection and testing should be carried out will vary depending on various factors. For example, a 110v hand-held power tool intended for use on a construction site should be visually checked by the user once a week, formally visually inspected once a month and given a formal combined inspection and test once every three months.

TOPIC FOCUS

Factors that influence the frequency of inspection and testing include:

- Legal standards and codes of practice.
- Type of equipment and whether or not it is hand-held.
- Manufacturers' 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 and duration of use.
- 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

Records should be kept of formal visual inspections and tests as proof of completion and so that a history of condition and defects can be maintained for future reference. It is common practice to fix a test sticker or label to an item after inspection or testing to indicate when the next inspection or test is due, and retain a register of the test results. In order to achieve this, it may be necessary to give each item of equipment an identification number. Controls will also be needed to ensure that unauthorised electrical equipment is not brought into the workplace and put into use without first being registered and tested - equipment as simple and commonplace as a kettle has been responsible for workplace fatalities.

All maintenance programmes showing the periods for inspection and testing should also be kept as formal records, including records of the findings and work carried out. Checking systems should be regularly monitored to ensure inspections and tests are completed on time and that any rectifications or replacements are carried out appropriately.

These records often form an inventory of items, especially portable appliances. Trends can be monitored to ensure that the correct items of equipment are selected and used in the right places, and regular incidents of fault or breakdown can indicate incorrect selection and use. For portable appliances, formal records are often supported with tags, labels and colour-coding of items to indicate conformity with the inspection and testing regime.

Advantages and Limitations of Portable Appliance Testing (PAT)

Advantages include the:

- Detection of faults not visible to the eye.
- Early removal/repair of unsafe equipment.
- Demonstration of legal compliance.
- Trends or patterns of faults that may be spotted.

Limitations are that:

- It provides proof of safety at one moment in time only.
- It does not ensure safe use or prevent misuse.
- Items may be missed and then remain untested.
- It cannot be applied to all equipment, (e.g. computers).

National General Certificate Legal Standards	International General Certificate Standards
• Electricity at Work Regulations 1989. • Electricity at Work Regulations (Northern Ireland) 1991.	• ILO C155 - Occupational Safety and Health Convention, 1981 (No. 155). • ILO R164 - Occupational Safety and Health Recommendation, 1981 (No. 164).

STUDY QUESTIONS

5. Explain earthing.
6. Identify the protection offered by the cord grip in a plug.
7. Identify the difference between a fuse and a circuit breaker.
8. Identify the difference between switching off and isolation.
9. Identify the protection offered by a reduced low-voltage transformer used to provide power to hand tools.
10. Identify the safety device that should be used when mains-supplied electric hand tools are being used outdoors.
11. Identify the user checks that might be carried out before an item of electrical equipment is used.
12. Identify the first step in treating a victim of electric shock.

(Suggested Answers are at the end.)

Summary

This element has dealt with some of the hazards and controls relevant to the use of electricity in the workplace. In particular, this element has:

- Outlined basic electrical principles, such as voltage, current and resistance, and the relationship between the three: Ohm's law ($V = I \times R$).
- Described the hazards of electricity as electric shock, burns (both direct and indirect), fire and explosion, arcing, and secondary effects.
- Explained the range of effects of electric shock, from mild discomfort and muscle tremor, through uncontrollable muscle contractions and respiratory failure, to ventricular fibrillation, cardiac arrest and severe burns, and how the severity of injury is influenced by several factors, such as system voltage, duration of contact, pathway through the body, body resistance, contact surface area, environmental factors and frequency.
- Outlined the reasons why portable electrical equipment is often involved in electrical accident, because it is often unsuitable for the job being done, misused, and not inspected or maintained.
- Described the various protective systems that can be used for electrical equipment, such as fuses (a weak link in the circuit), earthing (a low-resistance path to earth for fault current), isolation of supply (cutting the power), double insulation (two layers of insulation), residual current devices (sensitive, fast-acting trips), reduced and low voltage (reduced shock current).
- Outlined the importance of restricting work on electrical systems to competent persons only.
- Outlined the use of safe systems of work to control the high risks associated with work on or near electrical systems.
- Described an emergency procedure to be put in place if a person is injured in an electrical incident.
- Explained the importance of user checks, formal visual inspections and combined inspection and testing that can be used to ensure the safety of all electrical installations, equipment and appliances including portable appliances.

Exam Skills

QUESTION 1

Describe how the following two protective measures reduce the risk of electric shock **AND**, in **EACH** case, **give** an example of their application.

(a) Reduced low voltage. **(4)**

(b) Double insulation. **(4)**

Approaching Question 1

Think about the steps you would take to answer this question:

Step 1. The first step is to **read** the question carefully. Note that this question asks you to describe how reduced low voltage and double insulation reduce risk and, in each case, to give an example where the protection method is used.

Step 2. Now, highlight the **key words**. In this case, they might look like this:

Describe how the following two protective measures **reduce the risk** of electric shock **AND**, in **EACH** case, **give** an **example** of their application.

(a) **Reduced low voltage**. **(4)**

(b) **Double insulation**. **(4)**

Step 3. Next, consider the **marks** available. In this question, there are eight marks, so it is expected that around eight or nine different pieces of information should be provided. This question is split into two parts, with equal marks between the two. One mark in each part will be for the examples. The question should take around eight minutes in total.

Step 4. **Read** the question again to make sure you understand it and have a clear understanding of how risk is reduced, with an example in mind of its application. (Re-read your notes if you need to.) Questions on electricity are consistently answered badly, so NEBOSH are likely to make sure they feature regularly on papers to improve understanding.

Step 5. The next stage is to develop a **plan** - there are various ways to do this. Remind yourself, first of all, that you need to be thinking about 'reduced low voltage' and 'double insulation'. When you see the command word 'Describe', you need to create a picture in words. There are two command words in this question as you are also asked to 'give' an example. So, the answer plan will take the form of a bullet-pointed list that you need to develop into a picture.

Now have a go at the question. Draw up an answer plan, and then use it as the basis to write out an answer as you would in the exam.

Remember, you can always contact your tutor if you have any queries or need any further guidance on how to answer this question.

When you have finished, compare your plan and full answer with those that follow.

Suggested Answer Outline

Reduced Low Voltage
Example: portable, hand-held electrical tools on a construction site. • Transform voltage down to 110v or lower. • Shock voltage reduced, thereby reducing the risk of a fatal electric shock. • Safer extra low voltage of less than 50v.
Double Insulation
Example: hand-held, portable appliances, such as a laptop PC. • Two layers of insulation between body contact and fault condition. • Internal components insulated. • Conductive parts cannot come into contact with outer casings. • No need for earth connection.

Example of How the Question Could be Answered

(a) *Typically on construction sites, employees use hand-held power tools, such as drills or circular saws that are powered by electricity fed from a transformer. The transformer typically reduces the mains voltage or generated voltage to 110v, which reduces the shock voltage delivered and thus reduces the likelihood of a fatal electric shock. For lighting systems, even lower voltage may be used in an extra low voltage system and these systems typically are less than 50v.*

(b) *To remove the need for earthing on appliances such as hand-held, portable electrical equipment or laptop computers, double insulation is used. In this system, two independent layers of insulation are used over the live conductors of internal components - each layer alone is adequate to insulate the electrical equipment safely. The two layers of insulation make it unlikely that live conductors will come into contact with the outer casing of the laptop, ensuring that it is safe to handle. Since double-insulated, portable electrical equipment is not earthed, it must be inspected and maintained to ensure safety.*

Reasons for Poor Marks Achieved by Candidates in Exam

- A lack of knowledge on electricity and protective measures used in electrical systems.
- An over-simplified approach to double insulation - it is not about 'two pieces of plastic covering an electrical conductor'.
- Not answering the question at all - if you make no attempt at an answer you will receive no marks. Many candidates leave out questions like this.
- Not providing enough detail for the answer to qualify as a description, or failing to provide appropriate examples.

QUESTION 2

A mains electricity powered brushcutter (strimmer) is to be used to clear undergrowth in the grounds of a workplace.

(a) **Identify** safety features of the brushcutter that will reduce the risk of electric shock to the user. **(4)**

(b) Other than electricity, **identify** additional hazards associated with the brushcutter that the user could be exposed to. **(6)**

(c) Other than electricity safety features, **outline** the control measures to reduce the risks to the user when operating the brushcutter. **(6)**

(d) **Outline** additional control measures to reduce risks to other employees who may be in the vicinity of this work. **(4)**

Approaching Question 2

Think now about the steps you would take to answer the question:

Step 1. The first step is to **read** the question carefully. Note that for part (a) of the question, you are required to 'identify' electrical safety features of the brushcutter. Part (b) requires you to 'identify' additional hazards other than electricity. Part (c) requires you to ignore electricity-related control measures and 'outline' control measures to reduce risks to the operator. Part (d) requires an 'outline' of additional control measures to reduce risks to other employees in the vicinity.

Step 2. Now highlight the **key words**. In this case, they might look like this:

A **mains electricity** powered **brushcutter** (strimmer) is to be used to clear undergrowth in the grounds of a workplace.

(a) **Identify safety features** of the brushcutter that will **reduce** the **risk of electric shock** to the **user**. **(4)**

(b) Other than electricity, **identify additional hazards** associated with the brushcutter that the **user** could be **exposed** to. **(6)**

(c) Other than electricity safety features, **outline** the **control measures** to **reduce the risks** to the **user** when operating the brushcutter. **(6)**

(d) **Outline** additional **control measures** to **reduce risks** to **other employees** who may be in the vicinity of this work. **(4)**

Step 3. Next, consider the **marks** available. In this question, there are 20 marks available. Questions that are split into parts (this question is split into four parts worth four, six, six and four marks respectively) are often easier to pick up marks on, because the signposts NEBOSH use are so much easier to see with the question broken down into smaller sections. In part (a) of the question, you are asked to 'identify' safety features. So, you need to select and name the safety features that will reduce electric shock. Part (b) is worth six marks, so you need to identify at least six hazards not related to electricity to gain all the marks available. Part (c) is worth six marks and you are asked to 'outline' the control measures to protect the user. Part (d) is worth four marks and you are asked to 'outline' control measures to reduce risk to other employees who may be in the vicinity when the brushcutter is in use. The whole question should take around 25 minutes to write up and five minutes to read through and make any minor changes or additions.

Step 4. **Read** the question again to make sure you understand it and have a clear understanding of electricity safety (Element 5) and work equipment hazards and risk control (Element 4). (Re-read your notes if you need to.)

Step 5. The next stage is to develop a **plan** - a plan is critical for this question since it switches from hazards to control measures, from identifying factors to outlining factors and from electricity to work equipment risk. Remind yourself, first of all, that this question is all about the hazards and control measures associated with using a brushcutter (strimmer). To construct your sentence for part (a), list the safety features that will reduce the risk of electric shock and then in the answer give a brief description. Part (b) asks you to identify hazards other than electricity; again, list the key factors and develop these into a very brief description in your answer. Part (c) switches to an outline of safety features (other than those related to electricity) to reduce risk when operating the brushcutter. List the factors you identify in your answer plan and develop this into short sentences in your answer. Part (d) again asks for an outline of additional control measures to reduce risk to other employees. So, again, list the factors in your answer plan and then develop them into a brief sentence for your answer. Using examples to illustrate your answer will help convince the examiner that you understand the hazards and control measures related to using a brushcutter. So, the answer plan will take the form of bullet-pointed lists that you need to develop.

Your answer must be based on the key words you have highlighted. So, in relation to using a brushcutter (strimmer), for part (a) identify safety features to reduce the risk of electric shock to the user. For part (b), identify additional hazards the user can be exposed to. For part (c), outline control measures to reduce risks to the user. For part (d), outline control measures to reduce risks for other employees.

Now have a go at the answer plan. Provide this in table form, listing the factors that you would, then develop into an answer. Check your answer plan with the one suggested below. If you have more factors in your lists, then re-read the question to make sure you are answering what has been asked. If you have fewer factors than in the suggested answer plan, you may need to revise your notes.

Suggested Answer Outline

Part (a)
• Voltage. • Double-insulated. • Fused. • Earthed. • RCD. • Waterproof. • Well-made.
Part (b)
• Contact with rotating parts. • Struck by. • Slips/trips/falls. • Manual handling. • Noise. • Vibration. • Dust. • Biological hazards.
Part (c)
• Maintenance/selection. • Time. • Rotation of crew. • Guards. • PPE. • Information.
Part (d)
• Information. • Cordons/barrier tape. • Warning signage. • Alternative routes. • Operational hours. • Stand-by usher.

When you have an answer plan that meets the requirements of the question, have a go at providing a full answer under examination conditions. Give yourself 20 minutes to write the answer (this time-frame assumes you have spent five minutes on the answer plan). Your handwriting must be legible - if the examiner cannot read what is written then it cannot be marked. You will not be penalised in the exam for poor grammar or spelling, as long as your answer is clear and can be understood.

Remember, you can always contact your tutor if you have any queries or need any further guidance on how to answer this question.

When you have finished your answer, read the suggested answer below and compare it to your answer.

Example of How the Question Could be Answered

(a) *The mains electricity should be transformed down to 110 voltage supply. The brushcutter should be Class II double-insulated and the electrical components located in a waterproof casing. The brushcutter should be connected to the electrical supply via a Residual Current Device that will trip if earth leakage is detected. The brushcutter should be properly earthed and the cable should be of strong construction to prevent being damaged easily. There should be a fuse fitted in the circuit with an appropriate rating.*

(b) *Additional hazards faced when using the brushcutter would include contact by a person with the rotating parts of the cutter. The strimmer cable may eject stones or twigs striking the operator. During dry conditions, the strimming cable may also disturb dry soil and create dust in the breathing zone of the operator. The operator may slip on moist grass or trip over tree roots, causing falls to the ground. Manual handling will be a hazard when the operator carries the brushcutter and transformer. Noise from the motor and strimming cable will be a hazard, especially over the extended period the brushcutter is likely to be in use. Vibration generated by the motor and experienced by the operator through the machine handles will be a hazard. The presence of dog or vermin faeces will cause biological hazards to be present.*

(c) *Control measures to reduce the risks to the operator of the brushcutter include maintaining the equipment to achieve optimum performance and cutting efficiency, and selecting the best equipment to use for the job with low vibration levels built into the design and adequate power. The 'trigger' time of the operator should be restricted or a job rotation system operated to reduce exposure to vibration and noise. The guards on the machine should be correctly fitted and positioned to afford the operator maximum protection. The operator should be supplied with appropriate PPE, such as ear defenders, eye protection, dust mask, gloves, safety footwear, gaiters, and high-visibility jacket that may also be used to afford protection in cold weather. Operators should be given instruction in the safety features of the machine and information about the hazards present.*

(d) *Additional control measures required to protect other employees in the vicinity would include ensuring that everyone is informed about the brushcutting operation and the likely hazards that may result, cordoning off of the area where the brushcutter is operating with barrier tape, and erecting warning signs advising of hazards such as noise and trailing cables. Alternative routes through the area should be defined, avoiding close proximity to the brushcutting operation. Alternatively, other operations should be carried out when the brushcutting operation has been completed. A further control measure would be the use of an usher (stand-by operator) to keep others at a safe distance from the operation.*

Reasons for Poor Marks Achieved by Candidates in Exam

- Confusing risks with control measures and giving answers that were not pertinent to the question asked.
- Not giving a sufficient range of control measures to attract all the marks available.
- Providing insufficient detail to meet the requirements of 'outline'.
- If candidates use PPE as a control measure, then suitable examples must be provided, i.e. hard hat, gloves, safety footwear, etc.
- Not being well-prepared - you must read and re-read your course notes.

QUESTION 3

Outline the range of control measures that could be used to reduce the risk of injury from electricity when using a portable electrical appliance on a construction site. **(8)**

Approaching Question 3

Think about the steps you would take to answer this question:

Step 1. The first step is to **read** the question carefully. This is an 'outline' question - remember, that means you need to provide a brief description of the control measures, which might include some examples.

Step 2. Now, highlight the key words. In this case, they might look like this:

Outline the range of **control measures** that could be used to **reduce the risk** of injury from **electricity** when using a **portable electrical appliance** on a **construction site**. **(8)**

Step 3. Next, consider the **marks** available. There are eight marks available here, which suggests that eight pieces of information are required.

Step 4. **Read** the question again to make sure you understand it and have a clear understanding of the different ways in which the risk of electric shock can be reduced while using portable electrical equipment on a construction site. (Re-read your notes if you have to.)

Step 5. The next stage is to develop a **plan** - you are now familiar with how to do this. The answer plan will take the form of a bullet-pointed list that you need to develop into a full answer based on the key words that you have highlighted.

Now have a go at the question. Draw up an answer plan, and then use it as the basis to write out an answer as you would in the exam.

HINTS AND TIPS

If you aren't familiar with the construction environment, think about it as an outdoor workplace with vehicles and equipment in use.

When you have finished, compare your plan and full answer with those that follow.

Suggested Answer Outline

Controls for Portable Electrical Equipment on Construction Sites
• Reduced voltage. • RCDs. • Battery equipment. • Armoured cables. • Appropriate industrial equipment. • Maintenance and testing. • Visual checks by users. • Avoid use in wet weather unless it is suitable for use. • Training.

Example of How the Question Could be Answered

When portable electrical equipment is used on a construction site, there are many controls that can be used to reduce the risk of injury from electric shock. Ideally, the use of mains voltage should be avoided and replaced by battery-powered tools. If this is not possible, the voltage could be reduced to 110v - if this is generated by a centre-tapped transformer, a person can't receive a shock of more than 55v. The use of RCDs would also reduce the risk of injury by rapidly detecting fault currents and disconnecting from the supply. Where cables are used, these should be armoured to provide protection from the harsh environment, and located so as to avoid damage. Equipment should only be used in conditions that it was designed for - suitably robust, industrial equipment should be used rather than domestic equipment, and only suitable equipment should be used in wet conditions.

Users of electrical equipment should be trained to carry out simple visual inspections to detect simple faults before the equipment is used, and instructed when it should be taken out of use. Finally, maintenance should be carried out by competent persons to ensure that equipment, power supplies and cables are maintained in good working order.

Reasons for Poor Marks Achieved by Candidates in Exam

- Not providing the outlines required.
- Not relating to the construction-site environment and discussing portable electrical equipment generally.
- Not considering portable equipment and talking about other construction-site equipment.

Element 6

Fire Safety

Learning Outcomes

Once you've read this element, you'll understand how to:

1. Describe the principles of fire initiation, classification and spread.
2. Outline the principles of fire risk assessment.
3. Describe the basic principles of fire prevention and the prevention of fire spread in buildings.
4. Outline the appropriate fire alarm system and fire-fighting arrangements for a simple workplace.
5. Outline the factors which should be considered when implementing a successful evacuation of a workplace in the event of a fire.

Contents

Fire Initiation, Classification and Spread

IN THIS SECTION...

- Three things must be present for a fire to start: fuel, oxygen and heat.
- The five classes of fire (determined by the types of fuel) are: Class A (organic solids), Class B (flammable liquids), Class C (flammable gases), Class D (metals) and Class F (high-temperature fats).
- Fire can spread through a workplace by direct burning, convection, conduction and radiation.
- Fires have many different causes, but common causes are faulty or misused electrical equipment, deliberate ignition, hot works, heating and cooking appliances, and smoking materials.

Principles of Fire

The basic principles of fire and combustion can be represented by the fire triangle.


The fire triangle

For fire to exist, three things must be present:

- **Fuel** - a combustible material or substance (such as paper, wood, petrol, diesel, butane or acetylene) that is consumed during the combustion process.
- **Oxygen** - consumed during combustion when it is chemically combined with the fuel. Oxygen is present in air at a concentration of 21%. During a fire, oxygen can also come from other sources, including certain oxygen-rich chemicals (usually called oxidising agents), such as ammonium nitrate.
- **Heat** - a heat or ignition source is essential to start the combustion process. Once combustion has started, it generates its own heat which is usually sufficient to keep the fire burning (in other words, once the fire starts, the heat source can be removed and the fire stays alight). Some examples will be described later in this element.

Once a fire has started, it will produce heat, a flame (the zone where oxygen and flammable vapours are chemically combining in the combustion process) and smoke. The exact composition of the smoke will vary, but typically, smoke is made up of hot combustion gases, such as carbon monoxide (CO) and carbon dioxide (CO_2), and small particles (soot).

The fire triangle is useful for two reasons:

- **Fire prevention** - keeping the three elements apart means fire cannot start.
- **Fire-fighting** - by removing one of the elements, the fire will go out.

Classification of Fire

Fires are classified into five categories according to fuel type. The classification is useful as the basis for identifying which type of fire extinguisher to use (see later). Note that the classifications shown here are those used in the UK and the EU; different classification systems exist in other countries and regions. There is no global standard and it is important that workers know the system relevant to the country in which they find themselves working.

TOPIC FOCUS

Classification of fires:

- **Class A** - **solid materials**, usually organic, such as paper, wood, coal and textiles.
- **Class B** - **flammable liquids**, such as petrol, oil and solvents.
- **Class C** - **flammable gases**, such as methane, propane and acetylene.
- **Class D** - **metals**, such as aluminium or magnesium.
- **Class F** - **high-temperature fats** and oils, such as cooking fat fire.

Note that, in the EU system, there is no Class E fire. This classification was avoided because of potential confusion between Class E and electricity. Classification is done on the basis of the fuel that is burning. Electricity is not a fuel (though it can be an ignition source and it can certainly be a hazard when fighting fires).

Principles of Heat Transmission and Fire Spread

Once a fire has started, it can spread by four different methods: direct burning, convection, conduction, and radiation. In a real fire situation, all four methods may apply.

TOPIC FOCUS

- **Direct Burning**

  This is the simplest method of fire spread where a flame front moves along or through the burning material. For example, this happens when setting fire to the corner of a piece of paper with a match - think of how the flame front moves from the match and spreads across the paper.

- **Convection**

  This is the principle that hot air rises and cold air sinks. Hot gases generated by the fire rise straight up from the fire:

  - **Inside a building**, these hot gases will hit the ceiling and then spread out to form a layer underneath the ceiling. When these hot gases touch any combustible material (such as a wooden curtain pole), they may heat that material up sufficiently so that it bursts into flame.
  - **Outdoors**, these convection currents will contain burning embers that are carried in the currents until the air cools and the embers are dropped to the ground. This is a common way for forest fires to travel and jump over obstacles (such as roads).

- **Conduction**

  This is the principle that heat can be transmitted through solid materials. Some metals in particular conduct heat very efficiently, e.g. copper. Any pipes, wires, ducts or services running from room to room can act as conduits for heat and spread the fire, in the same way that a metal spoon heats up in a saucepan on the cooker.

- **Radiation**

  Heat energy can be radiated through air in the form of infrared heat waves which travel in straight lines (just like light) and can pass through transparent surfaces, such as glass. Radiant heat generated by a fire shines onto nearby surfaces and is absorbed. If the material heats up sufficiently, it can burst into flames.

Common Causes and Consequences of Fires in Workplaces

Causes

Fires in workplaces start for many different reasons. Some of the most common causes of workplace fires are:

Unsafe storage of gas cylinders

- **Electrical equipment** - this includes faulty wiring, overloaded conductors, misused equipment and the incorrect use of electrical equipment in inappropriate environments.
- **Deliberate ignition** - many workplace fires are started deliberately. In some cases, the workplace has been targeted, e.g. by a disgruntled employee or an unhappy customer; in other cases it has not, e.g. youths playing with matches on an industrial estate.
- **Hot work** - this includes any work involving the use of naked flames, (e.g. a propane torch or oxy-acetylene cutting equipment) or that creates a significant ignition source, (e.g. arc-welding and grinding).
- **Smoking** - in particular, carelessly discarded smoking materials, such as cigarette butts and matches.
- **Cooking appliances** - e.g. fat pans left unattended.
- **Heating appliances** - e.g. electric fan heaters and space heaters, especially when left unattended.
- **Unsafe use and storage of flammable liquids and gases** - e.g. petrol, acetone and Liquefied Petroleum Gas (LPG). Static sparks could be generated that could ignite a flammable vapour.
- **Mechanical heat** - generated by friction between moving parts, such as a motor and its bearings, or cold work generating sparks.
- **Chemical reactions** - these can also generate heat, e.g. rags soaked in oil and solvents are a fire hazard, because as the oil or solvents oxidise, heat is generated and there is a risk of spontaneous combustion.

Consequences

Of greatest concern is the potential for harm to people. Most of the people killed in workplace fires are not killed by the flames directly, but indirectly by smoke inhalation. Serious burns may also result.

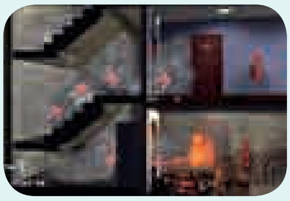
More commonly, fires cause enormous damage to buildings and building contents. Items that are not directly destroyed by the fire will often be severely affected by smoke damage. These losses will usually be covered by insurance.

Fire and fire-fighting can also do significant damage to the environment. Forest fires (though not a significant risk in all parts of the world) do huge damage. Fire-fighting can cause pollution because of the large volumes of contaminated water that run off the fire site into water courses.

STUDY QUESTIONS

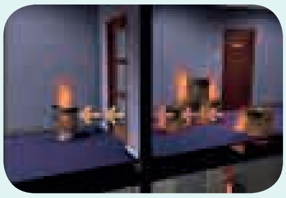
1. Explain briefly how each of the following might start a fire.
   (a) Friction.
   (b) Space heater.
2. What happens if you open a window to release the dense smoke in a room created by a fire?
3. Identify the fire classification of each of the following types of fire:
   (a) Butane gas cylinders burning in the storage area of a garden centre.
   (b) Fire in the paint shop of a car manufacturer.
   (c) Fire in an office.
4. Identify the process of heat transmission/fire spread shown in the following images.

(a)



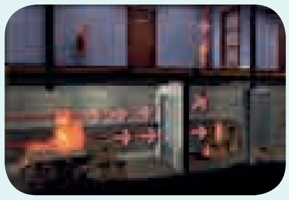
Source: Safe Practice 'Fire Safety'

(b)



Source: Safe Practice 'Fire Safety'

(c)



Source: Safe Practice 'Fire Safety'

5. What additional method of heat transfer/fire spread is not illustrated by the images above?

(Suggested Answers are at the end.)

Fire Risk Assessment

IN THIS SECTION...

- There are five steps to fire risk assessment:
  - Identify the fire hazards.
  - Identify the people at risk from fire.
  - Evaluate the risk from fire, remove or reduce the risks and protect from risk.
  - Record the findings, plan new controls and train those at risk.
  - Review the assessment.

Reasons for Carrying Out a Fire Risk Assessment

There are three main reasons for assessing and managing fire risks. These are to:

- **Prevent harm to people** - all employers have a moral duty to take appropriate steps to ensure the health and safety of their employees and other people.
- **Comply with the law** - employers have legal obligations regarding fire safety (see below) and can be penalised if they fail to do so.
- **Minimise the cost of fire at the workplace** - most businesses that suffer a major fire do not fully recover from its effects. If a factory or offices burn down, they may never be re-built, costing not only the business but all of the jobs.

Fire safety legislation and fire safety standards vary between countries, and from region to region. Fire risk assessment is a legal requirement in many countries. However, some factors should be considered in any workplace; these can best be described by applying risk assessment methods to fire safety. For the purposes of this course, we will consider the legal requirement relevant to the UK. This is the same as EU requirements and provides a good standard that can be applied to any workplace.

Compliance with RRFSO

In the UK, the **Regulatory Reform (Fire Safety) Order 2005 (RRFSO)** and associated legislation require a 'responsible person' to undertake a fire risk assessment and implement the findings of that assessment. In a workplace, the 'responsible person' will be the employer and any other person who has control of the premises or part of the premises, such as owners or occupiers.

MORE...

A series of guides to fire risk assessment have been published by the Department for Communities and Local Government. Each guide covers a different type of premises. These are available from:

www.gov.uk/workplace-fire-safety-your-responsibilities/fire-risk-assessments

Factors to be Considered in Carrying Out the Risk Assessment

The general principles of fire risk assessment are very similar to the five steps of general risk assessment (remember your Unit 1 studies), but with special emphasis on fire safety.

TOPIC FOCUS

The five steps of fire risk assessment are:

1. **Identify the fire hazards**:
   - Sources of fuel.
   - Sources of ignition.
   - Sources of oxygen.
2. **Identify the people who might be at risk**:
   - People in the premises.
   - Vulnerable people - always give them special consideration.
3. **Evaluate, identify and implement the fire precautions** that are required:
   - Fire prevention.
   - Prevention of the spread of smoke and flames.
   - Fire detection and alarm.
   - Fire-fighting equipment.
   - Means of escape.
   - Signs and notices.
   - Lighting.
4. **Record findings, plan, instruct and train**, including:
   - Emergency plans.
   - Information and instruction.
   - Training.
5. **Review and revise the assessment as necessary**.

Identify the Fire Hazards

The locations, types and amounts of the various potential fuels (combustibles) should be considered. All workplaces will contain simple combustibles such as paper, packaging materials and furniture. Some workplaces may contain large quantities of highly flammable or extremely flammable materials, such as solvents, fuel or gases.

Also of importance are potential ignition sources and the frequency and duration of occurrence. Hot works, electrical equipment, portable fan heaters, etc. should all be taken into account, especially heat sources that are frequently used for long periods of time and that require special attention to ensure safety, (e.g. hot work).

Sources of oxygen are significant factors to consider; oxygen cylinders and oxidising substances can both act as oxygen sources that can increase the risk of a fire starting and the severity of the resultant blaze.

Identify the People Who Might be at Risk

As with a general risk assessment, consider the general groups of people who might be affected by a fire in the workplace. These might be employees, contractors working on site, visitors and members of the public. The number of people affected might be relatively small, (e.g. 10 employees in a single workshop building) or very large, (e.g. in a shopping mall). Consideration should also be given to people who are in the vicinity of the workplace.

Disabled people need special consideration

Special consideration must be given to those who might be more at risk in a fire situation, such as:

- Lone workers, (e.g. cleaners).
- People working in isolated areas, (e.g. a plant room).
- The young, (e.g. toddlers in a crèche).
- The elderly, (e.g. residents in a care home).
- The disabled, (e.g. wheelchair users).

It might be acceptable in some instances to consider these people in groups, but in some cases it will be necessary to consider their particular needs on an individual basis. For example, a disabled worker in a multi-storey building may have impaired vision or impaired mobility; these two disabilities present very different problems and require different solutions.

Evaluate, Identify and Implement the Required Fire Precautions

The risk of a fire occurring must be evaluated and the risk to people must also be evaluated.

This can be done by thinking about:

- The potential fuels, ignition sources and oxygen sources.
- The methods by which fire might spread.
- How smoke and flames might travel in the workplace.
- The locations of the people in the premises.
- The structural fire resistance of the building, (e.g. the presence of timber structures).

A range of preventive and precautionary measures will be necessary for all workplaces. These will include the following issues, which are covered in more detail in the rest of this element:

- **Fire prevention** - ways of minimising the risks of a fire occurring.
- **Prevention of the spread of smoke and flames** - ways of minimising the risk to people, should a fire occur, and allowing them time to evacuate the premises safely.
- **Fire detection and alarm** - to ensure that a fire is detected as soon as possible once it has started and that every person in the premises is then alerted to the risk.
- **Fire-fighting equipment** - portable extinguishers and fixed installations.
- **Means of escape** - safe routes out of the premises to a place of total safety.

- **Signs and notices** - to indicate the escape routes and the emergency procedures.
- **Lighting** - to enable people to use the escape routes safely.

All of these fire precautions have to be inspected, tested and maintained in effective working order. This requires that a regime of routine checks is carried out at various frequencies. Records of these checks should be kept.

Record, Plan, Instruct and Train

The **significant findings** of the fire risk assessment must be recorded where the employer has five or more employees. The exact nature of the record will vary depending on the nature of the workplace. The record might include a line drawing of the workplace (a plan as seen from above) showing the various fire precautions and the means of escape.

New controls and an **emergency plan** must be developed outlining the emergency procedures in the event of a fire. In a simple workplace, this may be nothing more than a fire action notice. In a larger, more complex workplace, more detailed plans will need to be made. This may require consultation and co-operation with other occupiers or controllers of the premises. These plans must be recorded where the employer has five or more employees.

All relevant people must be given appropriate **information and instruction** on fire safety. This would include employees, contractors and visitors to the premises. The nature of the information and instruction provided varies, but would include fire prevention measures and emergency procedures.

All employees must be provided with appropriate fire safety **training**. Again, the exact nature of that training will vary, but should include issues such as fire prevention, emergency procedures and fire-fighting.

Review

Regular review of the fire risk assessment will ensure that it stays relevant and suitable.

In particular, the risk assessment should be reviewed:

- After significant changes that might affect fire safety, (e.g. a change to the fabric of a building or the introduction of a new combustible material).
- After a fire emergency (to ensure that all precautions worked as intended).
- Periodically, to ensure things have not been missed.

The assessment should be revised as necessary.

Temporary Workplaces and Changes to Workplaces

Fire safety must be provided for all workers at all times. If a workplace is temporary, then a fire risk assessment must be carried out and fire precautions must be implemented.

This is particularly the case on construction sites, where the nature of the work may mean rapid changes to the layout and nature of the workplace. In the UK, the **Construction (Design and Management) Regulations 2015** require that fire safety is considered in the Construction Phase Plan for the site and appropriate arrangements made.

If an existing workplace is to be changed or modified in some way and this will affect fire safety, then the fire risk assessment for those premises must be reviewed and revised as necessary. In a workplace where an Alterations Notice is in place, the local fire and rescue service must be notified of any alterations.

National General Certificate Legal Standards	International General Certificate Standards
• Regulatory Reform (Fire Safety Order) 2005. • Fire Safety (Scotland) Regulations 2006. • Fire Safety Regulations (Northern Ireland) 2010. • Construction (Design and Management) Regulations 2015. • Construction (Design and Management) Regulations (Northern Ireland) 2016.	• ILO C155 - Occupational Safety and Health Convention, 1981 (No. 155). • ILO R164 - Occupational Safety and Health Recommendation, 1981 (No. 164).

STUDY QUESTION

6. Outline the five steps of a fire risk assessment.

(Suggested Answer is at the end.)

Fire Prevention and Prevention of Fire Spread

IN THIS SECTION...

- Fire can be prevented by controlling potential fuel sources. Risk from fuel sources can be managed by elimination, substitution, minimising quantities and by safe use and storage.
- Fire can also be prevented by controlling potential ignition sources such as electrical equipment, hot works, discarded smoking materials, and cooking and heating appliances.
- Safe systems of work can be used to control work activities involving fire risk, e.g. permit-to-work systems can be used to manage the risk associated with hot works. This includes ensuring good standards of housekeeping.
- Flammable liquids must be used and stored with appropriate care to minimise the associated fire risk.
- If a fire does start within a building then structural measures will normally exist to contain the fire and smoke in one part of the building. This compartmentation must be maintained; doorways must be properly protected with self-closing fire doors.
- Electrical equipment must be of a suitable category for use in an explosive atmosphere.

Control Measures to Minimise the Risk of Fire in a Workplace

The best course of action to ensure fire safety is to prevent fires from starting. Fire prevention can be based on some simple ideas taken from the fire triangle:

- Control fuel sources.
- Control ignition sources.
- Control oxygen sources.

In particular, minimise these sources and keep them physically apart.

Flammable liquids

Control of Combustible and Flammable Materials

Combustible materials (such as paper, cardboard and wood), flammable liquids (such as white spirit) and flammable gases (such as butane, propane and methane) are all potential fuels and should be stored, handled, transported and used with appropriate care if the fire risk that they present is to be controlled.

The best option is to **eliminate** the combustible and flammable material entirely from the workplace. This might be done, for example, by disposing of old stocks of materials and substances that are no longer needed.

Alternatively, it may be possible to **substitute** one potential fuel source for another that presents less of a fire risk. For example, a petrol-powered generator might be changed to a diesel-powered one, eliminating the need to store and handle petrol. Since petrol is a highly flammable liquid (i.e. easily ignited at normal indoor and outdoor air temperatures) but diesel is not (i.e. not easy to ignite at normal indoor or outdoor air temperatures), there is a considerable reduction in fire risk.

If combustible and flammable materials cannot be eliminated or substituted, then the quantities of these materials present in the workplace should be **minimised**. This requires good stock control, housekeeping and waste management. For example, cardboard is used extensively by many manufacturing companies as a packaging material. It will be stored in bulk in a warehouse. Minimising the stocks of cardboard reduces the fire risk in the warehouse.

For the combustible and flammable materials that remain, arrangements must be made for safe use and storage.

DEFINITION

LIQUEFIED PETROLEUM GAS (LPG)

Propane or butane gas, or mixtures of the two. Often stored and transported in gas cylinders that can be moved by hand.

For example, if **Liquefied Petroleum Gas** (LPG) is present in a workplace, the following arrangements should be made:

- Cylinders (gas bottles) should be stored outside.
- The storage area should be fenced with a secure, lockable gate.
- Warning signs should be displayed.
- Ignition sources should be eliminated from the area.
- Bottles should be chained upright.
- The storage area should be separate from other buildings.
- Empty and full bottles should be kept separate.
- Oxygen bottles should not be stored with LPG.
- Only those bottles actually required should be removed from the storage area and returned after use.

Cylinders stored outside

Control of Ignition Sources

Poor control of potential ignition sources is a common cause of workplace fires:

- **Electrical equipment** should be routinely inspected and tested to ensure that it is safe. This will prevent faults developing that might cause sparks or overheating. Both portable appliances and fixed installations should be checked.
- **Hot work** should be controlled with a permit-to-work system unless it is being carried out in a purpose-built area, such as a welding bay in a workshop.

- **Smoking** should be controlled in the workplace. It is illegal to smoke in virtually all indoor workplaces. However, smoking outdoors is not illegal, so attention must be given to the:
  - Prohibition of smoking in areas where fire risk exists, (e.g. in the vicinity of an LPG storage compound).
  - Safe disposal of smoking materials in the designated outdoor smoking areas.
- **Cooking and heating appliances** should be used carefully and their use closely supervised. In particular, they should not be left unattended.
- **Mechanical heat** (such as friction from machinery and bearings) can be controlled by routine maintenance.
- **Deliberate ignition** can be controlled by making good security arrangements for the workplace. A perimeter fence, security staff at entrances, CCTV, security lighting, etc. can help.

Systems of Work

Systems of work must be designed to minimise fire risk. The degree to which this is done and the exact procedures implemented should be decided through the risk assessment process.

An example of a safe system of work applied to fire safety is the use of a permit-to-work system to control hot work (where naked flames or a significant ignition source will be created).

TOPIC FOCUS

Typical precautions for control of hot work include the following:

- Flammable materials are removed from the work area.
- Items that cannot be removed are covered with fire-retardant blankets.
- The floor is swept clean.
- Wooden floor is damped down.
- A suitable fire extinguisher is at hand.
- A 'fire-watcher' is present in the area.
- The work area is visited routinely after the work has finished to check the area for smouldering.

(Permit-to-work systems and hot work were discussed in some detail in Unit 1 Element 3.)

Good Housekeeping

Good housekeeping is fundamental to fire safety and is about keeping the workplace:

- **Waste-free** - by removing waste on a regular basis so that it does not build up and increase fire risk as a potential fuel source, (e.g. emptying full litter bins).
- **Tidy** - so that flammable and ignition sources are returned to safe storage after use, (e.g. solvent returned to the solvent store).
- **Well-ordered** - so that fuel and ignition sources are kept separate, (e.g. ensuring fan heaters are not obstructed).
- **Pedestrian routes clear** - so that they can be used in the event of a fire evacuation, (e.g. no obstructions by the office fire escape door).

Storage of Flammable Liquids

Many work activities require a limited quantity of flammable liquids to be held in the workplace, and these may be stored in suitable cabinets or bins of fire-resisting construction that are designed to retain spills.

> **DEFINITION**
>
> **FLASH POINT**
>
> The flash point of a liquid is the lowest temperature at which flammable vapour will form at the surface that can be ignited by the application of an external ignition source. Sustained combustion does not continue (the vapour burns briefly and then goes out).
>
> The lower the flash point, the lower the temperature at which it is possible to ignite the liquid.

All **flammable liquids** have a low 'flash point' (<60°C) and are therefore relatively easily ignited with an ignition source (such as a match) at normal room temperature.

Some of these liquids have very low flash points and so are labelled as 'highly flammable' or 'extremely flammable':

- Category 3 '**flammable liquids**' have a relatively low flash point (between 23°C and 60°C).
- Category 2 '**highly flammable liquids**' have a low flash point (<23°C) and a boiling point >35°C.
- Category 1 '**extremely flammable liquids**' have a low flash point (<23°C) and a boiling point <35°C.

(Note: the above classification and labelling is according to UN Globally Harmonised System and the **EU Classification, Labelling and Packaging of Chemicals Regulation**.)

Petrol (gasoline) is a common example of a highly flammable liquid. Quite simply, the lower the flash point, the more dangerous the substance, so it is essential that flammable liquids are used and stored safely. Because of the fire and explosion risk presented by flammable liquids, they are subject to additional legal control. In the EU, they are subject to the Explosive Atmospheres Directives (ATEX) which in the UK means they are classified as 'dangerous substances' under the **Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR)**. These Regulations sit alongside the **RRFSO** and impose a stricter regulatory regime on dangerous substances where significant fire and explosion risk exists.

Employers should determine the extent of the flammable atmosphere that could result from leaks and ensure all potential ignition sources are excluded.

Cabinets and bins storing flammable substances should be located in well-ventilated areas that are:

- away from the immediate processing area where possible; and
- do not jeopardise the means of escape from the area.

Flammable liquids should be stored separately from other dangerous substances that may increase the risk of fire or compromise the integrity of the container, such as oxidisers.

The recommended maximum quantities that may be stored in cabinets and bins are:

- no more than 50 litres for extremely or highly flammable liquids; and
- no more than 250 litres for other flammable liquids.

TOPIC FOCUS

Safe use of flammable liquids includes the following:

- Use the minimum volume of liquid required.
- Liquid should be in a properly labelled container.
- Ideally, the container will be metal with a self-closing lid.
- Use a metal tray to catch spills and have absorbent material available.
- Use away from heat and ignition sources.
- Ensure that workspace is well ventilated.
- Return containers to safe storage after use.

Safe storage of small volumes (extremely/highly flammable (<50 litres) or flammable (<250 litres)) in workrooms includes:

- Storing minimal volumes only.
- Closed containers.
- Storing in a purpose-built flammables cabinet. A flammables cabinet should:
  - Be fire-resistant (metal).
  - Have lockable doors and fire-resistant hinges and fastenings.
  - Be clearly signed.
  - Have a built-in catch tray.
- Storing away from potential ignition sources.

Safe storage of larger volumes of flammable liquid involves:

- Storing flammables in a purpose-built, single-storey flammables store, with segregated storage if necessary.
- The store built of non-combustible materials.
- The store having a lightweight roof for explosion relief.
- Ideally, the store built outdoors away from other buildings or having firewall protection.
- The store suitably fenced in a secure area.
- All electrical systems intrinsically safe.
- All other ignition sources eliminated.
- The store being well ventilated at high and low levels.
- All access doors lockable with sill to contain spillages.
- Adequate fire-fighting equipment.
- Suitable fire safety signs.
- Regular checks for security, secure and safe storage, leaks of liquids, etc.
- Having clear, safe access for the fire service together with adequate means of escape.

Structural Measures for Preventing the Spread of Fire and Smoke

Scenario

If a fire starts on the ground floor of a large, open-plan, multi-storey building that has open stairwells, **convection** will drive the hot smoke from the fire upwards. The smoke will fill the ground floor of the building and then rise up each of the open stairwells. Each stairwell will, in effect, become a chimney. The hot smoke will then fill the upper storeys of the building. The fire will not be contained and will spread through the building. The building will be destroyed or suffer severe damage. Any people in the building, especially in the upper storeys, will become trapped and die as a result of fire and smoke inhalation because they will not have time to escape and their escape route (the stairwells) will be full of smoke and flames.

Compartmentation

This is obviously not a desirable scenario. If fire prevention does not work and a fire does start in a building, then it should be contained and prevented from spreading. This can be done by designing the building in such a way that it is divided up into separate **compartments**, each surrounded by fire-resistant materials that can resist the spread of smoke and flame.

This **compartmentation** is done at the initial design and build stage but may also have to be done if a building is changed or modified. Local **building regulations** play a significant part in applying high standards of compartmentation to workplaces. This is why it is necessary to obtain building regulation approval for new buildings and some alterations to existing premises.

If the multi-storey building in our scenario is compartmentalised, when the fire starts on the ground floor it will be contained in one part of the building. This will give time for the fire to be detected, the alarm raised and the building evacuated. Containment may result in the fire dying down or even going out as a result of oxygen starvation. If this does not happen, then the fire will eventually break through the containment, but this will take time.

Constructing walls, floors and ceilings out of fire-resistant materials and ensuring that the building is broken up into appropriate compartments is only fully effective if any openings in the compartment walls are sealed.

Since people have to move through buildings, doors must be fitted to openings. These doors must be built to withstand the spread of smoke and flames. Such doors are known as **fire-resisting doors (fire doors)**.

Typical characteristics of a fire door include being:

- Rated to withstand fire for a minimum period of time, (e.g. 30 minutes).
- Fitted with:
  - A self-closing device.
  - An intumescent strip.
  - A cold smoke seal.
  - A vision panel of fire-resistant glass.
- Clearly labelled, (e.g. 'Fire Door - Keep Shut').

DEFINITIONS

INTUMESCENT STRIP

A strip built into the edge of a fire door that expands when it gets hot (>200 °C), sealing the gap between the door and the door frame.

COLD SMOKE SEAL

A plastic or foam strip that seals the gap between the door and frame at all times to prevent the spread of smoke.

Note that these are typical characteristics of fire doors and the actual specification will vary according to need.

Higher-specification fire doors may be needed to:

- Contain fire within compartments that contain greater fire risk, (e.g. a flammables store room).
- Keep fire out of compartments that contain fire-sensitive contents, (e.g. a IT server room).

Most fire doors are fitted with a self-closing device that pulls the door shut once a person has walked through it. Some fire doors are fitted with electromagnetic openers that keep the fire door open at all times. If the fire alarm activates or the electrical supply to the opener is interrupted, then the door is released and closes. This type of door is common in corridors with heavy pedestrian traffic where a normal fire door would be an obstruction.

Properties of Common Building Materials

Fire affects different building materials in different ways. The use of building materials, therefore, has to be tightly controlled to ensure that appropriate materials are used in a structure. For example, fire compartments must be robust enough to withstand the spread of fire for their design time, and structural elements in a building should not fail quickly when they are heated in a fire. Again, building regulations contain many requirements that relate directly to this fire safety issue:

- **Concrete** - usually very resistant to fire and does not collapse catastrophically. It may 'spall' (throw off small chunks).
- **Steel** - severely affected by high temperatures. Expansion may occur, pushing structural elements apart. Steel may also twist and warp; it can lead to sudden catastrophic building collapse.
- **Brick** - usually very resistant to fire (bricks are made by exposure to very high temperatures in a kiln). They may 'spall'.
- **Timber** - thin timber, such as floor boards, will burn, but thick timber, such as structural beams, may not fully burn in a building fire (a layer on the outside of the timber will char and protect the inner core). Thick timber is unlikely to fail suddenly, but will do so slowly.

To overcome the problems associated with using steel as a structural material, it is usually encased in concrete or coated with a fire-retardant foam or paint (intumescent paint) that insulates it from excessive heat.

Other materials can make a difference to fire resistance and the behaviour of a fire in a building, for example:

- **Insulation**, (e.g. wall insulation) can be combustible so fire-retardant versions must be used.
- **Wall coverings**, (e.g. paint and wallpaper) can make a difference to the way fire spreads across surfaces, so should also be closely controlled.

Protection of Openings and Voids

We have already noted that fire doors are used to ensure that door openings are protected in the event of fire. However, buildings, and the fire compartments that they are made up of, will inevitably have numerous voids and openings running through them, such as lift shafts, service conduits, air-handling ducts, voids between floors, roof voids, etc. and all of these need to be protected to ensure that smoke and flames cannot easily travel from one compartment to another. This protection can be done in many different ways, e.g. a self-closing shutter held open by a fusible link (a piece of soft metal that melts at a very low temperature, releasing the shutter). It is important that any new openings made in fire break walls are reinstated or protected in some way, e.g. when cables are run through a hole in a wall, the hole might be filled with fire-retardant foam.

Use of Electrical Equipment in Flammable Atmospheres

Electrical equipment sited in an atmosphere containing a mixture of dangerous substance and air could well ignite that explosive atmosphere if it is not built to the correct specification. For example, a standard UK mains voltage 230v inspection lamp taken into a storage tank containing petrol vapour would act as the ignition source for that petrol vapour.

Legislation, such as the **European ATEX directives**, governs the control of flammable atmospheres and the use of electrical equipment in those areas. In the UK, the **Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR)** requires that the employer must classify hazardous locations into **zones** and must then control the fire and explosion risks as appropriate.

TOPIC FOCUS

Hazardous Area Classification

For gases, vapours and mists, the zone classifications are:

- **Zone 0** - a place in which an explosive atmosphere is present **continuously**, or for long periods, or frequently.
- **Zone 1** - a place in which an explosive atmosphere is **likely to occur** in normal operation occasionally.
- **Zone 2** - a place in which an explosive atmosphere is not likely to occur in normal operation but, if it does occur, will persist for a **short period only**.

There are corresponding standards for dust explosion hazards - these are called Zone 20, Zone 21 and Zone 22.

One possible ignition source is electrical equipment, so the employer must select the appropriate work equipment for use in zoned areas. In the EU, the **ATEX Directive** sets standards for the specification of electrical equipment that is intended for use in classified hazardous areas. In the UK, this is achieved by the **Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations 2016**.

Electrical Equipment	Zone
Category 1	Zone 0 or Zone 20
Category 2	Zone 1 or Zone 21
Category 3	Zone 2 or Zone 22

MORE...

The HSE website contains more information on fire and explosion:

www.hse.gov.uk/fireandexplosion/index.htm

Note that Category 1 equipment can be used in Zones 1 and 2 as well, and Category 2 equipment can be used in Zone 2. Such electrical equipment will be marked with an Ex sign in a hexagon, with a number indicating the category. Electrical equipment described as **intrinsically safe** is Category 1 and therefore safe to use in Zones 0, 1 and 2.

National General Certificate Legal Standards	International General Certificate Standards
• Regulatory Reform (Fire Safety Order) 2005. • Fire Safety (Scotland) Regulations 2006. • Fire Safety Regulations (Northern Ireland) 2010. • Dangerous Substances and Explosive Atmospheres Regulations 2002. • Dangerous Substances and Explosive Atmospheres Regulations (Northern Ireland) 2003. • Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations 2016. • Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations (Northern Ireland) 2017.	• ILO C155 - Occupational Safety and Health Convention, 1981 (No. 155). • ILO R164 - Occupational Safety and Health Recommendation, 1981 (No. 164).

STUDY QUESTIONS

7. Outline measures to minimise the risk of fire in a woodworking area.
8. Identify the precautions that should be taken when using flammable liquids.
9. Outline the effects of fire on an unprotected steel beam.
10. Outline the typical characteristics of a fire door.

(Suggested Answers are at the end.)

Fire Alarm System and Fire-Fighting Arrangements

IN THIS SECTION...

- When a fire starts in a building, there must be an appropriate system to detect the fire early and raise the alarm with building occupants. A range of detection and alarm systems exist, with larger workplaces having fully automatic fire alarm systems relying on automated smoke or heat detectors linked into a central control system, in turn linked to alarm sounders/indicator lights.
- There must also be portable fire extinguishers available so that people can fight the fire if necessary. Fire extinguishers contain different extinguishing media, such as water, carbon dioxide, foam, dry powder and wet chemical. Each type of extinguisher is designed for use on specific classes of fire in different circumstances and each has strengths and limitations.
- All portable fire extinguishers must be inspected and maintained routinely to ensure safe operation. Training should be provided to users so that they are able to use extinguishers safely and effectively.

Fire Detection and Alarm Systems

One of the most critical factors in determining whether people live or die in a fire in a workplace is how quickly the fire is detected and how quickly people are alerted. This is also a critical factor in determining how easily the fire will be controlled and extinguished.

Ideally, fires will be detected as soon as they start, and building occupants will be alerted to the presence of the fire immediately, so that an appropriate response can be mounted. This response should usually be a full building evacuation and a call to the local fire service.

It is, therefore, essential that an appropriate fire detection and alarm system is used in a workplace. The exact type of system used will be subject to the fire risk assessment, local building regulations, guidance and standards, but some general principles can be applied:

Fire alarm

- **The simplest system** - in a very simple, low fire-risk workplace where all parts of the workplace can be seen by the occupants and there is no great fire risk, then no detection or alarm system may be required. If there is a fire, people will see the fire and shout 'fire'. This may be acceptable as long as the workplace is not so large that some people would not hear that shout.
- **Simple with more noise** - if the workplace is simple and low-risk, but large enough that building occupants might not hear a shouted alarm, then a hand-operated alarm might be used (such as a hand bell, whistle or air horn).
- **Manually-operated fire alarm** - the next step up is a fire alarm system that can be manually activated from call points. These call points are usually buttons behind a clear plastic disc that, when hit, breaks and activates the system. The system will have a central control box and sounders (and/or lights) at positions throughout the workplace that give the alarm.
- **Interlinked smoke alarms** - if there are rooms (such as plant rooms or stores) that are not normally occupied (so a fire might start there and no-one would notice), then a simple automatic detection and alarm system might be fitted, made up of interlinked smoke alarms. This consists of individual ceiling-mounted units that detect smoke from the fire and give the alarm sound. These are linked together so that when one sounder activates, all of the sounders emit the alarm.

- **Automatic fire detection and alarm** - a system made up of automatic detectors and manual call points linked into a central control box, linked in turn to sounders (and/or lights). If a person sees the fire, they can activate a manual call point and raise the alarm. If there is no person present, then the automatic detectors will activate the system and raise the alarm. This type of system is commonly used to protect medium- to high-risk workplaces, multi-storey buildings and workplaces where sleeping accommodation is provided (such as care homes).

An automatic fire alarm system can be quite simple or very complicated, depending on the workplace in which it is installed. In some workplaces, the building is subdivided into zones and the fire alarm system can give different warning sounds in different zones, depending on which zone the fire was detected in. In this way, phased (or staged) evacuations (see later) can be achieved.

The type of automatic fire detector that is used with a fire alarm system also varies, depending on the situation:

- **Smoke detectors** are very common, and:
  - Detect small smoke particles, are usually very sensitive and give early warning.
  - Are of two main types: ionising and optical.
  - Can give rise to false alarms if used in a humid, wet, dusty or smoke-filled atmosphere.
- **Heat detectors** are more suitable for certain applications, and:
  - Detect the excess heat generated by a fire, are usually less sensitive and give later warning.
  - Come in two main types: rate of rise and fixed temperature.
  - May not detect smouldering fires that are giving off smoke but not much heat.

Smoke detector

Portable Fire-Fighting Equipment

If a fire starts in a workplace, it may be possible to extinguish that fire quickly and effectively using a portable fire extinguisher. This might be done with minimal risk to the user, so preventing the fire from escalating, potentially saving life and property. If there is no portable fire extinguisher present, there will be no choice but to leave the fire to burn out of control.

ABC powder fire extinguisher

In addition to the portable extinguishers, other fire-fighting equipment can be found in workplaces, such as:

- **Fire blankets** - used to physically smother small fires. Very useful for cooking areas where fat fires might occur and also for smothering burning clothing.
- **Hose reels** - sited in buildings to allow fire teams to fight fires.
- **Sprinkler systems** - sited in buildings and warehouses to automatically dowse a fire.

Extinguishing Media

Fire extinguishers can contain different extinguishing media depending on the class of fire that they are intended for use on (in the EU regime, Classes A-F). The class of fire is indicated on the extinguisher using a symbol and letter. The fire extinguisher may also be labelled with the medium that it contains. Fire extinguishers are usually coloured red.

(In the UK, a colour-coding system was historically used for extinguishers to enable quick recognition of the different types, and this colour-coding has been retained to a degree - a small part of the body of the extinguisher, or the label, may be colour-coded.)

TOPIC FOCUS

The following types of portable fire extinguisher are commonly found in workplaces:

- **Water** - suitable for Class A fires. It works by cooling the fire. A standard water extinguisher is not suitable for use on Class B, D or F fires or live electrical equipment (this might lead to risk of shock). Certain specialised water extinguishers are available for use on Class B and F fires.
- **Carbon dioxide** - suitable for Class B fires and fires involving live electrical equipment. It works by smothering the fire. It is not suitable for use on Class D or F fires. It must be used with care because the body of the extinguisher gets very cold during use and can cause a freeze-burn injury. Carbon dioxide is an asphyxiant gas and so care must be exercised when using in an enclosed space.
- **Foam** - suitable for Class A and B fires. It works by smothering the fire or by preventing combustible vapours from mixing with air. Some specialist foam can be used on electrical fires but, again, you must be certain that you are using the right type. As the foam is wet, it is not suitable for Class F hot fat fires.
- **Dry powder** - suitable for all classes, with the exception of Class F, and use on live electrical equipment. It works by cooling the flames and may chemically interfere with the combustion process. It can be very messy and the powder must not be inhaled.
- **Wet chemical** - specifically designed to deal with high-temperature (>360°C) oil/fat fires (Class F). It reacts with burning oil to form thick suds, cooling and emulsifying the oil, putting out the flames and sealing the surface.

Classes of fire and extinguishing media

Siting, Maintenance and Training

Fire extinguishers should be positioned on fire exit routes, near exit doors and close to the specific hazard that they are provided to protect against (e.g. a fire blanket close to a gas hob in a kitchen). Ideally, no-one should have to travel more than 30 metres to reach an extinguisher. They should be fixed to the wall at a comfortable height (usually 1 metre for larger extinguishers and 1.5 metres for smaller ones) or may be on stands/trolleys. They should be clearly visible and signed.

Fire extinguishers must be **inspected and maintained** routinely to ensure that they are always available in safe working order:

- **Frequent routine inspections** - ensure that extinguishers are present at their designated positions and that they appear to be in good order (with their firing pin still tagged in place). This might be done as part of a routine housekeeping inspection or as a specific fire safety check, perhaps by fire wardens.
- **Planned preventive maintenance** - ensure that they remain in safe working order. This is normally carried out on an annual basis by a certificated engineer and may involve inspection, testing and dismantling (depending on the type of extinguisher).

Records should be kept of visual inspection and maintenance checks carried out.

Workers who might have to use portable fire extinguishers should be trained in safe use. This will be determined by the fire risk assessment. This training should include theoretical training (classroom-based) but should also include some practical training. This will normally involve workers using real fire extinguishers to put out real fires, set up under controlled circumstances either at the workplace or at a training centre. A typical training course would include:

- General understanding of how extinguishers operate.
- Importance of using the correct extinguisher for different classes of fire.
- Practice in the use of different extinguishers.
- When to tackle a fire, and when to leave it alone.
- When to leave a fire that has not been extinguished.

Records should be kept of training provided.

As always, local legislation and code of practice will influence fire extinguisher provision, siting, maintenance and training.

Access for Fire and Rescue Services

Fire-fighting vehicles need to be able to get close to the perimeter of a building so they can position and deploy high-rise equipment, such as turntable ladders, hydraulic platforms and pump appliances with fire hoses. Fire regulations in some countries may place a duty on occupiers of premises to maintain such access.

The requirements for vehicle access differ depending on the presence of fire mains (a water-supply pipe installed specifically for fire-fighting purposes), the size of the building and the type of fire-fighting vehicle to be used. For example, in the UK, for **small buildings** without a fire main, access for a pump appliance should be provided to 15% of the perimeter or to within 45 metres on every point on the building surrounds; for **large, high-rise buildings**, the entire perimeter will need to be accessible to fire-fighting appliances.

Access for vehicles must be kept clear at all times and any people assembling outside of buildings during a fire evacuation must be kept clear of fire-fighting vehicles and fire-fighters so as not to impede their access.

Fire-fighters need to have information relating to the contents of the building and any hazardous materials or processes and facilities that might create a risk to them while they carry out their duties. The emergency plan that the company has in place should include arrangements for nominated and competent persons to liaise with the fire service on their arrival.

It is quite usual for the fire and rescue service to carry out familiarisation visits at industrial premises or premises where there is sleeping accommodation, such as hospitals or care homes.

STUDY QUESTIONS

11. Identify the limitations of manual alarm systems and how they may be overcome.
12. Identify the two main types of automatic fire detector.
13. Outline the main points to be covered in training in the use of fire extinguishers.
14. Identify the three ways of extinguishing a fire.
15. Identify the classes of fire for which each of the following extinguishing agents/devices is suitable:
    (a) Water.
    (b) Carbon dioxide gas.
    (c) Dry powder.
    (d) Foam.
    (e) Fire blankets.

(Suggested Answers are at the end.)

Evacuation of a Workplace

IN THIS SECTION...

- The means of escape is the route that a person will take from wherever they happen to be in a building to a safe place outdoors.
- There are many factors that influence the means of escape, such as: travel distances, number of available escape routes, escape route width, design of any doors in the escape route and provision of suitable assembly points.
- In particular, the means of escape must be properly signed and provided with emergency lighting (if necessary).
- Every workplace must have procedures to ensure the safe evacuation of people from buildings in the event of fire.
- These procedures will require nominated staff to carry out certain duties, such as to act as 'fire marshals' (or 'fire wardens'). These nominated staff should be trained in their specific role.
- Information on fire evacuation procedures should be provided to others as appropriate.
- Fire drills allow staff to practise their emergency response and allow management to monitor the effectiveness of emergency arrangements.
- Special procedures may be required to ensure the safe evacuation of the infirm or disabled.
- Means of escape should be shown on the plans of a building.

Means of Escape

When a fire emergency occurs and people have to evacuate a workplace, there must be one or more escape routes available for them to use. This escape route is the '**means of escape**'. Local regulations, codes of practice and standards vary in determining exactly what might be required in each specific circumstance, but the following general principles can be applied:


Means of escape

- There should be a means of escape available to every person in a workplace, whether they are in an office, workroom, plant room, basement, on the roof or on a scaffold on a construction site.
- The means of escape should allow an able-bodied person to travel the entire route by their own unaided effort. They should not have to use machinery (such as a passenger lift) except in special cases (when the machinery must be rated for escape purposes).
- The means of escape must take a person from wherever they are in the workplace to a place of total safety outside the building where they are able to move away unrestricted.
- Two or more separate escape routes may have to be provided so that if one route is blocked, there is another available. This is common in high-occupancy, multi-storey buildings.
- The travel distance that a person has to cover, from their location in the building to the final exit out of the building, should be as short as possible (and must normally meet maximum distance criteria).
- The width of corridors, passageways and doors should be sufficient to allow the free and fast movement of the numbers of people that might be anticipated (and must normally meet minimum width criteria).
- The escape route should be clearly signed and appropriately lit. Emergency lighting should be provided where necessary (in case the mains power supply fails).
- The route that a person has to take should be unimpeded by obstructions, such as stored material or inappropriate doors.

Many factors affect the exact specification of the means of escape. Two important factors are the **number of people** that will be occupying any given room or area and the general **level of fire risk** of the workplace.

Travel Distances

One important characteristic of the means of escape is the **travel distance** that a person has to take from wherever they are in a room or area to the nearest available:

- Final exit (this will take them outside the building to a place of total safety).
- Storey exit (this will take them into a protected stairway).
- Separate fire compartment (containing a final exit).

This travel distance has to be assessed during the fire risk assessment when determining the means of escape and is subject to guidance. Generally, the higher the fire risk of the workplace, the shorter the travel distance has to be.

The number of exits is another important characteristic of the means of escape. In some instances, it may be acceptable to provide just one exit route from a room or area. However, if the fire risk is high, or if number of occupants is high (>60) or if travel distances are long, then two or more exits must be provided. The underlying principle of having two exits is that a person can turn in two completely different directions and then has two completely separate routes through and out of the building.

So, for example, the means of escape for a low-risk workplace with a small number of employees present, (e.g. 10) might consist of one exit involving a long travel distance (e.g. up to 45 metres). Whereas this would be unacceptable for a high-risk workplace with a large number of employees, (e.g. 200) where several alternative exits with short travel distances (e.g. <25 metres) would be required.

Stairs and Passageways

Stairs and passageways used as means of escape usually have to be protected against fire ingress to a higher degree than other parts of a building. This is to ensure that the stairs and corridors will be free of smoke and flame, so that they can be used as escape routes. So, the walls, floor and ceiling will be fire-resistant and any doors will be fire doors. It is important that these stairs and corridors are kept free of any equipment or materials that might start, or become involved in, a fire.

The width of stairs and corridors should be determined by the number of people who are going to use the route for escape. Higher numbers of people require wider corridors and stairs to move safely and quickly. For example, generally, escape routes should not be less than 750mm wide unless they are to be used by fewer than five people. Escape routes for use by wheelchair users must be wider (minimum 900mm).

Doors

Doors in the means of escape must be suitable. This means:

- Easily operated by a person in a hurry.
- Wide enough to allow unimpeded passage.
- Open in the direction of travel (though this is not a strict requirement where occupancy numbers are low).
- Can be opened at all times when they might be needed (not locked with a key or in such a way that a person inside cannot open them).
- May be fitted with a vision panel so that smoke and flames can be seen the other side of the door before it is opened.

Emergency (Escape) Lighting

Escape routes must be adequately lit. Normal workplace lighting will routinely achieve this, but there should be arrangements to cover non-routine situations, such as power failures. This is especially the case when night-time working is taking place or when the work area is internal to the building or has no external windows (i.e. no natural light).

Emergency escape lighting is necessary where power failure will result in blackout. In very simple workplaces this may be a rechargeable torch, but in most workplaces emergency lighting units are required.

Emergency escape lighting should:

- Illuminate the escape route.
- Illuminate fire signs and equipment.
- Be maintained in safe working order.
- Be tested routinely.

Routine testing usually takes the form of a monthly function test (to check that the light illuminates) and an annual discharge test. Records of maintenance and tests should be kept.

Exit and Directional Signs

The escape route should be easy to follow. Signs should be provided so that people can see their available escape routes quickly and easily, leading all the way to the final exit, also signed. These signs should meet the requirements of local legislation. For example, in the UK, the **Health and Safety (Safety Signs and Signals) Regulations 1996** that were discussed in Unit 1, establish the EU standard shape (rectangular), colour (green) and pictogram (which might be an arrow, a running man and a final exit door). They must be carefully selected and fixed so that they are very easy to interpret. Some signs, especially in critical positions, can also incorporate escape lighting, while others may be photoluminescent (signs that 'glow in the dark').

A fire escape sign and escape light

Assembly Points

An assembly point is a place where workers congregate once they have evacuated a building. This allows for a roll call to be taken and identification of any missing persons. Assembly points should be in a place of total safety:

- A safe distance from the building (it may be on fire).
- At a safe location (not in a high-hazard area).
- At a location where people can move further away if needed.
- Out of the way of fire-fighters.
- Clearly signed.

In some cases, a temporary assembly point or '**refuge**' may be provided inside a building. This might be used as a location where a person with impaired mobility temporarily waits for assistance to evacuate the building.

Assembly point sign

DEFINITION

REFUGE

A protected location (normally on, or adjacent to, a main means of escape) where people can wait for a short time.

Emergency Evacuation Procedures

Every workplace should have arrangements in place to deal with fire emergencies, including:

- evacuation procedures,
- nominating responsible staff to fulfil certain roles,
- training staff and providing information to visitors and members of the public, and
- conducting drills to test procedures.

Emergency procedures must be developed so that staff know what to do in the event of foreseeable fire emergencies. Appropriate procedures should tell people what to do if they discover a fire and what to do if the alarm sounds. These procedures are usually quite simple.

The emphasis in any procedure must be on personal safety and the key message must be to **sound the alarm, get out and stay out!**

Typical fire procedures

More complicated procedures may have to be developed for certain situations. For example, in a hospital, rather than use the basic approach given in our sample procedure, it might be more appropriate to carry out a **phased (staged) evacuation**. Here, only those in the immediate vicinity of the fire are evacuated at first, followed by a gradual evacuation falling back from the seat of the fire. In this way, the large numbers of people and the practical issues associated with moving the infirm might be managed more easily.

Fire Marshals

Whatever the fire evacuation procedures are, there will always be the need for some members of staff to take on particular roles in the emergency situation, perhaps as nominated '**fire marshals**' (sometimes called 'fire wardens') to take roll calls of workers at assembly points and report back to a responsible manager.

Fire marshals might be required to:

- Check all areas in the building to ensure that everyone knows that an evacuation is in progress and to help where necessary. This is common practice in buildings where members of the public may be present, (e.g. shopping centres).
- Give special assistance to the disabled and infirm. This may require the use of special evacuation equipment, such as an 'evac-chair'.
- Investigate the site of the fire (as indicated by the fire alarm system control panel).

Some workplaces operate a '**fire team**' whose role involves investigation of fire alarms and fire-fighting.

High-risk installations may even have their own in-house fire-fighters with all the vehicles, equipment and resources that might be available to the emergency services, (e.g. at an airport or chemical plant).

Roll Call

Once workers and contractors have evacuated a building and collected at their assembly points, it is usual to take a roll call to ensure that all persons are accounted for and no-one is missing. This means that arrangements must be made for taking an effective roll call; accurate lists of names of those on site must be produced and responsible individuals given the task of taking the roll call.

In some cases, e.g. in shopping centres, a roll call will be impractical, in which case an alternative method of ensuring that people have evacuated from the workplace will be required, (e.g. building checks by fire marshals).

Provision for the Infirm and Disabled

Staff with hearing or other disabilities must be accommodated within an evacuation plan. Plans must be in place to assist people with mobility problems or in wheelchairs who cannot use stairs if a lift is inactivated (in many cases, lifts and escalators are not appropriate as escape routes).

Provision must be made for the needs of other groups with limited mobility, such as the elderly or infirm. Temporary illness and infirmity must also be taken into account, e.g. a worker with a broken leg must be accommodated in the evacuation plan.

When these arrangements are put in place, the nature and degree of disability or infirmity must be taken into account, and this is best achieved in consultation with the individual concerned. Various solutions might then be sought.

For example:

- A worker with some hearing impairment might be capable of hearing the audible fire alarm in their work area, so no special arrangements are required.

- A profoundly deaf worker might not be able to hear the audible fire alarm, in which case a visible alarm (flashing light) might be used in conjunction with the audible alarm. Or a buddy system might be adopted where a colleague alerts the worker to the fire alarm. Or a technical solution might be sought involving a vibrating pager.
- A wheelchair user above ground level in a multi-storey building might be provided with a refuge adjacent to the stairwell. They might then be assisted down the stairs by nominated responsible individuals, perhaps with the aid of an 'evac-chair'. It must be noted that they should not be left alone in the refuge and that their safe evacuation is the responsibility of their employer, not the fire and rescue service.

In many instances, the specific arrangements for safe evacuation of a disabled person will require the development of a personal emergency evacuation plan. This should always be done with consideration of the personal dignity of the individual concerned. Note that it is important to take other employment law, such as disability discrimination law, into account. For example, in the UK, the **Equality Act 2010** makes it potentially unlawful to discriminate against someone on the basis of their disability.

Building Plans and Emergency Escape

The means of escape should be shown on plans of the building. These plans usually constitute one of the records of the fire risk assessment. In some instances, building plans should be posted up in the building so that people in the building can clearly see what their escape route should be, (e.g. in hotel rooms).

TOPIC FOCUS

Fire Plans

The following factors should be considered when developing a fire plan:

- Details of who is likely to be in the building:
  - Workers.
  - Visitors.
  - Contractors.
  - Vulnerable persons.
- Action to be taken by the person who finds the fire:
  - How will the alarm be raised?
  - How will the emergency services be contacted (will this be an automatic system or will someone be required to phone the fire service)?
- Escape routes:
  - Number and location.
  - Travel distances.
  - Provision of fire exit route signs.
  - Emergency lighting of escape corridors and stairwells.

(Continued)

TOPIC FOCUS

- Fire-fighting equipment:
  - Provision of portable equipment (types and location).
- Action to be taken after evacuation:
  - Roll call.
  - Fire marshals to check building is evacuated.
- Training in:
  - Use of equipment.
  - Fire drills.
  - Co-operation with other employers on site.

Training and Information

All employees in a workplace should be provided with basic information about fire safety in general and the fire procedures in particular. This should be done at induction and might be repeated periodically or as the need arises.

Information on fire procedures should also be provided to contractors and visitors, perhaps through contractor or visitor induction training programmes, or by providing written information.

Informing members of the public about fire procedures can be more of a problem since, in many workplaces, they can walk in off the street and there is no opportunity for providing written information, (e.g. at a shopping centre).

In these circumstances, a public address system may be the best way of keeping the public informed of an emergency situation and the action that they should take.

Appropriate additional training should be provided to staff who:

- Might have to use portable fire extinguishers or other fire-fighting equipment.
- Have a fire marshalling role.
- Will be assisting infirm or disabled people during an evacuation.
- Are members of the fire team.

Records of all training should be kept. Employers must take into account the health and safety capabilities of employees when entrusting them with fire safety tasks. This will apply at all levels of employee training, including competent persons, fire marshals, etc.

Fire Drills

Fire evacuation arrangements need to be tested by carrying out fire drills. Generally, fire drills should be conducted annually (the actual frequency should be determined by the fire risk assessment).

Fire drills:

- Allow workers to practise emergency procedures.
- Enable the effectiveness of procedures to be tested to ensure that fast, effective evacuation of the building takes place and that all workers behave in an appropriate manner.

Records of fire drills, learning points and follow-up actions should be kept.

National General Certificate Legal Standards	International General Certificate Standards
• Regulatory Reform (Fire Safety Order) 2005. • Fire Safety (Scotland) Regulations 2006. • Fire Safety Regulations (Northern Ireland) 2010. • Health and Safety (Safety Signs and Signals) Regulations 1996. • Health and Safety (Safety Signs and Signals) Regulations (Northern Ireland) 1996.	• ILO C155 - Occupational Safety and Health Convention, 1981 (No. 155). • ILO R164 - Occupational Safety and Health Recommendation, 1981 (No. 164). • ISO 7010: International standard for safety signs.

STUDY QUESTIONS

16. Identify the purpose of signs used on escape routes.
17. Outline the main requirements for an escape route.
18. What is an assembly point and how might it differ from a refuge?
19. Outline the responsibilities of fire marshals during a fire evacuation.
20. What might take place at an assembly point following an evacuation?

(Suggested Answers are at the end.)

Summary

This element has dealt with some of the hazards and controls relevant to fire in the workplace.

In particular, this element has:

- Outlined some of the basic principles of fire safety, such as: the fire triangle, the five classes of fire, the methods by which fire can spread, and some of the common causes of workplace fires.
- Described the reasons for carrying out a fire risk assessment, and shown fire risk assessment as a five-step process of identifying fire hazards: identifying the people who might be at risk; evaluating, identifying and implementing fire precautions required; recording the findings, planning and training; and reviewing the assessment as necessary.
- Explained how fire and the spread of fire can be prevented by controlling potential fuel sources, (e.g. safe use and storage of flammable liquids) and potential ignition sources, (e.g. hot work).
- Outlined the structural measures that exist to contain fire and smoke in the event of a fire starting, and the use of self-closing fire doors to protect door openings.
- Described the general principles of fire detection and alarm systems.
- Discussed the main types of fire extinguisher commonly used, such as water, carbon dioxide, foam and dry powder, and the strengths and limitations of each type.
- Outlined the principal characteristics of a means of escape, such as: travel distances, number of available escape routes, escape route width, design of any doors in the escape route, assembly points, signage and emergency lighting.
- Described basic requirements for evacuation procedures, fire marshals, training and information, the capabilities of employees, fire drills and special procedures for the infirm or disabled, and the inclusion of escape routes in building plans.

Exam Skills

QUESTION 1

(a) **Identify TWO** ways in which an alarm can be raised in the event of a fire. **(2)**

(b) **Identify** the issues to consider in the selection and siting of portable fire extinguishers. **(6)**

Approaching Question 1

Think now about the steps you would take to answer the question:

Step 1. The first step is to **read** the question carefully. Note that this question asks you to identify how an alarm can be raised and issues in selection and siting of extinguishers.

Step 2. Now, highlight the **key words**. In this case, they might look like this:

(a) **Identify TWO** ways in which an **alarm** can be **raised** in the event of a **fire**. **(2)**

(b) **Identify** the **issues** to consider in the **selection** and **siting** of **portable fire extinguishers**. **(6)**

Step 3. Next, consider the **marks** available. In this question, there are eight marks, so it is expected that around eight or nine different pieces of information should be provided. The first part specifically asks for two pieces of information, therefore if you provide more than two, only the first two will be marked. The question should take around eight minutes in total.

Step 4. **Read** the question again to make sure you understand it and have a clear understanding of ways to raise the alarm in the event of a fire and the issues in selecting and siting portable fire extinguishers. (Re-read your notes if you need to.)

Step 5. The next stage is to develop a **plan** - there are various ways to do this. Remind yourself, first of all, that you need to be thinking about 'ways to raise the alarm' and 'selection and siting of extinguishers'. When you see the command word 'identify', you need more than just a list. You must select and name the ways or issues given in your answer. So, the answer plan will take the form of a bullet-pointed list of which we need a brief explanation.

Your answer must be based on the key words you have highlighted. So, in this case, we need to identify two ways to raise an alarm and identify issues in selection and siting of portable extinguishers.

Now have a go at the question. Draw up an answer plan, and then use it as the basis to write out an answer as you would in the exam.

HINTS AND TIPS

Do not write several sentences for part (a) because it's only worth two marks and you may not leave enough time to pick marks up on the second part of the question.

Remember, you can always contact your tutor if you have any queries or need any further guidance on how to answer this question.

When you have finished, compare your plan and full answer with those that follow.

Suggested Answer Outline

Raise the Alarm (Two needed)
• Shouting. • Automatic through smoke/heat detection. • Manually operated break-glass alarms. • Handbell/klaxon/horn.
Selection
• Type of extinguisher for class of fire. • Number/size to be provided. • Size of premises. • Number of floors.
Siting
• Ease of access. • Visibility. • Proximity to escape routes. • Fixed to wall or on stands/trolleys. • Exposure to weather or sources of damage. • 30m travel distance. • Same position on each floor in a multi-storey building.

Example of How the Question Could be Answered

(a) *Two ways that an alarm can be raised in the event of a fire are that smoke detectors may detect smoke and sound the alarm, or an employee may see a fire and break the glass in an alarm call point to activate the alarm.*

(b) *Issues to be considered in the selection of portable fire-fighting equipment include considering the class of fire the extinguisher is likely to be called into action to fight. The type of premises is also an issue in the selection process; it may be multi-storey or cover a large area. Issues to consider in the siting of extinguishers include the travel distance to get an extinguisher which must be under 30 metres, the need to provide extinguishers on escape routes, the visibility of the extinguisher, when the premises are occupied, if the location may cause the extinguisher to be exposed to weather or adverse conditions (fume), if there is a wall of sufficient strength to hold the bracket to wall-mount the extinguisher, or whether stands or trolleys are needed to hold the extinguishers.*

Reasons for Poor Marks Achieved by Candidates in Exam

- A lack of knowledge on the process of selecting or siting a fire extinguisher.
- Going into detail about classes of fire or types of extinguisher - this was not the question set.
- Not answering the question at all - if you make no attempt at an answer you will receive no marks.

QUESTION 2

Identify EIGHT different causes of typical fires in workplaces. **(8)**

Approaching Question 2

Think now about the steps you would take to answer the question:

Step 1. The first step is to **read** the question carefully. This time you have been asked to "identify" eight common causes of fire. You will remember that when asked to "identify", NEBOSH want you to 'select and name'.

Step 2. Now, **highlight** the key words. In this case, almost all of the words are critical:

Identify EIGHT different **causes** of typical **fires** in workplaces. **(8)**

Step 3. Next, consider the **marks** available. Here, you are asked for eight causes of fire - each will be worth one mark.

Step 4. **Read** the question again to make sure you understand the causes of fire in the workplace. (Re-read your notes if you have to.)

Step 5. The next stage is to develop a **plan** - you are now familiar with how to do this. The answer plan will take the form of a bullet-pointed list that you need to develop into a full answer based on the key words that you have highlighted.

Now have a go at the question. Draw up an answer plan, and then use it as the basis to write out an answer as you would in the exam.

When you have finished, compare your plan and full answer to those that follow.

Suggested Answer Outline

Causes of Typical Workplace Fires
• Discarded smoking materials. • Electrical faults/overheating. • Friction, e.g. grinding gears. • Blocked vents on electrical equipment. • Static discharge. • Welding and grinding. • Hot surfaces, e.g. cooker hotplates. • Arson. • Incorrect use of equipment. • Chemical reactions.

Example of How the Question Could be Answered

Eight common causes of workplace fires are:

- *Arson - many fires are started deliberately.*
- *Carelessly discarded smoking materials, possibly owing to smoking in unauthorised areas.*
- *Electrical faults resulting in overheating or overloading.*
- *Friction, e.g. grinding gears due to poor maintenance.*
- *Chemical reactions resulting in heat being generated.*
- *Static discharge igniting flammable vapours when handling solvents.*
- *Sparks while welding.*
- *Contact with intentionally hot surfaces, such as cooker hotplates.*

Reasons for Poor Marks Achieved by Candidates in Exam

- Giving several electrical causes of fire - only one mark would be available for electrical equipment.
- Not identifying the causes of fire - just the ignition source.

Element 7

Chemical and Biological Health Hazards and Risk Control

Learning Outcomes

Once you've read this element, you'll understand how to:

1. Outline the forms of, the classification of, and the health risks from exposure to, hazardous substances.
2. Explain the factors to be considered when undertaking an assessment of the health risks from substances commonly encountered in the workplace.
3. Explain the use and limitations of occupational exposure limits including the purpose of long-term and short-term exposure limits.
4. Outline control measures that should be used to reduce the risk of ill health from exposure to hazardous substances.
5. Outline the hazards, risks and controls associated with specific agents.
6. Outline the basic requirements related to the safe handling and storage of waste.

Contents

Forms of, Classification of, and Health Risks from Hazardous Substances

IN THIS SECTION...

- Chemicals are encountered in different physical forms, such as solids, dusts, fumes, gases, mists, vapours and liquids.
- This significantly affects how these substances might enter the body.
- Biological agents, such as fungi, bacteria and viruses, can be hazardous to health.
- Chemicals are classified according to their health effects as: acute toxicity, skin corrosion/irritation, eye corrosion/irritation, respiratory or skin sensitisation, carcinogenicity/mutagenicity/reproductive toxicity, and specific target organ toxicity.
- Hazardous substances often have an acute or short-term health effect, or they may have a chronic or long-term health effect. Or they may have both.

Introduction to Health Risks from Hazardous Substances

Exposure to chemical and biological health hazards can cause an immediate health risk, (e.g. asphyxiation from carbon monoxide (CO) gas) or even physical injury, (e.g. corrosive skin burn from sulphuric acid). Less obviously, exposure can also have long-term health effects, which may build gradually over time, (e.g. lead poisoning) and, in some instances, will not be apparent until years after the exposure that caused them, (e.g. lung cancer caused by asbestos). We will now look at the forms and classification of chemicals and biological agents that cause these short-term and long-term health effects.

Forms of Chemical Agents

The physical form of a chemical makes a big difference to how easy it is for that chemical to enter the body. For example, a bar of stainless steel contains hazardous metals such as chromium and nickel, but they cannot enter the body when the bar is in its solid, massive state. But, if the bar is welded, then a welding fume is generated and these metals become airborne; now they can be inhaled into the lungs.


Large dust cloud created by disc cutting concrete

The physical forms of chemicals are:

- **Solid** - a solid block of material, (e.g. a lead ingot).
- **Dust** - very small solid particles normally created by grinding, polishing, milling, blasting, etc. and capable of becoming airborne, (e.g. flour dust, rock dust).
- **Fume** - very small metallic particles that have condensed in the air during work with molten metal, (e.g. welding) to create an airborne cloud.
- **Gas** - a basic state of matter; it expands to fill the space available, (e.g. carbon dioxide).
- **Mist** - very small liquid droplets suspended in air, normally created by spraying, (e.g. paint spraying).
- **Vapour** - the gaseous form of a substance that exists as a solid or liquid at normal temperature and pressure, (e.g. vapour given off by acetone solvent).

- **Liquid** - a basic state of matter; free-flowing fluid, (e.g. water at 20°C).
- **Fibres** - thread-like particles that are very small and can become airborne, (e.g. asbestos).

Forms of Biological Agents

Biological agents are micro-organisms, such as:

- **Fungi** - moulds, yeast and mushrooms. Most are harmless to humans, but some can cause disease, such as fungal infections, (e.g. athlete's foot) and farmer's lung (an allergic irritation caused by inhaling mould spores).
- **Bacteria** - single-celled organisms that are found in vast numbers in and on the human body. Some are harmless, some are beneficial, (e.g. certain gut bacteria) and some cause disease, (e.g. Legionnaires' disease caused by the *Legionella* bacteria).
- **Viruses** - very small infectious organisms that reproduce by hijacking living cells to manufacture more viruses. Many cause disease, (e.g. hepatitis B, caused by the hepatitis B virus).

Classification of Chemicals Hazardous to Health

Chemicals can be broadly classified according to three types of danger:

- **Physico-chemical** - such as highly flammable, explosive or oxidising.
- **Health** - such as toxic or carcinogenic.
- **Environmental** - such as harmful to aquatic life.

In the UK and the EU, the classification of hazardous substances supplied into a workplace is covered by the **European Regulation (EC) No. 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures (CLP Regulation)**. This Regulation puts a duty on the manufacturer, importer and supplier to appropriately classify any substance or mixture that they supply. They must also ensure that it is appropriately packaged and labelled.

The **CLP Regulation** implements the United Nations **Globally Harmonised System of Classification and Labelling of Chemicals (GHS)** within the EU. Knowledge of this legal framework is not required for Certificate purposes. It is simply sufficient to recognise that the classification and labelling has been harmonised to introduce one global standard.

In this element, we are concerned with the **health effects**. These can be further subdivided to give a variety of classifications that indicate how the chemical actually affects health.

TOPIC FOCUS

Health hazard classifications:

- **Acute toxicity** - small doses cause death or serious ill health when ingested, inhaled or absorbed through the skin, (e.g. potassium cyanide).
- **Skin corrosion/irritation** - destroys living skin tissue on contact or causes skin inflammation on contact.
- **Serious eye damage/eye irritation** - destroys eye tissue on contact or causes temporary inflammation of the eye.
- **Respiratory or skin sensitisation** - may cause sensitisation of the respiratory system or the skin through repeated or prolonged contact.
- **Germ cell mutagenicity** - may cause genetic damage that can be passed down to the next generation.
- **Carcinogenicity** - may cause cancer (abnormal and uncontrolled growth of cells in the body).
- **Reproductive toxicity** - may cause sterility or birth defects to an unborn child.
- **Specific target organ toxicity (single and repeat exposure)** - causes damage to body organs as a result of one single, large over-exposure or multiple exposures.
- **Aspiration hazard** - may cause damage to the respiratory system if accidentally inhaled into the lungs.

Some chemicals are **sensitising agents**. This means that they are capable of producing an allergic reaction that will gradually worsen on repeat exposures.

There are two groups of sensitising chemicals:

- **Respiratory sensitisers** - these can cause asthma on inhalation into the lungs, (e.g. flour dust and isocyanates).
- **Skin sensitisers** - these can cause allergic dermatitis on contact with the skin, (e.g. epoxy resin).

DEFINITIONS

ASTHMA

A condition where the airways of a person's lungs become irritated in response to a trigger, constricting in size and producing excess mucus, making breathing difficult.

DERMATITIS

A non-infectious skin condition where the skin becomes dry, flaky, cracked and painful.

There are two main types of dermatitis associated with exposure to hazardous substances:

- **Primary contact dermatitis** - which occurs following immediate, repeated or prolonged contact. Once exposure is stopped, the symptoms subside.
- **Allergic or secondary contact dermatitis** - which occurs following contact with a skin-sensitising agent. This form of dermatitis often appears on parts of the body other than the point of contact with the substance and can flare up in response to very small exposures once the person has become sensitised.

Typical symptoms of dermatitis: dry, flaky, inflamed skin

Acute and Chronic Health Effects

Two different types of effect can occur when a person is exposed to a hazardous substance:

- **Acute effects** - the effects are **short-term**. The effects usually appear immediately or within a relatively short time after exposure, e.g. a few minutes. Acute effects often occur as a result of exposure to high levels of the substance, sometimes over very short periods of time, e.g. exposure to high concentrations of chlorine gas causes immediate irritation to the respiratory system.

  Acute effects will often disappear once exposure has stopped. However, some substances, such as cyanide, have such a pronounced acute effect that exposure is likely to be fatal.

- **Chronic effects** - the effects are **long-term**. Sometimes, the effects will persist for months or years. Sometimes, the effects will last a lifetime. Chronic effects often occur as a result of exposure to lower levels of the substance over long periods of time, are usually gradual, and are often progressive and irreversible. For example, respiratory sensitisation to flour dust can occur as a result of repeated exposure to flour dust over several years. Once a worker is sensitised, their reaction to flour dust may last the rest of their life. Some chronic health effects only become apparent years after exposure, e.g. asbestosis occurs 10-20 years after multiple exposures to asbestos.

Note that many hazardous substances can have both acute **and** chronic effects. For example, exposure to high concentrations of industrial cleaning solvent can have a narcotic effect (acute), and daily exposure to much lower levels can cause liver damage if it continues for many years (chronic). Alcohol is another toxic substance that has both acute and chronic health effects.

Specific examples of chemical and biological agents hazardous to health and outlines of their health effects can be found in the section on specific agents later in this element.

National General Certificate Legal Standards	International General Certificate Standards
• European Regulation (EC) No. 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures (CLP Regulation).	• United Nations Globally Harmonised System of Classification and Labelling of Chemicals. • ILO C170 - Chemicals Convention, 1990 (No. 170). • ILO R177 - Chemicals Recommendation, 1990 (No. 177).

STUDY QUESTIONS

1. Identify the physical forms of chemicals that may exist in the workplace.
2. Identify five health hazard classifications of chemicals.
3. Outline the difference between acute and chronic ill-health effects.

(Suggested Answers are at the end.)

Assessment of Health Risks

IN THIS SECTION...

- Hazardous substances enter the body by four main routes: inhalation, ingestion, absorption through the skin and injection through the skin. The body has defence mechanisms that protect it from the entry of hazardous substances and from their harmful effects.
- Assessing risk from exposure to hazardous substances is a six-step process: identify the hazardous substances present and the people who might potentially be exposed, gather information about the substance, evaluate the health risk, identify any controls needed and implement them, record the assessment and action taken, and review.
- Product labels, Guidance Notes and material Safety Data Sheets (SDS) are all relevant sources of information in the assessment process.
- It is sometimes necessary to monitor the concentration of a hazardous substance in the air in order to assess the extent of worker exposure to ensure that legal limits are not exceeded.

Routes of Entry

Some hazardous substances cause harm simply on skin contact. For example, corrosive chemicals, (e.g. hydrochloric acid) cause direct chemical burns to the skin, and irritants and skin sensitisers, (e.g. epoxy resin) cause their effects on skin contact. Many other hazardous substances, however, have to get **into** the body in some way in order to have a harmful effect.

TOPIC FOCUS

There are four main routes of entry for hazardous substances into the body:

- **Inhalation** - the substance is breathed in through the nose and mouth and down into the lungs. This is a significant route of entry for many hazardous substances in the gas, vapour, mist, fume or dust form. People have to breathe, so if the hazardous substance is present in the air around them, then it will be inhaled.
- **Ingestion** - the substance is taken in through the mouth and swallowed down into the stomach, and then moves on through the digestive system. This is a less significant route of entry since people are unlikely to deliberately swallow a hazardous substance. Ingestion usually occurs by cross-contamination (of the hands by a toxic substance) or by mistaken ingestion.
- **Absorption through the skin** - the substance passes through the skin and into the tissues beneath and then into the bloodstream. Only some substances, (e.g. organic solvents) are able to permeate the skin in this way, but when they can, this route can be very significant, since any skin contact allows absorption.
- **Injection through the skin** - the substance passes through the skin barrier either by physical injection, (e.g. a needle-stick injury or animal bite) or through damaged skin, (e.g. cuts and grazes). This route is significant for many biological agents, (e.g. the hepatitis virus).

These represent the four main routes of entry, though there are others, such as through the lining of the eye (which has a very rich blood supply) and by aspiration (inhaling a liquid into the lungs).

Inhalable and Respirable Dust

Dust can be inhaled through the nose and mouth, but not all dust will travel down deep into the lungs. Dust is made up of small particles of various diameters. Large dust particles are filtered out by the lungs' defence mechanisms before they can travel down into the lungs; smaller particles are not trapped by these defences and will travel deep into the lungs.

These two types of dust are called:

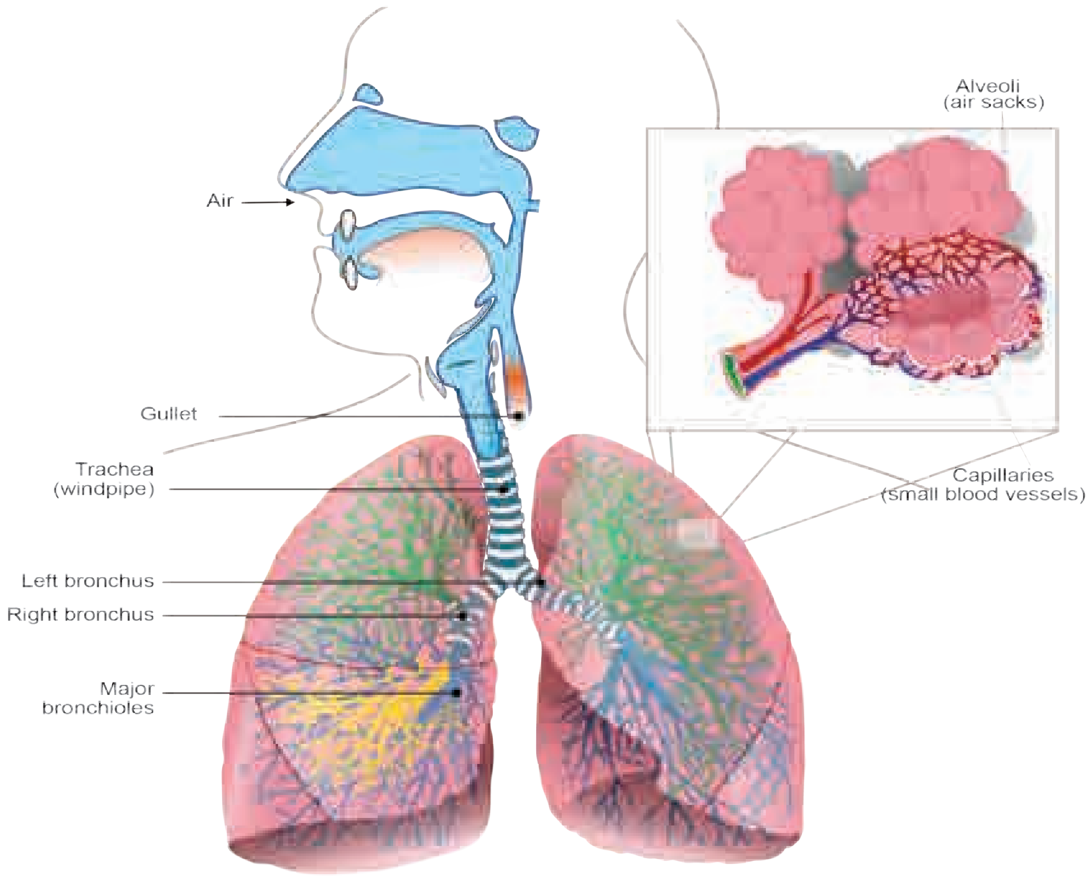
- **Inhalable dust** - particles of all sizes that can be inhaled into the nose and mouth.
- **Respirable dust** - particles less than 7 microns (7/1,000 mm) in diameter that can travel deep into the lungs on inhaled breath.

Defence Mechanisms

The body has two main categories of defence mechanism to combat attack by biological agents and damage by chemicals. Very broadly, these are:

- Cellular defence - ('internal' defence) which allows cells to fight bacteria and other toxins mostly from blood, respiratory and ingestion entry routes.
- Superficial defence - ('external' defence) that protects against toxins that enter through the skin and against the collection of contaminants by the hairs and mucus in the nose and throat.

The following sections will cover some of the basic defence mechanisms.



The respiratory system

Respiratory Defences

The respiratory system is made up of the nose and nasal cavity, windpipe (trachea) and lungs. The air passes down the bronchi and bronchioles to the alveoli. These are small air sacs and are where oxygen enters the bloodstream.

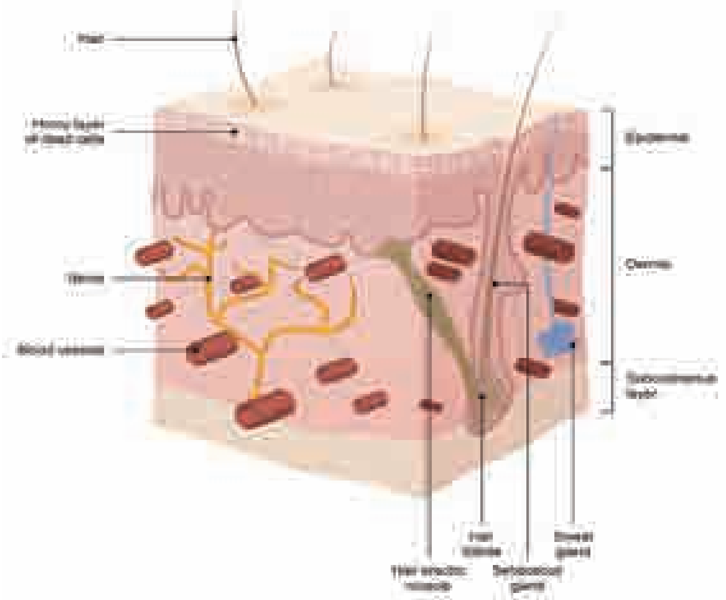
The respiratory system is protected by the following defences:

- The **sneeze reflex**.
- **Filtration in the nasal cavity** (which has a thick mucus lining that particles stick to) - this is very effective at removing large particles; only particles less than 10 microns in diameter pass through. This mechanism will successfully prevent entry of larger fibres, such as asbestos, and larger particulates in dust, such as silica, but will not prevent smaller asbestos fibres or fine powders, such as cement and finer silica dusts.
- **Mucociliary escalator** - the bronchioles, bronchi and trachea are lined with small hairs (cilia). Mucus, lining these passages, is gradually moved by these cilia up out of the lungs. Any particles trapped in this mucus are cleaned out of the lungs by this mechanism. This filtration mechanism is effective at removing particles larger than 7 microns in diameter. This will collect medium-sized asbestos fibres, silica and larger particulates in dust, but, again, will not defend against the finer fibres and particulates.
- **Macrophages/phagocytes** - scavenging white blood cells that ingest, attack and destroy organic particles. For example, fine dust that is not captured by the ciliary escalator will progress deeper into the lungs where macrophages try to destroy the dust particles.
- **Inflammatory response** - any particles that cannot be removed by macrophages are likely to trigger an inflammatory response. This causes the walls of the air sacs (alveoli) to thicken and become fibrous. This can be temporary or may result in permanent scarring and reduced lung function. Silicosis is scarring of the lung tissue as a result of the inhalation of silica crystals (e.g. in rock dust), and asbestosis is scarring of the lung tissue caused by inhalation of asbestos.

Skin Defences

The skin forms a waterproof barrier between the body and the outside world. It is made of two layers, the outer **epidermis** and the inner, thicker **dermis**. Defence mechanisms include:

- A thick layer of dead cells at the surface of the epidermis that are constantly being replenished as they wear off.
- Sebum - an oily fluid secreted onto the surface of the skin that has antiseptic properties.



Cross-section of skin

When damaged, the skin shows an inflammatory response: the area of damage becomes inflamed, swelling occurs, red and white blood cells collect at the site of the damage, and fibrous cross-connections form and scar tissue may result. Exposure to detergents will remove the protective sebum allowing the agent to contact the skin, causing irritation. More severe reactions can occur through exposure to acids which can burn the skin.

Assessment of Health Risks

Where workers might potentially be exposed to hazardous substances through the course of their work, it will be necessary to assess that potential to ensure that harm does not occur. In the UK, this is a requirement of the **Control of Substances Hazardous to Health Regulations 2002 (COSHH)**. These regulations reflect EU Directive requirements.

The steps to carrying out a hazardous substance risk assessment are:

1. Identify the hazardous substance present and the people who might potentially be exposed.
2. Gather information about the substances.
3. Evaluate the health risk.
4. Identify any controls needed and implement them.
5. Record the assessment and action taken.
6. Review.

When identifying the hazardous substances present in the workplace, remember that they can be created by work processes. For example, welding metal creates a metal fume; mixing bleach and acid together can create chlorine gas. These hazardous substances (the metal fume and the chlorine gas) do not come pre-packaged and labelled, but are created by the work process.

You can collect together information about hazardous substances by referring to various information sources (see later). The information then has to be used to evaluate the health risks associated with the actual work practices.

TOPIC FOCUS

Factors to consider when carrying out an assessment of hazardous substance exposure are the:

- **Hazardous nature** of the substance present - is it toxic, corrosive, carcinogenic, etc.?
- **Potential ill-health effects** - will the substance cause minor ill health or very serious disease, and will these result from short-term or long-term exposure?
- **Physical forms** that the substance takes in the workplace - is it a solid, liquid, vapour, dust, fume, etc.?
- **Routes of entry** the substance can take in order to cause harm - is it harmful by inhalation, ingestion, skin absorption, etc.?
- **Quantity** of the hazardous substance present in the workplace - including the total quantities stored and the quantities in use or created at any one time.

(Continued)

TOPIC FOCUS

- **Concentration** of the substance - if stored or used neat or diluted, and the concentration in the air if airborne.
- **Number of people** potentially exposed and any vulnerable groups or individuals - such as pregnant women or the infirm.
- **Frequency** of exposure - will people be exposed once a week, once a day or continuously?
- **Duration** of exposure - will exposure be very brief, last for several hours or last all day?
- **Control measures** that are already in place - such as ventilation systems and PPE.

All these factors have to be taken into account when undertaking the assessment, then the adequacy of any existing control measures can be decided and additional controls and precautions selected.

Sources of Information

Information about the nature of a hazardous substance can be obtained from many different sources, but three of the most commonly used sources are the product label, the material Safety Data Sheet (SDS) and relevant Guidance Notes that contain information on occupational exposure limits.

Product Labels

It is becoming more common for labels to be applied which comply with the requirements of more than one country, and the classification and labelling of substances is being harmonised through the implementation of the UN **Globally Harmonised System** (**GHS**).

A product label will carry the following information:

- The name of the substance/mixture.
- Some idea of the components that make the product hazardous (though this often depends on the overall classification of the product).
- An indication of the danger, which may be by specific warning phrases or symbols, or a combination of both.
- Basic precautions to take (things to avoid or PPE to wear, etc.).
- Name, address and telephone number of the supplier.

A label showing the key information about the hazardous nature of the product

In the UK and the EU, substances must be classified, labelled and packaged according to the **CLP Regulation (EC Regulation 1272/2008)**.

Guidance Documents

HSE Guidance Note EH40

Occupational Exposure Limits (OELs) are legal limits on the airborne concentrations of substances that employees can be exposed to. In the UK, these OELs are called **Workplace Exposure Limits** (**WELs**) and they are published by the HSE in **Guidance Note EH40**. This document can, therefore, be a useful source of reference when undertaking a hazardous substance risk assessment. WELs will be explained fully in the next section of this element.

Alongside the UK-specific guidance documents, there are other occupational exposure limits published by other authorities such as:

- **EU List of Indicative Limit Values** - the EU has published limit values for 19 chemical agents in the list of indicative limit values. These must be adhered to by the European member states and are recognised in EH40 in the UK.
- **ACGIH List of Threshold Limit Values (US)** - in comparison, the American Conference of Governmental Industrial Hygienists (ACGIH) in the US has developed a series of Threshold Limit Values (TLVs) for certain chemicals that represent guidelines (non-legal standards).

Safety Data Sheets

These are intended to provide end users with sufficient information about a substance for them to take appropriate steps to ensure safe use, including transport and disposal. The **Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)** is an EU regulation that requires manufacturers, importers and suppliers of hazardous substances to prepare and provide safety data sheets. The basic design and section headings for this document follow a standard established by this Regulation.

TOPIC FOCUS

Safety data sheets contain the following information:

1. **Identification of the substance and of the company** - including name, address and emergency contact phone numbers.
2. **Hazards identification** - a summary of the most important features, including adverse health effects and symptoms.
3. **Composition/information on ingredients** - chemical names.
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/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 effects, which could include effects on aquatic 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, (e.g. explanation of abbreviations used).

Limitations of Information

The above sources of information are important, but they have limitations in assessing health risk:

- They contain general statements of the hazards. They do not allow for the localised conditions in which the substances are to be used which may affect the risk.
- The information can be highly technical and so meaningless to the non-specialist.
- Individual susceptibility to substances varies; a person can be very prone to the health effects of a certain chemical.
- They provide information about the specific substance or mixture in isolation and do not take into account the effects of mixed exposures.
- The information represents current scientific thinking and there may be hazards present that are not currently understood.

Hazardous Substance Monitoring

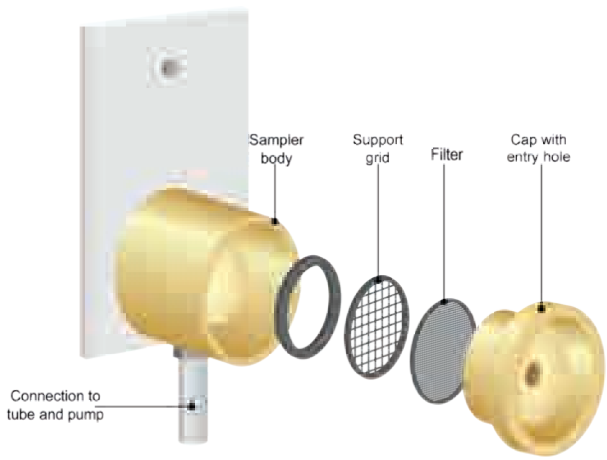
The Role of Hazardous Substance Monitoring

Many hazardous substances are hazardous by inhalation. An obvious question to ask if people are working in an area where they might inhale such a hazardous substance is: 'What is the concentration of this substance in the air?' Sometimes, the only way to answer that question is to undertake some form of **monitoring**. Monitoring makes use of various types of sampling equipment to give an indication of the concentration of a contaminant in air.

Monitoring might be appropriate in the following circumstances:

- When failure or deterioration of the control measures could result in serious health effects.
- When measurement is required so as to be sure that an occupational exposure limit (e.g. WEL) is not exceeded.
- As a check on the effectiveness of control measures.
- If adequate control of exposure is no longer being maintained, following process or production changes, for example.

Monitoring can be carried out using various items of equipment. One example of this equipment is outlined below just to illustrate the basic principle. Personal dosimetry for dust exposure in the workplace can be carried out using an air pump, tube and sampling head. This equipment can be worn by a worker, so gives an indication of personal exposure. A pre-weighed filter is fitted into the sampling head, air is drawn through it by the pump for a chosen period of time, then the filter is removed and re-weighed. The concentration of dust in the atmosphere can be calculated based on these measurements. This will be an average value over the chosen period of time.



Dust sampler head showing filter in position (Based on original source MDHS 14/4 General methods for sampling and gravimetric analysis of respirable, thoracic and inhalable aerosols, HSE, 2014 - www.hse.gov.uk/pubns/mdhs/pdfs/mdhs14-4.pdf)

Limitations of Hazardous Substance Monitoring

There are several limitations that must be considered before monitoring hazardous substances:

- **Accuracy of results** - monitoring equipment is often limited in its accuracy, and variations between different times of use will occur.
- **Variations in personal exposure** - even when careful monitoring has been carried out, there may still be variation in employee's personal exposure from the monitoring results as a result of personal habits and one-off events.

- **Absence of a standard** - monitoring for monitoring sake is of no use if there is no occupational exposure limit (e.g. a WEL or TLV) to compare monitoring results to. Not all hazardous substances have an occupational exposure limit set (see later).
- **Other exposure routes** - monitoring focuses exclusively on airborne contaminants. But if the substance can be absorbed through the skin, then another route of entry is available and air monitoring may not give a true indication of the actual exposure that is taking place.

MORE...

Follow the link below for more details about the **hazardous substances and risk assessment**:

www.hse.gov.uk/coshh/index.htm

National General Certificate Legal Standards	International General Certificate Standards
• Control of Substances Hazardous to Health Regulations 2002. • Control of Substances Hazardous to Health Regulations (Northern Ireland) 2003. • European Regulation (EC) No. 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures. • European Regulation (EC) No 1907/2006 on the Registration, Evaluation, Authorisation and Restriction of Chemicals.	• United Nations Globally Harmonised System of Classification and Labelling of Chemicals. • ILO C170 - Chemicals Convention, 1990 (No. 170). • ILO R177 - Chemicals Recommendation, 1990 (No. 177).

STUDY QUESTIONS

4. Identify the routes of entry of chemical and biological agents into the body.
5. What information is generally provided on the label of a substance which has been classified as dangerous?
6. What is the purpose of safety data sheets?

(Suggested Answers are at the end.)

Occupational Exposure Limits

IN THIS SECTION...

- Occupational exposure limits - **workplace exposure limits** in the UK - are the maximum concentrations of airborne substances, averaged over a reference period, to which employees may be exposed by inhalation.
- Short-term exposure limits combat the sudden acute effects of exposure; long-term exposure limits combat the long-term chronic effects.
- There are limitations to the effectiveness of WELs in ensuring that employees are not exposed to harmful levels of hazardous substances.
- Occupational exposure limits vary by country and region as there are currently no globally recognised standards.

Occupational Exposure Limits (OELs)

There are no harmonised global standards for **Occupational Exposure Limits** (**OELs**). The terms used to describe them - as well as definitions, methods for calculating exposures, and the legal status of the limits - vary between countries. So, it is important to select the correct OEL for the country you are working in and use the correct codes of practice in interpretation (see the guidance documents referred to earlier, for example).

Worker being exposed to airborne contaminant

However, the purpose of all OELs is similar - to put a limit in place so that employees will not be exposed to high concentrations of airborne substances (either for short durations of time, or for long periods of the working day) where scientific evidence suggests that this would cause a risk to health.

For the purposes of this course, we will look at the specific legal standard that exists within the UK and use this as a model for explaining hazardous substance OELs and how they work. In the UK, the OELs for chemicals are known as **Workplace Exposure Limits** (**WELs**), and these are defined and have legal status under the **Control of Substances Hazardous to Health Regulations 2002** (**COSHH**).

DEFINITION

WORKPLACE EXPOSURE LIMIT (WEL)

The maximum concentration of an airborne substance, averaged over a reference period, to which employees may be exposed by inhalation.

The purpose of WELs is to put a ceiling in place so that employees will not be exposed to high concentrations of airborne substances (either for short durations of time or for long periods of the working day) where the scientific evidence suggests that there is risk to health.

WELs have legal status under the **COSHH Regulations** and can be found listed in the HSE Guidance Note **EH40**. If a WEL is exceeded, then a breach of the **COSHH Regulations** has taken place; this might lead to enforcement action or prosecution.

MORE...

The HSE website includes the current edition of the EH40 *Workplace Exposure Limits Guidance Note* at:

www.hse.gov.uk/pubns/books/eh40.htm

Short-Term and Long-Term Limits

WELs are time-weighted average exposures; in other words, they are calculated by measuring a person's average exposure over a specific reference period of time.

The two reference periods of time used are:

- **15 minutes** (called the Short-Term Exposure Limit (STEL)).
- **8 hours** (called the Long-Term Exposure Limit (LTEL)).

The reasons for having two limits are:

- **Short-term exposure limits** combat the ill-health effects of being exposed to very high levels of the substance for short periods of time (minutes).
- **Long-term exposure limits** combat the ill-health effects of being exposed to relatively low concentrations of the substance for many or all hours of every working day through an entire working lifetime.

The effects of a short-term exposure may be very different from long-term exposure - some substances could be fatal at high concentrations, while others may cause dizziness and have narcotic effects. For example, high concentrations of solvent vapour may cause an employee to become dizzy and possibly unconscious, while longer-term, lower concentration exposures could result in damage to internal organs, such as the liver.

The Significance of Time-Weighted Averages

DEFINITION

TIME-WEIGHTED AVERAGE

Average exposure to a contaminant over a specified period of time, such as eight hours or 15 minutes.

Consider an employee working with solvents in a manufacturing process:

- They are exposed to short, high-concentration 'bursts' of the substance during certain stages of the work process.
- They are also exposed to background levels of the solvent that are always present in the work area.

The short-term exposures to high concentrations of the solvent are controlled by calculating the concentration over 15-minute periods of time to give a 15-minute **Time-Weighted Average (TWA)** exposure. This is then compared to the STEL. If the worker's exposure is below the STEL, then this is legally acceptable. If it is above the STEL, then it is legally unacceptable.

The long-term exposures to background low-level concentrations of the solvent are controlled by calculating the concentration over eight-hour periods of time to give an eight-hour **TWA** exposure. This is then compared to the LTEL. If the worker's exposure is below the LTEL then this is legally acceptable. If above, then not.

Limitations of Exposure Limits

It is important to remember that workplace exposure limits have their limitations:

- WELs are designed only to control the absorption of harmful substances into the body following inhalation. They are not concerned with absorption following ingestion or through contact with the skin or eyes. So, for example, the concentration of organic solvent in a person's body may be at damagingly high levels, even though the WEL has not been exceeded, because most of the solvent may have been entering through the skin by direct contact with the liquid solvent rather than by inhalation of solvent vapour.
- They take no account of individual personal susceptibility. This is particularly important in the case of substances that produce an allergic response; once a person has become sensitised, the exposure limit designed to suit the average person has no further validity.
- They only protect workers against inhalation of harmful levels of airborne substances if the control measures that should be in use are working properly and are being used correctly.
- They do not take account of the synergistic (or combined) effects of mixtures of substances, e.g. the use of multiple substances. Some chemicals are harmful individually but much more harmful in combination. One example is asbestos and cigarette smoke - both can cause lung cancer, but the lung cancer risk of an asbestos worker who smokes is multiplied many times (it isn't simply doubly dangerous).
- They may become invalid if the normal environmental conditions are changed, e.g. changes in temperature, humidity or pressure may increase the harmful potential of a substance.
- Some limits do not consider all the possible health effects of a substance, e.g. impact on the skin, such as dermatitis, would not be considered with an airborne limit.

International Standards

As we have seen, different standards are applied in different regions of the world.

In the EU, there are Indicative Limit Values (which are included in EH40 in the UK).

In the USA alone, several different groups recommend what occupational exposure limits should be:

- The American Conference of Governmental Industrial Hygienists (ACGIH) sets Threshold Limit Values (TLVs), as described above.
- The National Institute for Occupational Safety and Health (NIOSH) recommends Recommended Exposure Limits (RELs).
- The American Industrial Hygiene Association (AIHA) has developed Workplace Environmental Exposure Limits (WEELs).
- The Occupational Safety and Health Administration (OSHA) enforces Department of Labour Permissible Exposure Limits (PELs).

The safe levels of exposure set out above may vary due to different time-measuring periods, different measuring criteria (equipment used), different expected airborne concentrations, and various other criteria determining the toxicity of a substance.

It is therefore important to be aware of the relevant limits when working internationally, and to monitor, calculate and compare measurements to the relevant exposure limits using the correct method.

National General Certificate Legal Standards	International General Certificate Standards
• Control of Substances Hazardous to Health Regulations 2002. • Control of Substances Hazardous to Health Regulations (Northern Ireland) 2003.	• ILO C170 - Chemicals Convention, 1990 (No. 170). • ILO R177 - Chemicals Recommendation, 1990 (No. 177).

STUDY QUESTIONS

7. Define the term 'workplace exposure limit'.
8. Give two limitations of WELs.

(Suggested Answers are at the end.)

Control Measures

IN THIS SECTION...

- Exposure to hazardous substances should be prevented or, if that's not possible, controlled below any relevant occupational exposure limit.
- A general hierarchy of controls can be applied to controlling exposure:
  - Eliminate or substitute the substances.
  - Change the process.
  - Reduce exposure time.
  - Enclose or segregate.
  - Local exhaust ventilation.
  - Dilution ventilation.
  - Respiratory protective equipment.
  - Other personal protective equipment.
  - Personal hygiene.
  - Health surveillance, including biological monitoring.
- Local exhaust ventilation works by extracting airborne contamination from the place where it is created using an inlet hood linked to a filter and fan by ductwork. Such systems have to be inspected and maintained to ensure their ongoing effectiveness.
- Respiratory protective equipment can be subdivided into two groups: respirators (filtering facepiece, half-mask, full-face, and power types) and breathing apparatus (compressed air and self-contained types).
- Exposure to carcinogens, mutagens and asthmagens should be prevented. Where this is not possible, exposure must be reduced to as low a level as is reasonably practicable.

The Need to Prevent or Control Exposure

Preventing exposure to hazardous substances is the most effective way of controlling the health risk that they represent.

Where exposure cannot be prevented, it should be **controlled**. If there is an OEL (e.g. in the UK, a WEL) relevant to the chemical, then exposure must be controlled **below the OEL**.

These two approaches to the management of the health risks created by hazardous substances are required by statute law (such as the **COSHH Regulations** in the UK).

Principles of Good Practice

The following eight '**principles of good practice**' exist with regard to controlling exposure to hazardous substances:

- Minimise emission, release and spread of hazardous substance.
- Account for all relevant routes of entry into the body when developing control measures.
- Use exposure control methods that are proportional to health risk.

- Choose the most effective and reliable control options.
- Use PPE in combination with other control measures, if adequate control cannot otherwise be achieved.
- Regularly check and review the control measures that are in place to ensure that they remain effective.
- Provide information and training so that workers are fully aware of the risks presented by exposure and the correct measures to minimise those risks.
- Ensuring that any control measures implemented do not increase the overall risks to health and safety.

In the EU and in the UK, these eight 'principles of good practice' exist in statute law (in the UK, specifically Schedule 2A of **COSHH**).

The Practical Control of Exposure

It is possible to use a **hierarchy of controls** for substances hazardous to health to practically apply the principles of good practice listed above. This is similar to the general hierarchy of controls considered in Unit 1 of the Certificate course.

In the rest of this section, we will be considering prevention of exposure and the associated hierarchy of controls.

Elimination or Substitution

It may be possible to eliminate or substitute the substance, by:

- Eliminating the process or type of work that requires the use of the substance, (e.g. outsourcing a paint-spraying operation).
- Changing the way that the work is done to avoid the need for the substance, (e.g. screwing rather than gluing).
- Disposing of unused stock of the substance that is no longer required.
- Substituting the hazardous substance for a non-hazardous alternative, (e.g. switching from an irritant to a non-hazardous floor cleaner).
- Substituting the hazardous substance for one that has a lower hazard classification, (e.g. switching from a corrosive to an irritant).
- Changing the physical form of the substance to one that is less intrinsically harmful, (e.g. massive solid rather than powder).

Process Change

It may be possible to change the process so as to reduce the risks associated with the substance. For example:

- Applying a solvent by brush rather than by spraying reduces airborne mist and vapour.
- Vacuuming rather than sweeping keeps dust levels down.

Reduce Exposure Times

There is a simple relationship between the length of time a person is exposed to a hazardous substance and the dose of substance that they receive: double the time, double the dose; half the time, half the dose. It is therefore sensible to minimise the time period over which people are working with hazardous substances, especially where the hazardous substance can have an acute effect. If a short-term exposure limit (15-minute TWA) exists for the substance, then this limit must not be exceeded.

Enclosure and Segregation

It may be necessary to totally enclose the hazardous substance inside process machinery, storage tanks, etc. on a small or large scale. For example, flour dust used in an industrial bakery can be totally enclosed in silos, storage tanks and direct-dosed mixing machinery and moved from one to the other by sealed pipelines. Hundreds of tonnes of flour dust might be handled in this way without the dust escaping into the workplace environment.

Segregating the hazardous substance in the workplace may also be a possibility; it might be stored in a segregated storage area and used in an area away from other work processes and unauthorised personnel.

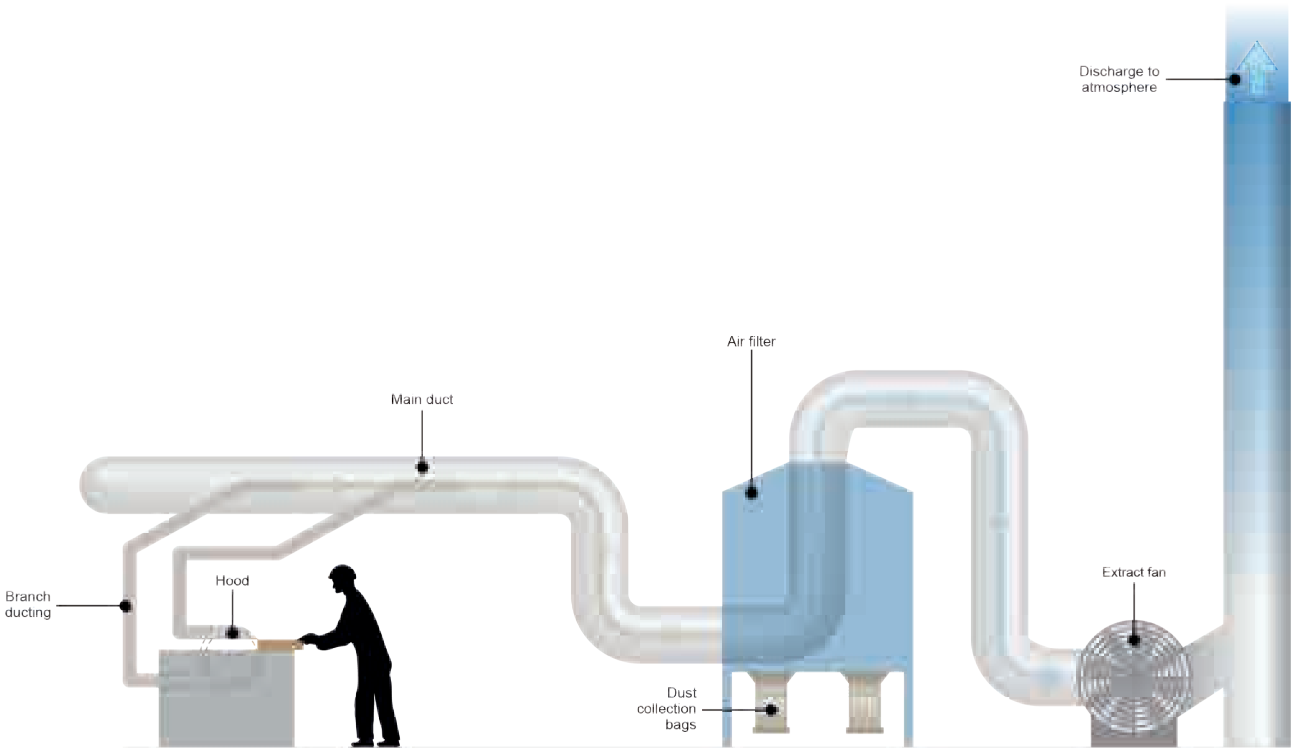
Local Exhaust Ventilation (LEV)

One common control for substances that might become airborne is the use of **Local Exhaust Ventilation** (**LEV**) systems. A wide variety of different types of LEV is available but the basic principle of an LEV system is the extraction of contaminated air at the point of generation and then the filtering of the contaminant out of the air, allowing the clean air to exhaust to atmosphere.

TOPIC FOCUS

A **typical LEV system** consists of:

- An **intake hood** that draws air from the workplace in the immediate vicinity of the contaminant.
- **Ductwork** that carries that air from the intake hood.
- A **filter system** that cleans the contaminant from the air to an acceptable level.
- A **fan** of some sort that provides the motive force to move the air through the system.
- An **exhaust duct** that discharges the clean air to atmosphere.



A typical LEV system extracting sawdust from a bench-mounted circular saw

A variety of different intake hoods are used on LEV systems, but they can be categorised into two main types:

- **Captor hoods** - these capture the contaminant by drawing it into the system, overcoming the contaminant's initial velocity (which may have been taking it away from the hood, such as during grinding).
- **Receptor hoods** - these are positioned in such a way that the contaminant is moving in that direction already, so less air movement is required to achieve uptake, (e.g. a large intake hood suspended above a bath of molten metal; the metal fume will be hot and rising up into the hood on convection currents).

Effectiveness of an LEV system will be **reduced** by:

- Poorly positioned intake hoods.
- Damaged ducts.
- Excessive amounts of contamination.
- Ineffective fan due to low speed or lack of maintenance.
- Blocked filters.
- Build-up of contaminant in the ducts.
- Sharp bends in ducts.
- Unauthorised additions to the system.

LEV systems should be routinely inspected and maintained to ensure their ongoing effectiveness, through:

- **Routine visual inspection** - to check the integrity of the system, signs of obvious damage and build-up of contaminant, both outside and inside the ductwork; filters should be visually inspected to ensure they are not blocked; the exhaust out-feed should be checked.
- **Planned preventive maintenance** - may include replacing filters, lubricating fan bearings and inspecting the fan motor.
- **Periodic testing** - to ensure that air velocities through the system are adequate. This can be done by visual inspection of the intake hood using a smoke stick, measuring air velocities at the intake and in the ductwork using anemometers, and measuring static pressures using manometers and pressure gauges.

Testing of LEV systems on a 14-month basis is a legal requirement under **COSHH**.

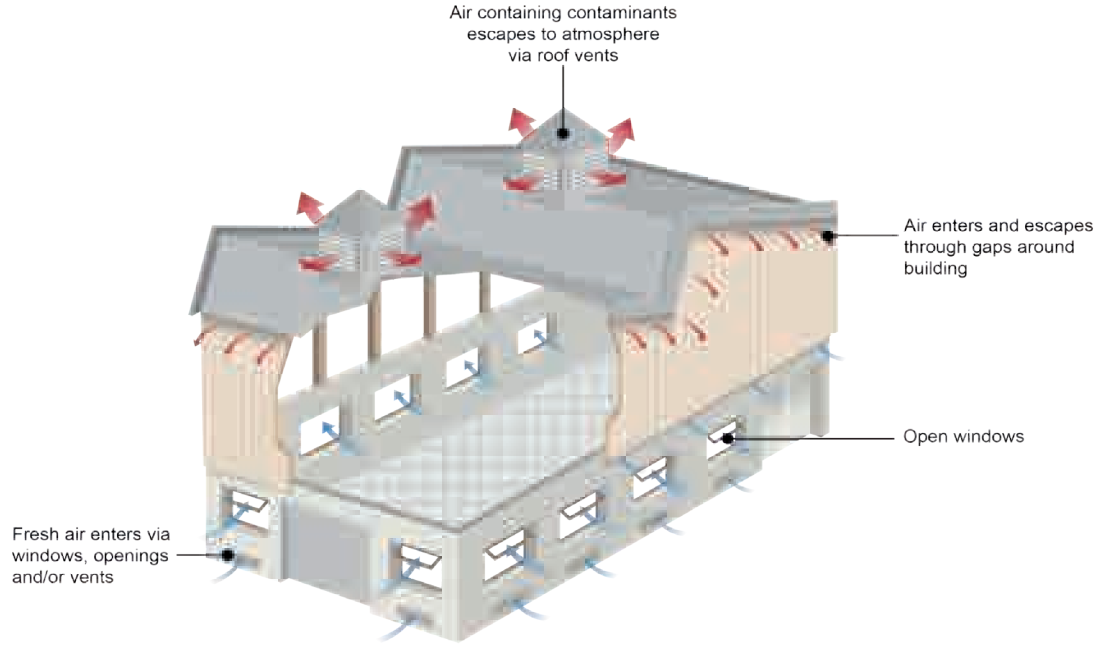
MORE...

Further information on LEV can be found on the HSE website at:

www.hse.gov.uk/lev

Dilution Ventilation

Dilution ventilation operates by diluting the contaminant concentration in the general atmosphere to an acceptable level by changing the air efficiently in the workplace over a given period of time, e.g. a number of complete changes every hour. These air changes might be **passive**, by providing low-level and/or high-level vents or **active**, using powered fans.



Passive dilution ventilation

The system is intended to remove gas contaminants (sometimes fumes) and keep the overall concentration of any contaminant to below the WEL.

Dilution ventilation is appropriate where:

- The WEL of the harmful substance is high.
- The rate of formation of the gas or vapour is slow.
- Operators are not in close contact with the contamination generation point.

If a powered system is used, fans must be appropriately sited. If the contaminant is:

- **Lighter** than air, it will naturally rise up inside workrooms and can be extracted at high level.
- **Heavier** than air, it will sink to the floor and low-level extraction will be more appropriate.

Limitations of dilution ventilation systems are that:

- They are not suitable for the control of substances with high toxicity.
- They do not cope well with the sudden release of large quantities of contaminant.
- They do not work well for dust.
- They do not work well where the contaminant is released at a point source.
- Dead areas may exist where high concentrations of the contaminant are allowed to accumulate.

Respiratory Protective Equipment

DEFINITION

RESPIRATORY PROTECTIVE EQUIPMENT

Any type of personal protective equipment specifically designed to protect the respiratory system, e.g. self-contained breathing apparatus.

Personal protective equipment is often used as a control measure when dealing with hazardous substances. You will know about the general principles of PPE and its uses and limitations from your studies of Unit 1.

Those general principles can be applied to Respiratory Protective Equipment (RPE).

There are two main categories of RPE:

- **Respirators** - these filter the air taken from the immediate environment around the wearer.
- **Breathing apparatus** - this provides breathable air from a separate source.

A worker wearing a filtering facepiece respirator to prevent inhalation of wood dust

Respirators

Respirators come in a variety of types:

- **Filtering facepiece respirator** - the simplest type, consisting of a filtering material held over the nose and mouth by an elastic headband.

  This type of respirator is useful to prevent inhalation of dust (and sometimes gas and vapour), but is not suitable for high concentrations of contaminant, for use against substances with high toxicity, or for long-duration use.

Use and benefits	Limitations
Cheap	Low level of protection
Easy to use	Does not seal against the face effectively
Disposable	Uncomfortable to wear

- **Half-mask or ori-nasal respirator** - this consists of a rubber or plastic facepiece that fits over the nose and mouth with one or two canisters (cartridges) that contain the filtering material.

  This gives a much higher level of protection than the filtering facepiece respirator, but does not protect the eyes.

  When the wearer inhales, they create negative air pressure inside the facepiece; this means that any leaks in the respirator, (e.g. poor seal against the face or a split in the rubber) will allow contaminated air in.

A worker wears a half-mask respirator to seal asbestos lagging around a pipe

Use and benefits	Limitations
Good level of filtration	No built-in eye protection
Good fit achievable	Negative pressure inside facepiece
Easy to use	Uncomfortable to wear

- **Full-face respirator** - this is similar to the half-mask but has a built-in visor that seals in the eyes and face.

  The full-face respirator gives a high level of protection against airborne contaminants and protects the eyes. This can be important where the contaminant can cause eye irritation or be absorbed through the eye.

A full-face respirator with filtering canister (or cartridge)

Use and benefits	Limitations
Good level of filtration	Restricts vision
Good fit achievable	Negative pressure inside facepiece
Protects the eyes	Uncomfortable to wear

- **Powered respirator** - a powered fan blows filtered air to the wearer. Usually made up of a helmet and face visor, with the air blown down over the face from the helmet.

  This type of respirator does not have a tight seal with the wearer's face and is especially suited to dusty, hot environments where the stream of air moving over the face is a benefit.

Use and benefits	Limitations
Intermediate level of filtration	Heavy to wear
Air movement cools wearer	No tight face seal
Air stream prevents inward leaks	Limited battery life

Breathing Apparatus

There are two common types of Breathing Apparatus (BA):

- **Compressed airline BA** - air is supplied down a small-bore hose at high pressure. Supply can be from a certified breathing air compressor or from cylinders of air on a trolley. Pressure is then stepped down by a regulator and air supplied at low pressure to the user's face mask. It is commonly seen in areas such as spray paint booths.

Use and benefits	Limitations
Supply of air is not time-restricted if a compressor is used	Hose can be long, but not endless
Positive pressure inside facepiece	
Wearer is not burdened with cylinder	

- **Self-contained BA** - breathable air is supplied from a pressurised cylinder worn by the user.

  This type of BA gives the wearer complete freedom of movement, but it is the most heavy and bulky type and the air cylinder does have a limited capacity.

A fire-fighter wearing self-contained BA

Use and benefits	Limitations
Complete freedom of movement	Supply of air is time-restricted
Positive pressure inside facepiece	Equipment is bulky and heavy
	More technical training is required

Selection, Use and Maintenance of RPE

RPE must be selected carefully to ensure that it is suitable.

TOPIC FOCUS

Factors affecting the suitability of RPE include the:

- Concentration of the contaminant and its hazardous nature.
- Physical form of the substance, e.g. dust or vapour.
- Level of protection offered by the RPE.
- Presence or absence of normal oxygen concentrations.
- Duration of time that it must be worn.
- Compatibility with other items of PPE that must be worn.
- Shape of the user's face and influence on fit.
- Facial hair that might interfere with an effective seal.
- Physical requirements of the job, such as the need to move freely.
- Physical fitness of the wearer.

The level of protection offered by an item of RPE is usually expressed as the **Assigned Protection Factor (APF)**. This is simply a measure of how well the RPE keeps out the contaminant.

Any RPE selected must meet relevant standards, (e.g. it must be CE-marked).

Users of RPE should receive appropriate information, instruction and training. In particular, they should understand:

- How to fit the RPE.
- How to test it to ensure that it is working effectively.
- The limitations of the item.
- Any cleaning requirements.
- Any maintenance requirements, (e.g. how to change filter).

Arrangements should be made to maintain RPE in line with manufacturers' instructions and any legal standards that might exist. This should include the need to repair or replace damaged items. Maintenance should only be carried out by competent personnel.

Other Personal Protective Equipment

There are other types of personal protective equipment routinely used to give protection against hazardous substances.

Hand Protection

Gloves (short-cuff) and **gauntlets** (long-cuff) can give protection against:

- Chemicals, e.g. acids, alkalis and solvents.
- Biological agents, e.g. viruses in blood.
- Physical injury, e.g. a knife cut with associated infection risk.

Where protection against chemicals is concerned, care must be taken to ensure that the material that the gloves are made from is suitable for the chemical in question.

A laboratory worker uses nitrile gloves to prevent contact with chemical reagents being handled in a fume cupboard

Eye Protection

Three different types of eye protection are commonly used to protect the eyes from hazardous substances:

- **Safety spectacles** - these offer a degree of front and side protection but do not completely encase the eye.
- **Safety goggles** - these completely encase the eye and offer better splash and impact resistance.
- **Face visors** - these cover the eyes and face, so offering a higher degree of protection.

A face visor offers eye and full face protection in the event of splashes

Body Protection

The body can be protected from hazardous substances by the use of a range of clothing, such as:

- Overalls (prevent direct skin contact with agents such as grease).
- Aprons (prevent spills and splashes from getting onto normal work wear and soaking through to skin).
- Whole-body protection (the entire body is encased in a protective chemical-resistant suit).

Workers wearing chemical suits respond to an emergency spill

Personal Hygiene and Protection Regimes

Personal hygiene is often critical to prevent exposure to hazardous substances. Many biological agents and some hazardous chemicals are put onto the skin or into the mouth by cross-contamination. For example, a laboratory worker's hands become contaminated with bacteria in the lab; they then touch their nose or mouth and the bacteria have direct access. Alternatively, food or cigarettes can be cross-contaminated by hand contact and then put into the mouth.

Without hand-wash facilities this worker is at risk of cross-contamination from chemical and biological agents

It is essential that good hygiene practices are adopted, as appropriate, such as:

- Hand-washing routines when leaving workrooms.
- Careful removal and disposal of potentially contaminated PPE to prevent cross-contamination to normal clothes.
- Prohibition of eating, drinking and smoking in work areas.

This will require the provision of appropriate washing facilities (water, soap and drying equipment), PPE and work clothes-changing facilities, and rest and food preparation areas.

In some instances, it may be possible to vaccinate workers against certain biological agents, e.g. vaccination against hepatitis B is often provided to first aiders on a voluntary basis.

Vaccination can confer immunity against specific biological agents

There are many issues to consider before embarking on a vaccination programme:

- Worker consent must be obtained.
- Vaccination does not always grant immunity.
- Vaccination can give workers a false sense of security.

In most situations, vaccination should only be offered when indicated by law, ACoP or guidance.

Health Surveillance

Health surveillance is a system of ongoing health checks, and often involves carrying out some form of medical examination or test on employees who are exposed to substances such as solvents, fumes, biological agents and other hazardous substances.

Note: similar health checks may be required for those exposed to noise, vibration, etc., and are covered in Element 8.

Health surveillance is important to enable early detection of ill-health effects or diseases, and also helps employers to evaluate their control measures and educate employees. The risk assessment will indicate where health surveillance may be needed, but it is required where:

- there is an adverse health effect or disease linked to a workplace exposure, and it is likely that the health effect or disease may occur, and
- there are valid techniques for detecting early signs of the health effect or disease, and
- the techniques themselves don't pose a risk to employees.

There are **two types of health surveillance** commonly carried out:

- **Health monitoring** - where the individual is **examined for symptoms and signs of disease** that might be associated with the agent in question. For example, a worker in a bakery might have a lung function test to check for signs of asthma; flour dust is a respiratory sensitiser capable of causing occupational asthma.
- **Biological monitoring** - where a **blood, urine or breath sample is taken** and analysed for the presence of the agent itself or its breakdown products. For example, a worker in a car battery manufacturing plant might have a blood sample taken to test for the levels of lead in the bloodstream.

When necessary, health surveillance should be conducted on first employment, to establish a 'baseline', and then periodically. It can also be done when a person leaves employment as a final check. The need for health surveillance is usually subject to Regulations, ACoPs and guidance.

MORE...

There is a range of industry-specific guidance on health surveillance at:

www.hse.gov.uk/health-surveillance/index.htm

Further Control of Carcinogens, Mutagens and Asthmagens

DEFINITIONS

CARCINOGEN

A substance that can induce the growth of malignant tumours (cancer tumours capable of causing serious ill health or death).

MUTAGEN

A substance that can cause changes (mutations) in the genetic material (DNA) of a cell, leading to heritable genetic defects.

ASTHMAGEN

A substance that is related to the development of asthma symptoms.

Exposure to carcinogens, mutagens and asthmagens should be prevented, but if this is not reasonably practicable then control of exposure to the substance would only be considered acceptable if:

- the WEL had not been exceeded,
- the eight principles of good practice had been used, and
- exposure had been reduced to **As Low a level As is Reasonably Practicable (ALARP)**.

To achieve this, the following should be applied:

- Total enclosure of process and handling systems, unless this is not reasonably practicable.
- Prohibition of eating, drinking and smoking in potentially contaminated areas.
- Regular cleaning of floors, walls and other surfaces.
- Designation of areas that may be contaminated with the use of warning signs.
- Safe storage, handling and disposal.

National General Certificate Legal Standards	International General Certificate Standards
• Control of Substances Hazardous to Health Regulations 2002. • Control of Substances Hazardous to Health Regulations (Northern Ireland) 2003.	• ILO C170 - Chemicals Convention, 1990 (No. 170). • ILO R177 - Chemicals Recommendation, 1990 (No. 177). • ILO C139 - Occupational Cancer Convention, 1974 (No. 139). • ILO R147 - Occupational Cancer Recommendation, 1974 (No. 147).

STUDY QUESTIONS

9. Identify the principles of control illustrated by the following measures:
   (a) Using granulated pottery glazes instead of powders.
   (b) Vacuum-cleaning rather than sweeping up with a broom.
   (c) Job rotation.
   (d) Using water-based adhesives rather than solvent-based ones.
10. Outline the difference between local exhaust ventilation and dilution ventilation?
11. Outline what 'dead areas' are and why they are a problem for dilution ventilation systems.
12. Identify the four main types of respirator and the two main types of breathing apparatus.
13. Identify the key criteria in the selection of the appropriate respirator to use.
14. Outline the main purpose of routine health surveillance.

(Suggested Answers are at the end.)

Specific Agents

IN THIS SECTION...

- Asbestos causes several serious ill-health conditions: asbestosis, lung cancer, mesothelioma and pleural plaques.
- Those responsible for the repair and maintenance of premises have a duty to manage asbestos on those premises. This duty involves identifying Asbestos-Containing Materials (ACMs), recording their locations and condition, assessing the risks of exposure, making and implementing an asbestos management plan and providing information to those who might potentially be exposed.
- Any work on asbestos-containing materials must be carried out by competent people using a safe system of work. Often, this work can only be carried out by licensed contractors.
- Other hazardous substances that can cause severe ill health include: blood-borne viruses (such as the hepatitis B virus), carbon monoxide (that can cause asphyxiation), cement (may cause corrosive burns), Legionella bacteria (cause Legionnaires' disease), Leptospira bacteria (cause leptospirosis), silica (causes silicosis) and wood dust (may cause asthma or nasal cancer).

Asbestos

Asbestos is a generic name given to a collection of naturally occurring minerals that have been used extensively as fire-resistant building and insulating materials. Asbestos has excellent heat resistance characteristics and is chemically inert. The three main forms of asbestos are blue (known as crocidolite), brown (amosite) and white (chrysotile). Historically, they have been incorporated into many building parts such as roofs (asbestos cement), ceilings (ceiling tiles), walls and ceilings (in fire breaks), floors (floor tiles), pipes (downpipes), decorative plasters ('artex') and insulation (pipe lagging). It may also be found as asbestos rope or gaskets in old equipment, such as furnaces, chemical pipework or boilers. Material that asbestos incorporated into it is called an **Asbestos-Containing Material** (ACM).

Asbestos

Health Risks Associated with Asbestos

Asbestos is hazardous by inhalation.

Four forms of disease are associated with asbestos exposure:

- **Asbestosis** - where asbestos fibres lodge deep in the lungs and cause scar tissue formation. If enough of the lung is scarred then severe breathing difficulties occur. It can prove fatal, as well as increase risk of cancer.
- **Lung cancer** - asbestos fibres in the lung trigger the development of cancerous growths in the lung tissue. It is usually fatal.
- **Mesothelioma** - asbestos fibres in the lung migrate through the lung tissue and into the cavities around the lung and trigger the development of cancerous growths in the lining tissue. It is always fatal.
- **Diffuse pleural thickening** - thickening of the lining tissue of the lung (sometimes known as 'pleural plaques') that causes breathing difficulties. It is not fatal.

The symptoms of these diseases do not become apparent until years after exposure has occurred (10-15 years for asbestosis and 30-40 years for mesothelioma).

Though asbestos use is now banned in many countries such as the UK, it remains a serious health risk as it is still present in many buildings.

Any work on existing structures where asbestos is present involves the potential to disturb asbestos. Demolition, refurbishment, installation and even minor repair work can expose workers to asbestos by inhalation.

Controls Associated with Asbestos

Legal frameworks for the management of asbestos vary depending on country and region. Here we will look at the practical controls created by the legal framework in the UK.

Where work involves disturbing **Asbestos-Containing Materials (ACMs)** (e.g. construction or refurbishment work) then, in most instances, the ACMs should be removed prior to the work commencing. In the UK, such work is subject to the **Control of Asbestos Regulations 2012** and, in almost all instances, must be carried out by an **HSE-licensed contractor**.

In general:

- The work must be notified to the local enforcement agency (there are some exceptions for small-scale works with low risk of fibre release).
- The work area must be sealed within an enclosure to prevent the escape of air contaminated with asbestos dust.
- The sealed area must be ventilated by a negative pressure ventilation system with high-efficiency particulate air filters. Access is via an airlock.
- Workers entering the sealed area must wear protective clothing and respiratory protective equipment to prevent dust inhalation.
- Workers leave the enclosure and are decontaminated, removing their 'dirty' overalls and showering in a decontamination unit before leaving in clean clothes. The overalls are treated as asbestos waste.
- All ACMs and wastes removed must be securely double-bagged, labelled and disposed of as a hazardous waste at a site licensed to receive it.
- Monitoring of asbestos dust levels in the air must be carried out both inside and outside the sealed work area.
- Worker exposure must not exceed a specified Control Limit (similar in principle to a WEL). In the UK, this is currently 0.1 fibres per cubic centimetre of air (0.1f/cm^3).
- The sealed enclosure should only be removed once monitoring has confirmed that asbestos dust levels have dropped below safe limits and a clearance certificate has been issued.
- Workers must be provided with health surveillance.

Removal and bagging of ACM

Managing Asbestos in Buildings

The occupiers and owners of buildings should be aware of the presence of asbestos, and the **Control of Asbestos Regulations 2012** require them to put in place an **Asbestos Management Plan** and hold an **Asbestos Register**.

TOPIC FOCUS

The duty to manage asbestos involves:

- Identifying asbestos and potential ACMs so that their location and condition is known.
- Assuming that if materials exist in the building that have the potential to contain asbestos, but the presence of asbestos has not been proven, that they are ACMs.
- Making and keeping an up-to-date record (Asbestos Register) with details of these materials.
- Assessing the risks of anyone being exposed to asbestos fibres from these materials.
- Making and implementing an asbestos management plan to manage the risks from these materials.
- Providing information to anyone who is likely to work on or disturb the ACMs (such as contractors working in an area where ACMs have been identified).

Identifying ACMs in a building usually involves some form of survey. Sometimes, samples have to be taken for analysis. Conducting a survey can be done in-house, by competent people, but in many instances must be done by an external **competent surveyor**.

Where ACMs are in a:

- **Good condition** (i.e. the asbestos fibres in the material are not free to leave the material and form an airborne dust) then they can be **labelled** (where possible) but left undisturbed.
- Damaged but **acceptable condition** (i.e. the ACM is damaged but the asbestos fibres in the material are not free to leave the material and form an airborne dust) they can be **encapsulated** (covered and made safe), labelled and left in place.
- **Poor condition** (i.e. the asbestos fibres are loose and can become airborne), or **likely to be disturbed**, they should be **removed**.

Work on ACMs, such as encapsulation, repair or removal work, must always be done by competent people using appropriate work methods and precautions. For low-risk work, this might be any suitably competent person. For other types of work, it must be carried out by an **HSE-licensed contractor**.

Blood-Borne Viruses (BBVs)

There are many viruses that can be transferred from one person to another by transfer of blood and other body fluids. Perhaps the best known of these Blood-Borne Viruses (BBVs) are hepatitis and Human Immunodeficiency Virus (HIV, the causative agent of Acquired Immune Deficiency Syndrome (AIDS)). Hepatitis B and C present the greatest risk in the workplace, so will be used as an example.

There are several forms of hepatitis (A, B, C, etc.) caused by different strains of the virus. The route of infection depends on the virus type, e.g. hepatitis A is contracted orally by cross-contamination with faecal material containing the hepatitis A virus, so sewage workers are at risk.

Hepatitis B and **C** are transmitted in body fluids, such as blood, so occupations at risk would include healthcare workers (doctors and nurses), fire-fighters, police and waste disposal workers. The virus survives for long periods outside the body and can survive harsh treatment that would kill other micro-organisms (such as boiling in water). Contaminated body fluids can cause infection by contact with damaged skin, needle-stick injury and even splashing to the eyes and mouth.

Symptoms of the disease include jaundice and liver damage. Though many people are able to make a full recovery, some will become long-term sufferers and some will continue to carry the virus but do not display any symptoms of infection.

Typical controls include:

- The use of PPE, such as gloves and eye protection when handling potentially contaminated material.
- Correct disposal of potentially contaminated material as clinical waste.
- Prevention of needle-stick injuries by correct disposal of sharps in a sharps bin.
- Decontamination and disinfection procedures.
- Vaccination where appropriate.
- Procedures to deal with accidental exposures, (e.g. needle-stick injury).

MORE...

Further information on BBVs can be found at:

www.hse.gov.uk/biosafety/blood-borne-viruses/index.htm

Carbon Monoxide (CO)

Carbon monoxide (CO) is a colourless, odourless gas usually encountered as a by-product of partial combustion, (e.g. a poorly maintained heating boiler). It is hazardous by inhalation.

During normal respiration, oxygen from the atmosphere is absorbed by the red blood cells in the blood and chemically bound to haemoglobin (a protein) so that it can be carried around the circulatory system to body tissues. Carbon monoxide interferes with this oxygen-carrying process by binding onto the haemoglobin molecule at the same place where the oxygen should be. This prevents oxygen transportation and can lead to death by **asphyxiation**. Low levels of CO (0.005%) will cause a progressively worsening headache. Levels of 1.3% will cause immediate unconsciousness and death within three minutes. Note that this can occur even though oxygen concentrations are normal at 21%.

Typical controls include:

- Restricting work on gas systems to competent engineers only.
- Maintenance and testing of boilers and flues.
- Good general workplace ventilation.
- LEV for vehicle exhausts in workshops.
- Care in the siting of equipment containing combustion engines.
- Carbon monoxide alarms.
- Confined space entry control.

MORE...

Further information on CO can be found at:
www.hse.gov.uk/gas/domestic/co.htm

Cement

Cement is used extensively in the construction industry to make mortar and concrete. In its dry powder form, it is an **irritant** dust, easily inhaled or blown into the eyes. Once mixed with water, it is **corrosive** on skin and eye contact.

Cement is used extensively in the construction industry

Workers can be exposed to cement during:

- Mixing operations - in both the dry powder and mixed, wet form.
- Bricklaying and concrete pouring - in the wet form.

The harmful effects of exposure include:

- Irritation or corrosive burns to the eyes.
- Irritation of the respiratory tract.
- Irritant **dermatitis** on skin contact.
- Allergic dermatitis on repeated skin contact.
- Corrosive burns to the skin on prolonged contact.

Typical controls include:

- Eliminating or reducing exposure.
- Use of work clothing and PPE, such as gloves, dust masks and eye protection.
- Removal of contaminated clothing.
- Good hygiene and washing on skin contact.

Legionella Bacteria

Legionella bacteria are water-loving soil bacteria that are found naturally in the environment. The bacteria are hazardous when inhaled into the lungs, where they cause **Legionnaires' Disease** (also called 'legionellosis').

This can occur when water systems in a workplace become contaminated with the bacteria (which breed in warm conditions) and then that contaminated water is sprayed to create a mist (with living bacteria inside the droplets). The most common sources for outbreaks of the disease are outdoor cooling towers associated with air-conditioning systems. Water containing the bacteria is sprayed inside the cooling tower, then drifts out of the top of the cooling tower and is inhaled by passers-by. These people may then develop the disease.

Symptoms start as 'flu-like (fever, headache, muscle pain, etc.) and then progress to **pneumonia**. The disease can prove fatal, especially for the elderly, infirm or immuno-suppressed, or if not diagnosed early.

Typical controls include:

- **Management Controls**
  - Assessment of the risk from Legionella.
  - A written control scheme (see below).
  - Appointment of a 'responsible person' to carry out risk assessment, manage and implement the written scheme of controls.
  - Review of control measures.

  There are also duties placed on those involved in the supply of water systems.
- **Practical Controls**
  - Avoid water temperatures between 20°C and 45°C and conditions that favour bacteria growth.
  - Avoid water stagnation which can encourage biofilm growth.
  - Avoid using material that can harbour bacteria and provide them with nutrients.
  - Control the release of water spray.
  - Keep water, storage systems and equipment clean.
  - Use water (chemical) treatments where necessary.
  - Carry out water sampling and analysis.
  - Ensure correct and safe operation and maintenance of water systems.

MORE...

Further information on Legionella including the ACoP L8, *Legionnaires' Disease - The control of legionella bacteria in water systems*, is available at:

www.hse.gov.uk/legionnaires/index.htm

Leptospira Bacteria

Leptospira bacteria commonly infect animals such as rats, mice, cattle and horses. Rats and cattle are significant carriers of the disease **leptospirosis**.

Infected rats pass the bacteria in their urine, perhaps onto wet surfaces or into water where the bacteria can stay alive. If contaminated water comes into contact with cuts or grazes, or is ingested, then infection may occur. Occupations at risk are those who work with potentially infected animals (e.g. dairy farmers) or in wet areas where there may be rats (e.g. sewer workers or water sports instructors).

The disease **leptospirosis** starts with 'flu-like symptoms and then progresses to a more serious phase involving jaundice. At this stage, the disease is causing liver damage and may be known as **Weil's disease**. If diagnosed early, the disease is usually treated successfully. It can prove fatal, especially if diagnosed late.

Rats are the main carrier of the leptospira bacteria in the UK

Typical controls include:

- Preventing rat infestation, by good housekeeping and pest control.
- Good personal hygiene (e.g. hand-washing).
- PPE (especially gloves).
- Covering cuts and grazes.
- Issuing workers with an 'at risk' card to be shown to GP to allow early diagnosis.

MORE...

Further information on leptospirosis is available at:

www.hse.gov.uk/construction/healthrisks/hazardous-substances/harmful-micro-organisms/leptospirosis-weils-disease.htm

Silica

DEFINITION

SILICA

A crystalline mineral component of rock commonly encountered in the mining, quarrying, pottery and construction industries. Commonly known as 'quartz'.

Silica is hazardous by inhalation. When inhaled, **Respirable Crystalline Silica** (**RCS**) dust is deposited deep in the lungs where it causes scar tissue to form (silicosis is very similar to asbestosis). This progressive disease leads to breathlessness and chest pain and can prove extremely disabling and fatal, by heart and lung failure.

Typical controls include:

- Prevention of exposure by use of alternative work methods.
- Dust suppression by water jet/spray.
- Local exhaust ventilation.
- Respiratory protective equipment.
- Health surveillance (lung function test and chest X-ray).

MORE...

The following link provides more details on silicosis:

www.hse.gov.uk/lung-disease/silicosis.htm

Wood Dust

Wood dust is hazardous on inhalation and causes **asthma**. All wood dusts cause irritation to the respiratory system. Certain types of wood dust are more likely to cause asthma than others and are therefore categorised as asthmagens.

Hardwood dusts can cause nasal cancer (cancer of the nasal cavity behind the nose). Again, certain types of hardwood are more strongly associated with risk of cancer and are therefore recognised as carcinogens. Workers in the woodworking industry are most at risk of exposure to wood dust.

Typical controls include:

- Local exhaust ventilation systems.
- The use of vacuuming to clean up dust (not sweeping).
- Respiratory protective equipment.
- Health surveillance (usually annual questionnaires).

In **all** of the examples given above, the **COSHH Regulations** require:

- Risk assessment of potential exposure.
- Prevention or control of exposure.
- Maintenance of the various control measures used.
- Provision of information, instruction and training for employees.

National General Certificate Legal Standards	International General Certificate Standards
• Control of Substances Hazardous to Health Regulations 2002. • Control of Substances Hazardous to Health Regulations (Northern Ireland) 2003. • Control of Asbestos Regulations 2012. • Control of Asbestos Regulations (Northern Ireland) 2012.	• ILO C170 - Chemicals Convention, 1990 (No. 170). • ILO R177 - Chemicals Recommendation, 1990 (No. 177). • ILO C162 - Asbestos Convention, 1986 (No. 162). • ILO R172 - Asbestos Recommendation, 1986 (No. 172).

STUDY QUESTIONS

15. Explain how carbon monoxide (CO) is hazardous to health.
16. Identify three diseases associated with asbestos exposure.
17. Outline how cement is hazardous to health.

(Suggested Answers are at the end.)

Safe Handling and Storage of Waste

IN THIS SECTION...

- Waste must be handled and stored safely prior to disposal.
- Employers must risk assess the storage and handling of waste to ensure safety and absence of health risk to workers.

Waste

DEFINITION

WASTE

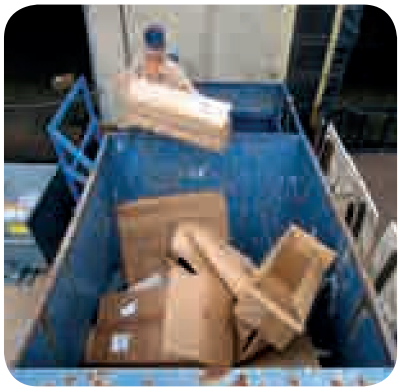
Something that is discarded, or is going to be discarded.

It is important to consider the health and safety issues associated with the management of waste in a workplace. Factors to consider include the following:

- The **hazardous** nature of the waste - the waste may be inherently hazardous to staff involved in handling it, e.g. toxic or radioactive. This may require the use of PPE.
- The waste may present a **manual handling** risk. This might be overcome by the use of mechanical handling equipment or handling aids.
- Storage equipment, such as skips, bins and compactors, may be difficult to **access** and may require steps or platforms to allow safe use.
- Waste containers/skips should be stored on concrete surfaces and not on unstable or unmade ground (grass or earth) to prevent ground and groundwater contamination.

Landfill site

- Compactors will have **moving parts** that must be effectively guarded to prevent access.
- Collection **vehicles**, such as skip lorries, present a significant hazard when manoeuvring, especially when reversing (and should be seen back by a banksman).
- The waste may present a temptation to scavengers (e.g. waste metals) and to vandals (unlocked storage tank valves) and so must be **secured**.
- Stored liquid waste should be contained in either a **double-skinned container** or the vessel should be contained in a **bund**.
- Bunds should have the capacity to store **110% of the volume of the largest container** in the bund. Provision should be made to empty the bund of rainwater.



Worker loading a waste compacter

- Where waste liquids are pumped, transferred or decanted, the transfer points or tanker connections should be contained in a bunded area or the operation carried out over a drip tray.

- Bunds should be protected from vehicle damage and regularly inspected for leaks.
- Any escape may have the potential to cause **pollution**. Adequately securing the waste might control this risk, but emergency spill or release plans may also be required, along with the necessary personnel, equipment and training to put these plans into effect.
- Different waste types (**waste streams**) must be **segregated** to prevent the mixing and contamination of one type of waste with another. This usually requires separate secure storage for each type of waste and the clear identification of types.
- Appropriate **documentation** should accompany the waste and the duty of care, to dispose of waste in line with legal requirements, must be fulfilled.

DEFINITIONS

BUND

A wall built around a tank or vessel which is designed to contain the contents of the tank, should it rupture. The bund wall and base must be impervious to water and should not have any penetrations through it. Bunds can also be portable, pallet-sized trays to contain drum spillages or spills from offloading or decanting (sometimes called 'drip trays').

DOUBLE-SKINNED VESSEL

As an alternative to bunding, a tank may have an inner and an outer wall. In the event that one is ruptured, the other will contain the contents.

TOPIC FOCUS

Spill containment procedures are important wherever liquid pollutants are present. Measures that could be taken include:

- The provision of spill kits containing booms to contain the spillage and absorbent granules or pads to soak up the spill (ready for safe disposal).
- Drain covers which can be used to seal surface water drains.
- Containers and equipment (such as shovels) for the collection of the spill.
- PPE for workers to wear during clean up operations.
- A safe system of work on collection and safe disposal.
- Training of operators in the use of the spill kits.

MORE...

Browse the following website for more information:

www.hse.gov.uk/waste/index.htm

National General Certificate Legal Standards	International General Certificate Standards
• Control of Substances Hazardous to Health Regulations 2002. • Control of Substances Hazardous to Health Regulations (Northern Ireland) 2003.	• ILO C170 - Chemicals Convention, ILO C170 - Chemicals Convention, 1990 (No. 170). • ILO R177 - Chemicals Recommendation, 1990 (No. 177).

STUDY QUESTION

18. Identify six hazards that might arise when handling and storing waste for disposal.

(Suggested Answer is at the end.)

Summary

This element has dealt with some of the hazards and controls relevant to hazardous substances in the workplace.

In particular, this element has:

- Outlined the different physical forms of chemicals (solids, dusts, fumes, gases, mists, vapours and liquids) and biological agents (fungi, bacteria and viruses) that can be hazardous to health.
- Identified the classification of hazardous chemicals (acute toxicity, skin corrosion/irritation, eye corrosion/irritation, respiratory or skin sensitisation, carcinogenicity/mutagenicity/reproductive toxicity, and specific target organ toxicity) and the meaning of the terms 'acute' and 'chronic' when used to describe their effects.
- Explained the main routes of entry into the body (inhalation, ingestion, absorption through the skin and injection through the skin).
- Noted some principles for assessing risk from exposure to hazardous substances and the sources of information used (especially product labels, manufacturers' safety data sheets and guidance notes such as EH40).
- Identified the requirement to undertake basic monitoring to assess concentrations of hazardous substances in the workplace.
- Outlined the principle of Occupational Exposure Limits (OELS), such as Workplace Exposure Limits (WELs) and the use of short-term and long-term exposure limits.
- Outlined the principles of good practice for controlling exposure.
- Described a hierarchy of controls for hazardous substances: eliminate or substitute the substances, change the process, reduce exposure time, enclose or segregate, local exhaust ventilation, dilution ventilation, respiratory protective equipment, other personal protective equipment, personal hygiene, and health surveillance.
- Outlined basic principles of local exhaust ventilation and dilution ventilation.
- Described types of respiratory protective equipment: respirators (filtering facepiece, half-mask, full-face and power types) and breathing apparatus (compressed air and self-contained types).
- Described the ill-health effects of asbestos, various chemicals, (e.g. carbon monoxide) and biological agents, (e.g. Legionella) found in workplaces and the general controls required.
- Identified basic issues associated with waste disposal.

Exam Skills

QUESTION 1

Employees can be exposed to chemical agents in the workplace.

(a) **Identify FOUR** forms that chemical agents can take. **(4)**

(b) **Outline** the differences between the acute and chronic health effects from exposure to chemical agents. **(4)**

Approaching Question 1

Think about the steps you would take to answer the question:

Step 1. The first step is to **read** the question carefully. Note that this question asks for forms of chemical agents and effects from exposure to chemical agents, so outlining the chronic effects from exposure to fungi, for example, will not score any marks at all because they are not chemical agents.

Step 2. Now highlight the **key words**. In this case, they might look like this:

Employees can be exposed to **chemical agents** in the workplace.

(a) **Identify FOUR forms** that chemical agents can take. **(4)**

(b) **Outline** the **differences** between the **acute** and **chronic** health effects from exposure to chemical agents. **(4)**

Step 3. Next, consider the **marks** available. In this question there are eight marks, so it is expected that around eight or nine different pieces of information should be provided. This question asks specifically for four forms of chemical agents - you should therefore provide four or five. The second part asks for the differences between acute and chronic effects from chemical agents - here, you might provide four or maybe more pieces of information. The question should take around eight minutes in total.

Step 4. **Read** the question again to make sure you understand it and have a clear understanding of chemical agents and differences between acute and chronic effects. (Re-read your notes if you need to.)

Step 5. The next stage is to develop a **plan** - there are various ways to do this. Remind yourself, first of all, that you need to be thinking about 'chemical agents'. When you see the command word 'identify', you simply need to select and name the form of the chemical agents. So, the answer plan and the answer would take a very similar form which is not much more than a list. For part (b), the examiners would be looking for an **outline** of the differences between acute and chronic health effects.

Your answer must be based on the key words you have highlighted. So, in this case, we need to identify four forms of chemical agents that employees can be exposed to and outline the differences between acute and chronic health effects.

Now have a go at the question. Draw up an answer plan, and then use it as the basis to write out an answer as you would in the exam.

Remember, you can always contact your tutor if you have any queries or need any further guidance on how to answer this question.

When you have finished, compare your plan and full answer with those that follow.

Suggested Answer Outline

(a)	Forms of chemical agents - solids, dusts, fumes and fibres, gas, mists/aerosols, vapours, liquids. (Four needed.)
(b)	Differences between acute and chronic health effects: **Acute** • Short-term. • Usually rapid response. • Usually recede on cessation of exposure. • Adverse effects appear after single high level of exposure. **Chronic** • Long-term. • Usually slow response. • Usually do not recede on cessation of exposure. • Adverse effects more likely to appear after long-term low levels of exposure.

Example of How the Question Could be Answered

(a) *Dust - finely ground solid materials which can become airborne; mists - finely dispersed liquid droplets suspended in air; liquids - substances which are fluid; metals which are fumes - tiny metal particles in the air which are formed when molten metal vapourises and then recondenses.*

(b) *An acute health effect is a short-term effect normally experienced as an immediate or rapidly produced adverse reaction, such as inflammation of the skin, when exposed to a chemical. Acute effects usually follow a single big over-exposure during a short period of time. Acute effects are usually reversible by removing the offending agent.*

A chronic health effect is a long-term effect normally experienced as a result of prolonged or repeated exposure with a gradual, and often irreversible, effect. Often, the chronic effects from exposure go unrecognised for long periods of time. Chronic effect may last a lifetime.

Reasons for Poor Marks Achieved by Candidates in Exam

- Providing a list for part (a) without identifying the form of the agent.
- Answering a question that was not asked and supplying answers on subjects such as routes of entry to the body.
- Using examples of chronic illnesses that are not caused by chemical agents (e.g. using noise-induced hearing loss as an example of a chronic illness).

QUESTION 2

(a) **Identify THREE** different forms of biological agent that might be encountered at work. **(3)**

(b) **Identify THREE** routes of entry by which a biological agent might possibly gain entry to the body. **(3)**

(c) **Give TWO** typical control measures that could be used to reduce the risk of worker exposure to a biological agent. **(2)**

Approaching Question 2

By now you should hopefully be getting quicker at these questions, so try this one in 15 minutes. At this stage, it doesn't matter if it takes you longer but on the day you will need to do each eight-mark question in about eight minutes.

Think now about the steps you would take to answer the question:

Step 1. The first step is to **read** the question carefully. Remember the command words - you are required to 'identify' and 'give' here, so think about the level of detail that this calls for.

Step 2. Now highlight the key words. In this case, they might look like this:

(a) **Identify THREE different forms** of **biological agent** that might be encountered at work. **(3)**

(b) **Identify THREE routes of entry** by which a biological agent might possibly gain entry to the body. **(3)**

(c) **Give TWO** typical **control measures** that could be used to reduce the risk of worker exposure to a biological agent. **(2)**

Step 3. Next, consider the **marks** available. You should aim to provide a piece of information for every mark allocated. Here, you have been told exactly how many pieces of information you need to provide for each part of the question.

Step 4. **Read** the question again to make sure you understand about biological agents and their routes of entry, which should also help you suggest control measures. (Re-read your notes if you have to.)

Step 5. The next stage is to develop a **plan** - you are now familiar with how to do this. The answer plan will take the form of a bullet-pointed list that you need to develop into a full answer based on the key words that you have highlighted.

Now have a go at the question. Draw up an answer plan, and then use it as the basis to write out an answer as you would in the exam.

HINTS AND TIPS

Check carefully the type of hazardous agent the question is asking about.

When you have finished, compare your plan and full answer to those that follow.

Suggested Answer Outline

Forms of Biological Agent	Routes of Entry	Control Measures
Bacteria. Viruses. Fungi.	Three from: • Inhalation. • Absorption. • Ingestion. • Injection.	Two from: • Respiratory protection, e.g. dust masks. • Gloves and goggles. • Good hygiene procedures. • Disinfection and destruction of materials. • Cover wounds. • Immunisation, e.g. hep B.

Example of How the Question Could be Answered

(a) Three different forms of biological agents include bacteria, viruses and fungi.

(b) Three possible routes of entry for a biological agent include inhalation (e.g. of dusts or spores), absorption (through the skin, eyes or mucus membranes), and injection (e.g. through needle-stick injuries).

(c) Two typical control measures include the use of PPE - such as goggles and gloves - to prevent skin and eye contamination with biological agents, or the use of immunisation to provide immunity from infection for some agents, such as hepatitis B vaccinations given to health workers or first aiders.

Reasons for Poor Marks Achieved by Candidates in Exam

This may look like a daunting question, but as little detail is required, it could prove quite a quick question to answer. By asking about the types of agent, then the routes of entry, the question has naturally led you to consider control measures.

Element 8

Physical and Psychological Health Hazards and Risk Control

Learning Outcomes

Once you've read this element, you'll understand how to:

1. Outline the health effects associated with exposure to noise and appropriate control measures.
2. Outline the health effects associated with exposure to vibration and appropriate control measures.
3. Outline the health effects associated with ionising and non-ionising radiation and appropriate control measures.
4. Outline the meaning, causes and effects of work-related stress and appropriate control measures.

Contents

Noise

IN THIS SECTION...

- Exposure to excessive noise causes Noise-Induced Hearing Loss (NIHL) as well as other health and safety risks.
- Noise exposure standards are based on a worker's daily personal noise exposure. An exposure of 85 dB(A) over an eight-hour work shift is generally considered to be the upper exposure standard at which action has to be taken to reduce exposure.
- Noise exposure should be assessed by undertaking a noise survey using a sound level meter.
- Control of exposure to noise can be achieved by:
  - Reducing the noise at source: by elimination, substitution, maintenance, damping and silencing.
  - Interrupting the pathway from source to receiver: by isolation and absorption.
  - Protecting the receiver: by providing an acoustic haven or PPE.
- There are two types of hearing protection: ear defenders and ear plugs. Both types have strengths and limitations.
- Health surveillance in the form of hearing tests (audiometry) is required where employee exposure is above the upper exposure action value.

The Effects of Exposure to Noise

There are many health and safety issues associated with noise in the workplace.

Physical Effects

Physical effects include:

- Temporary reduction in hearing sensitivity as a result of short-duration exposure to excessively loud noise, e.g. muffled hearing after a loud concert.
- Noise-Induced Hearing Loss (NIHL) - permanent, progressive loss of hearing as a result of repeated exposure to excessively loud noise.
- Tinnitus - persistent ringing in the ears as a result of repeated exposure to excessively loud noise. This may be temporary or permanent.
- Inability to hear:
  - hazards such as vehicles;
  - alarms and warning sirens;
  - conversation and spoken instructions;

  as a result of background noise.

Exposure to excessively loud noise can have a range of effects

Psychological Effects

Psychological effects include:

- Stress effects - caused by irritating nuisance/background noise.
- Difficulty concentrating and an increase in errors caused by nuisance/background noise.

Perhaps the most serious effect is **noise-induced hearing loss** (or industrial deafness). This is usually caused by long-term, repeated exposure to excessively loud noise (though it can be caused by one-off exposure to extremely loud noise).

When people are exposed to excessively loud noise, the hearing mechanism itself is damaged. The hearing mechanism transmits noise from the outside environment through the outer and middle ear to the inner ear (the transmission route is ear canal; eardrum; hammer; anvil; stirrup; cochlea). Microscopically small sensory hairs in the cochlea in the inner ear then detect the noise and send nerve impulses to the brain. Exposure to excessively loud noise disturbs and destroys these microscopically small hairs.

One-off exposure to high-noise levels, (e.g. four hours of work in a high-noise area) will probably cause a temporary loss of hearing sensitivity (called '**temporary threshold shift**') and temporary ringing in the ears (**tinnitus**). The microscopically small hairs have been disturbed, but not damaged beyond repair. Repeated exposures result in **permanent threshold shift** - irreparable damage because the sensory hairs are parts of nerve cells that do not regenerate. This is **noise-induced hearing loss**.

This hearing loss does not normally occur quickly, but over years as noise exposure continues. The damage is **progressive and irreversible** - once it starts, any further exposure to excessive noise will result in further damage.

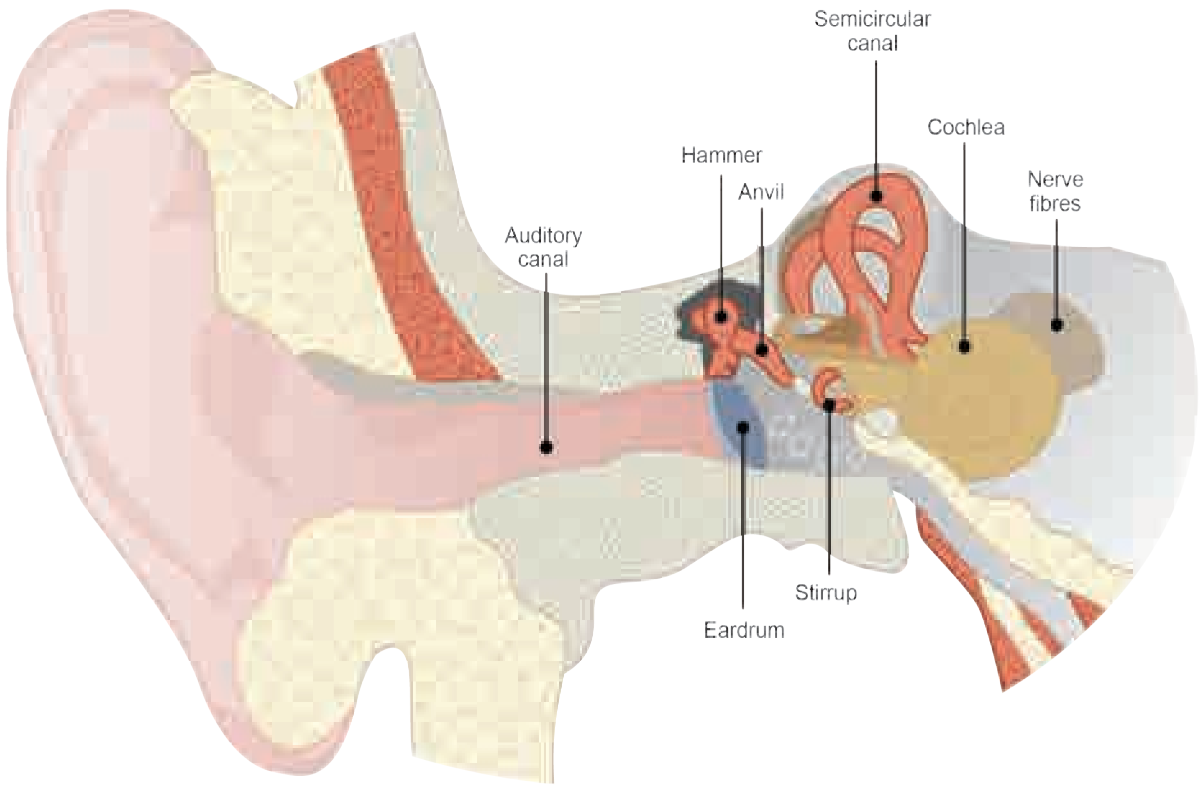


Diagram showing the internal parts of the ear

Terminology

The following basic terminology is used in the measurement and assessment of noise exposures in the workplace:

- **Sound pressure** - the air pressure of sound waves moving through the air. This pressure is measured using the decibel (dB) scale.
- **Intensity** - a measure of the energy carried by sound pressure waves moving through the air (which we subjectively call the 'volume' or 'loudness').
- **Decibel (dB)** - the unit of sound pressure level. The decibel scale is a logarithmic scale; this means that relatively small increases in decibel value actually represent very large increases in intensity. For example, an increase of just 3 dB represents a doubling of sound intensity.
- **Frequency** - a measure of the number of sound pressure waves that pass a fixed point in one second (the 'pitch'); the unit is the hertz (Hz). The human ear is sensitive to noise across a wide range of frequencies: from 20Hz (very low frequencies - bass) to 20,000Hz (very high frequencies - high pitch). Equally, there are some sounds the human ear can't hear as they are outside of this frequency range, e.g. a high-pitched whistle.
- **A-weighting** - during noise assessment, A-weighting is applied to the decibel values at different frequencies to give a sound pressure level expressed as **dB(A)**. This A-weighting converts the decibel value to take into account the sensitivity of the human ear across a range of frequencies. In other words, it is the decibel value corrected for the sensitivity of the human ear.
- **C-weighting** - during noise assessment, C-weighting may be applied to the decibel values at different frequencies to give a sound pressure level expressed as **dB(C)**. This C-weighting gives a more accurate reading for **impulse** noise - single loud bangs that would not be properly recorded using the dB(A) scale.

Typical decibel levels associated with different noise sources

Measurement in dB(A)	Sound
0	The faintest audible sounds
20-30	A quiet library
50-60	A conversation
65-75	A loud radio
90-100	A power drill
140	A jet aircraft taking off 25m away

The Assessment of Noise Exposure

Damage to hearing in the form of noise-induced hearing loss and tinnitus is dependent on the 'dose' of noise that a person receives. This 'dose' of noise is determined by the sound pressure level that the person is exposed to in combination with, the duration of time that they are exposed to it for.

In order to work out what a worker's exposure to noise is in the workplace and whether the dose of noise that they have been exposed to is excessive, or not, the employer has to undertake some form of technical **noise assessment**. In most countries, this noise assessment requirement is written into legal standards. Though the technical details vary, it is easiest to demonstrate the general principle by considering one regulatory regime: the one used in the UK and the EU.

Noise assessments are required, by the **Control of Noise at Work Regulations 2005**, where there is likely to be significant exposure to noise. Simple hearing checks can be used to estimate noise levels; if normal conversation cannot be heard at a distance of two metres from the speaker then the noise levels are likely to be in the region of 85 dB(A).

Where a noise assessment is needed, some form of noise measurement will probably have to be carried out. Before this is done, information has to be obtained from the workplace, (e.g. about the noise sources in the workplace and shift patterns). This background information can then be used to target the survey and can help in the interpretation of results.

Different types of sound level meter (noise meter) are used to undertake noise measurements. Because these are scientific instruments they have to be calibrated before use.

The results of a noise survey need to be interpreted to give an accurate estimate of workers' exposures. These exposures can then be compared to the legal standards and any necessary action identified.

Noise measurement and assessment is a complex topic that should only be undertaken by a competent person.

Noise Exposure Standards

The **Control of Noise at Work Regulations 2005** recognise exposure standards that have been set on the basis that the amount of damage done to the ear is dependent on the amount of energy absorbed by the inner ear. This is determined by two factors:

- **Noise level** (measured in dB(A)).
- **Duration of exposure** (in hours and minutes).

These two factors determine the 'dose' of noise absorbed (a similar principle to hazardous substances and OELs/WELs outlined in Element 7). So, it is necessary, when undertaking a noise assessment, to measure a worker's actual exposure to noise (which will fluctuate) and then to calculate what the equivalent eight-hour exposure will be. This is referred to as their **daily personal noise exposure** ($L_{EP,d}$). In some cases, a weekly personal noise exposure is calculated instead ($L_{EP,w}$). Worker's exposure to **peak sound pressures** from impulse noise (loud bangs) is also measured.

Once a worker's daily personal noise exposure and peak exposure have been estimated, they are compared to the legal standards. There are three of these standards: a lower exposure action value, an upper exposure action value and a limit value.

The **lower exposure action values** are:

- A daily or weekly personal noise exposure of 80 dB(A).
- A peak sound pressure of 135 dB(C) for impulse noise.

The **upper exposure action values** are:

- A daily or weekly personal noise exposure of 85 dB(A).
- A peak sound pressure of 137 dB(C) for impulse noise.

The **exposure limit values (as absolute limits)** are:

- A daily or weekly personal noise exposure of 87 dB(A).
- A peak sound pressure of 140 dB(C) for impulse noise.

If worker exposure lies at or above one of these standards, then the employer is required to undertake certain actions.

These actions are set out as follows:

TOPIC FOCUS

The actions triggered by the three noise at work standards:

- **Lower Exposure Action Value**

  At or above this value, the employer must:

  – Carry out and record a noise assessment.

  – Provide information, instruction and training to employees.

  – Make hearing protection available.

  (Note that they do NOT have to enforce the use of that hearing protection.)

- **Upper Exposure Action Value**

  At or above this value, the employer must:

  – Carry out and record a noise assessment.

  – Reduce noise exposure to the lowest level reasonably practicable by means other than hearing protection.

  If noise levels are **still** above 85 dB(A), the employer must:

  – Establish mandatory hearing protection zones.

  – Provide information, instruction and training to employees.

  – Provide hearing protection and enforce its use.

  – Provide health surveillance (audiometry). (See later.)

- **Exposure Limit Value**

  At or above this value, the employer must immediately prevent exposure and reduce it below the limit value.

So, for example, if a noise assessment shows that a worker's exposure to noise is:

- A daily personal noise exposure of 82 dB(A) as a result of moderately loud background machinery (i.e. above the lower exposure action value but below the upper exposure action value), then the employer must provide information, instruction and training on the risk to hearing and make hearing protection available on request.
- A peak exposure of 139 dB(C) as a result of impulse noise (i.e. above the upper exposure action value but below the limit value), then the employer must reduce exposure using technical and administrative control measures other than PPE to the extent that they can. If this does not reduce exposure below the upper exposure action value (137 dB(C)), then the employer must designate a mandatory hearing protection zone; display signs; provide hearing protection; provide information, instruction and training; and enforce the use of the PPE.
- A daily personal noise exposure of 92 dB(A) as a result of excessively loud machinery use (i.e. above the limit value), then the employer must immediately stop work and reduce exposure below the limit value (perhaps by introducing PPE and then considering how to achieve compliance with the upper exposure action value requirements).

Basic Noise Control Measures

In simple terms, noise exposure can be controlled in three ways, by:

- Reducing the noise at source.
- Interrupting the pathway from source to receiver.
- Protecting the receiver.

The following sections deal with each of these techniques in more detail.

Reducing Noise at Source

This can be achieved by:

- **Eliminating the source** - completely remove the noise source; not practical in many instances.
- **Substituting the source** - change the noise source for something else that does the same job but generates less noise, (e.g. change a petrol-driven machine for an electric version).
- **Modifying the process** - e.g. by changing from glass to plastic bottles, noise from a packing line can be reduced; or by replacing a compressed-air rivet gun with a screw fixing, manufacturing noise can be reduced.
- **Maintenance** - machinery often produces noise because it is in need of maintenance.
- **Damping** - machine parts (especially metal surfaces) can sometimes resonate in harmony with noise being produced by the machine (like a cymbal that rings when hit). This exaggerates the noise generated. Damping changes the resonance characteristics of the metal part to prevent it ringing in this way. This can be achieved by changing the part, stiffening it or even adding material to one side of it.
- **Silencing** - any machine that produces exhaust gases, (e.g. a diesel generator) should be fitted with a silencer on the exhaust to suppress noise.

Interrupting the Pathway

This can be achieved by:

- **Insulation** - in some instances, it is possible to build an **acoustic enclosure** around the noise source. Noise is generated inside the enclosure but cannot penetrate through the walls to the outside work environment. For example, a static diesel generator might be placed in a separate building with sound-insulating walls.
- **Isolation** - noise is often transmitted in the form of mechanical vibration from machinery into supporting structures, (e.g. from a compressor into the floor it is mounted on). Isolation involves separating the machine from any supporting structure using vibration-absorbent mats or springs. This breaks the transmission pathway.
- **Absorption** - once noise has escaped from its source, it may travel directly to the receiver through air or may be reflected off hard surfaces (such as walls and ceilings). Absorption involves putting sound-absorbing material in the workplace to absorb these sound waves before they can reach the receiver, e.g. a sound-absorbent material might be used to line a wall, preventing reflection of sound waves in much the same way that carpets and curtains in a house stop sound reverberating round the room.

Protect the Receiver

This can be achieved by:

- **Acoustic haven** - if the workplace is inherently very noisy and it is not possible to apply the above controls, then an acoustic haven might be built that workers can retreat into to escape the noisy environment.
- **Hearing protection** - if none of the above is effective or possible, then some form of hearing protection should be used to reduce the amount of noise that penetrates to the worker's ear.

Hearing Protection

Hearing protection prevents harmful levels of noise from reaching the ear.

The two principal types are:

- **Ear defenders or muffs** - these encase the outer ear in a cup with some sort of foam- or gel-filled cushion to seal against the side of the head.

Advantages of Ear Defenders	Limitations
Easy to supervise and enforce use as they are visible	Uncomfortable when worn for long time
Less chance of ear infections	Must be routinely inspected, cleaned and maintained
Higher level of protection possible through all sound frequencies; bone transmission is reduced	Efficiency may be reduced by long hair, spectacles or earrings
Can be integrated with other PPE, e.g. safety helmets	Incompatible with some other items worn
Re-usable	Need dedicated storage facility

- **Ear plugs** - these fit into the ear canal.

Advantages of Ear Plugs	Limitations
Cheap	Difficult to see when fitted, so supervision and enforcement difficult
Disposable	Risk of infection if dirty or if cross-contaminated when inserted
Often more comfortable to wear	
Do not interfere with any other items worn, (e.g. PPE)	

Various factors must be taken into account when selecting hearing protection, such as the noise levels and the strengths and limitations of the various types available. Employees should be involved in the selection process. Often, one of the most significant factors is the ease of enforcement (ear defenders can be seen from a distance whereas ear plugs cannot).

Whichever type of hearing protection is chosen, arrangements should be made for:

- Information, instruction and training - on how to wear the hearing protection; its limitations in use; cleaning, maintenance and replacement arrangements.
- Safe storage - in hygienic locations.

Worker near noisy machinery wearing ear defenders

- Cleaning:
  - Ear defenders are often designed to be dismantled for easy cleaning.
  - Plugs are usually disposable.
- Maintenance - including routine inspection and replacement of worn parts, (e.g. cushions on ear defenders).
- Replacement - of lost or damaged items.

Attenuation

Each make and model of hearing protection will have their own **attenuation characteristics** - i.e. ability to filter out noise. This is important because the hearing protection selected by the employer must be good enough to reduce noise levels at the worker's ear to an acceptable level. The level of noise able to penetrate to the ear must be calculated to ensure that it is below any relevant exposure limit; to do this, information is required on the:

- Noise characteristics of the workplace (from a noise survey).
- Attenuation characteristics of the hearing protection (the reduction in noise level they give). The attenuation characteristics of the hearing protection come from the manufacturer.

Note that ear defenders can give higher attenuation than ear plugs because some noise can be transmitted through the bone of the skull - this transmission route is partly blocked by defenders but not by plugs. Also note that the attenuation characteristics of hearing protection are measured in laboratory conditions. Ear defenders, in particular, can give lower attenuation in practice because of hair, glasses or earrings which push the ear defender away from the side of the head.

Hair, glasses and earrings can stop ear defenders working effectively

The Role of Health Surveillance

Health surveillance is appropriate for workers exposed to high noise levels, in the form of **audiometry**. Audiometry is a medical test that quantifies the sensitivity of a person's hearing across a range of frequencies (low pitch to high pitch). It normally involves the worker sitting in a soundproof booth with headphones on, listening for faint beeps and indicating when the beeps can be heard. The results can show whether a person's hearing is being affected by exposure to loud noise and, if so, to what extent.

The **Control of Noise at Work Regulations 2005** indicate that audiometry should be carried out on all workers potentially exposed at, or above, the 85 dB(A) $L_{EP,d}$ action level (i.e. those working in mandatory hearing protection areas). It might also be conducted on workers with known hearing damage at lower levels (80 dB(A) $L_{EP,d}$).

Any worker who might potentially be exposed to damaging noise levels should be given an audiometry test when they first start work, to establish a baseline for their hearing and to indicate whether they have pre-existing damage.

Audiometry allows:

- Identification of workers with:
  - Pre-existing hearing damage.
  - New hearing damage (which may be work-related).
- Removal/exclusion of such workers from high-noise areas (to protect them from further hearing loss).
- Investigation of noise controls to identify and rectify problems (to protect others in the same work area).

Audiometry should be conducted by trained, competent persons with the potential for referral of cases to a medical practitioner.

Occupations at Risk

The following occupations may be at risk from excessive noise exposure:

- Construction workers - as a result of plant and machinery operation, such as concrete breakers.
- Uniformed services - such as army personnel exposed to noise from small arms and artillery.
- Entertainment sector workers - such as night club staff exposed to loud music.
- Manufacturing sector workers - exposed to industrial machinery noise.
- Call centre staff - exposed to loud noise and acoustic shock from the use of headsets.

MORE...

Browse the HSE website for more information on noise at work, at:

www.hse.gov.uk/noise/index.htm

National General Certificate Legal Standards	International General Certificate Standards
• Control of Noise at Work Regulations 2005. • Control of Noise at Work Regulations (Northern Ireland) 2006.	• ILO C155 - Occupational Safety and Health Convention, 1981 (No. 155). • ILO R164 - Occupational Safety and Health Recommendation, 1981 (No. 164). • ILO C148 - Working Environment (Air Pollution, Noise and Vibration) Convention, 1977 (No. 148). • ILO R156 - Working Environment (Air Pollution, Noise and Vibration) Recommendation, 1977 (No. 156).

STUDY QUESTIONS

1. What does a daily personal exposure of 85 dB(A) mean?
2. What are the limitations of ear defenders and ear plugs?

(Suggested Answers are at the end.)

Vibration

IN THIS SECTION...

- Exposure to excessive vibration into the hand can cause hand-arm vibration syndrome. Health effects can also be seen for whole-body vibration.
- Exposure standards exist for both hand-arm vibration and whole-body vibration.
- Vibration exposure can be controlled by:
  - Reducing the vibration at source - by eliminating the source, substituting the source, changing work techniques and maintenance.
  - Interrupting the pathway from source to receiver - isolation.
  - Limiting the duration of exposure.
- Health surveillance is required where workers are exposed to high levels of hand-arm vibration.

Introduction to Vibration

Vibration is similar in many respects to noise, both in terms of its physical characteristics and preventive measures. Vibration is the oscillatory (back and forth) motion of an object. There are two types of vibration exposure that give rise to occupational health effects:

- **Hand-arm vibration** - this is mechanical vibration that passes into the hands and arms as a result of having your hands on the handles or grips of a tool.
- **Whole-body vibration** - this is the mechanical vibration that passes into your body through your feet and legs or backside as a result of standing or sitting on a vibrating surface.

So, for example, a worker using an angle grinder would be exposed to hand-arm vibration, whereas a dumper truck driver would be exposed to whole-body vibration.

Health Effects of Exposure to Vibration

The health effects associated with vibration exposure depend on the type of exposure and fall into two main categories.

Typical vibration white finger
Source: L140 Hand-arm vibration, HSE, 2005 (www.hse.gov.uk/pubns/priced/l140.pdf)

Hand-Arm Vibration Syndrome (HAVS)

Hand-Arm Vibration Syndrome (**HAVS**) is a condition that specifically affects the hands and arms as a result of a significant hand-arm vibration dose.

Symptoms include:

- **Vibration white finger** - the blood supply to the fingers shuts down (often in response to cold) and the fingers turn white (known as 'blanching'). The blood supply returns after a time and the fingers become red and painful.
- **Nerve damage** - the nerves carrying sensory information from the fingers stop working properly, resulting in 'pins and needles' and a loss of pressure, heat and pain sensitivity.

- **Muscle weakening** - where grip strength and manual dexterity are reduced.
- **Joint damage** - abnormal bone growth at the finger joints can occur.

HAVS normally results from long-term exposure (5 to 10 years or more) to hand-arm vibration, (e.g. from use of a chainsaw). It is an incurable condition. Once damage has been done, it is unlikely to reverse, and any further exposure to vibration will do further damage. The most appropriate treatment for most workers is for them to give up the use of vibrating hand-tools.

The other health effect associated with hand-arm vibration exposure is **carpal tunnel syndrome** (see work-related upper limb disorders in Element 3).

Whole-Body Vibration Effects

This is a relatively poorly understood area of concern. Health effects can result from a significant vibration dose to the body, normally through the buttocks (from sitting, e.g. a dumper truck driver) or the feet and legs (from standing, e.g. aircraft cabin crew). The most significant health effect is back pain as a result of damage to the soft tissues of the spine (such as the intervertebral discs) though other effects have been reported (such as vertigo).

The Assessment of Vibration Exposure

There are many parallels between vibration and noise as an occupational health risk. Damage to the body in the form of hand-arm vibration syndrome and back pain is dependent on the ‘dose’ of vibration that a person receives.

This ‘dose’ of vibration is determined by the vibration level (called the ‘vibration magnitude’) that the person is exposed to in combination with the duration of time that they are exposed to it for.

In order to work out what a worker's exposure to vibration is in the workplace and whether the dose of vibration that they have been exposed to is excessive, or not, the employer has to undertake some form of technical **vibration assessment**. In most countries, this vibration assessment requirement is written into legal standards. Though the technical details vary, it is easiest to demonstrate the general principle by considering one regulatory regime: the one used in the UK and the EU.

Vibration assessments are required, by the **Control of Vibration at Work Regulations 2005**, where workers are likely to receive a significant exposure to vibration.

Vibration exposure standards are set on the basis that the amount of damage done is dependent on the amount of energy absorbed by the body.

This is determined by the:

- **Vibration magnitude** (measured in $m.s^{-2}$).
- **Duration of exposure** (in hours and minutes).

These two factors determine the ‘dose’ of vibration absorbed (the same principle as applied to noise). This dose is called the **eight-hour energy equivalent vibration magnitude**, or **A(8)**. This is same principle as the daily personal noise exposure, $L_{EP,d}$.

When undertaking a vibration assessment, it is necessary to estimate a worker’s actual exposure to vibration (which will fluctuate) and then calculate what the equivalent eight-hour exposure will be. An assessment might measure vibration exposure directly using a meter (accelerometer) or it might use manufacturers’ data.

The results of a vibration survey need to be interpreted to give an accurate estimate of workers’ exposures. These exposures can then be compared to the legal standards and any necessary action identified.

Vibration measurement and assessment is a complex topic that should only be undertaken by a competent person.

Vibration Exposure Standards

The regulations recognise the two different types of vibration exposure (hand-arm vibration and whole-body vibration) and two daily personal vibration exposure levels are set which put different legal requirements on the employer. One is called the daily exposure action value, the other is the daily exposure limit value.

- **The daily exposure action value is:**
  - 2.5 $m.s^{-2}$ A(8) for hand-arm vibration.
  - 0.5 $m.s^{-2}$ A(8) for whole-body vibration.
- **The daily exposure limit value is:**
  - 5.0 $m.s^{-2}$ A(8) for hand-arm vibration.
  - 1.15 $m.s^{-2}$ A(8) for whole-body vibration.

If workers are exposed to either hand-arm vibration or whole-body vibration at or above either of these levels then the employer must take action.

TOPIC FOCUS

The actions triggered by the two vibration at work standards:

- **The daily Exposure Action Value** (2.5 $m.s^{-2}$ A(8) for hand-arm vibration; 0.5 $m.s^{-2}$ A(8) for whole-body vibration).

  At or above this level, the employer must:
  - Carry out a vibration assessment.
  - Reduce vibration exposure to the lowest level reasonably practicable.
  - Provide information, instruction and training to employees.
  - Carry out health surveillance.
- **The Daily Exposure Limit Value** (5.0 $m.s^{-2}$ (A8) for hand-arm vibration; 1.15 $m.s^{-2}$ A(8) for whole-body vibration).

  The employer must:
  - Carry out a vibration assessment.
  - Immediately reduce exposure below the ELV.

Please note that there is no mention in the legal standard of the use of PPE as a control option.

So, for example, if a vibration assessment shows that a worker's exposure to noise is:

- A hand-arm vibration A(8) of 3.5 $m.s^{-2}$ (i.e. above the exposure action value but below the limit value), then the employer must reduce exposure to the extent that they can. They must also provide information, instruction and training to employees and health surveillance.
- A whole-body vibration A(8) of 1.5 $m.s^{-2}$ (i.e. above the limit value), then the employer must immediately stop work and then reduce exposure below the limit value.

Basic Vibration Control Measures

In simple terms, vibration exposure can be controlled in three ways:

- Reduce the vibration at source.
- Interrupt the pathway from source to receiver.
- Limit the duration of exposure.

Note that, unlike noise, there is no PPE option. This is because there is conflicting evidence about the effectiveness of PPE at preventing vibration transmission and many authorities do not recognise PPE as a means of exposure control.

Reduce Vibration at Source

- **Eliminate the source** - completely remove the vibration source, perhaps by mechanising the use of tools, (e.g. using a concrete breaker mounted on an excavator arm rather than hand-operated) or by changing work methods (clamping rather than welding, removing the need to grind away welds).
- **Substitute the source** - change the vibration source for something else that does the same job but generates less vibration. This can be done by changing the type of equipment or tool being used, but can often be achieved by using the same type of tool but simply buying a low-vibration magnitude model.
- **Changing work techniques** - there may be ways of doing the work that do not produce as much vibration, (e.g. cutting holes in masonry using a diamond-tipped drill rather than a tungsten hammer drill).
- **Maintenance** - machinery often produces vibration because it is in need of maintenance. Bits in particular should be kept sharp.

This job involves vibration exposure to the hands that must be assessed and controlled

Interrupt the Pathway

- **Isolation** - vibration is transmitted through solid materials by direct contact, (e.g. from the two-stroke motor of a chainsaw, to the chassis supporting that motor, to the handles, to the hands). Isolation involves separating vibrating parts from the user's hands using anti-vibration mountings. This breaks the transmission pathway. This approach can be applied to hand-tools, such as chainsaws, and to vehicles - the suspension of a seat in a vehicle cab is isolating the driver from vehicle vibration.

Limit the Duration of Exposure

There is a direct relationship between vibration dose and duration of exposure: halve the time, halve the dose. This leads to two possible control options:

- **Limit the duration of exposure** by calculating how long a worker might use a particular tool before they approach a relevant action or limit value.
- **Job rotation**, so that vibration exposure is shared between several workers with no one worker receiving above the relevant action or limit value.

We noted above that PPE may not give protection from vibration exposure because it may not prevent transmission of vibration from hand grip to hand effectively. In spite of that, hand protection is important when using vibrating hand tools because the hands should be kept warm and dry. Cold, wet hands are more prone to injury from vibration and symptoms are more likely to be expressed, so gloves should be worn to keep the hands warm and dry.

As with all workplace precautions, information, instruction and training are essential control measures. Operators should be aware of the hazards and risks associated with hand-arm and whole-body vibration and the controls implemented to reduce those risks. They also need to be aware of the signs and symptoms associated with exposure and how to report problems.

Role of Health Surveillance

Health surveillance is appropriate for workers exposed to high-vibration levels. In the first instance, this health surveillance might simply consist of looking at a worker's medical history and asking about symptoms of health effects. If problems are detected, then tests might be carried out.

Health surveillance should usually be carried out on all workers potentially exposed at or above the exposure action value. Any worker who might potentially be exposed to damaging vibration levels should be checked when they first start work to establish a baseline and to indicate whether they have pre-existing damage.

As with noise, health surveillance allows:

- Identification of workers with:
  - Pre-existing damage.
  - New damage (which may be work-related).
- Removal/exclusion of such workers from vibration sources (protecting them from further injury).
- Investigation of vibration controls to identify and rectify problems (protecting others in the same work).

Health surveillance should be conducted by trained, competent persons with the potential for referral of cases to a medical practitioner.

MORE...

More information on vibration at work can be found on the HSE website at:

www.hse.gov.uk/vibration/index.htm

National General Certificate Legal Standards	International General Certificate Standards
• Control of Vibration at Work Regulations 2005. • Control of Vibration at Work Regulations (Northern Ireland) 2005.	• ILO C155 - Occupational Safety and Health Convention, 1981 (No. 155). • ILO R164 - Occupational Safety and Health Recommendation, 1981 (No. 164). • ILO C148 - Working Environment (Air Pollution, Noise and Vibration) Convention, 1977 (No. 148). • ILO R156 - Working Environment (Air Pollution, Noise and Vibration) Recommendation, 1977 (No. 156).

STUDY QUESTION

3. Identify the symptoms of hand-arm vibration syndrome.

(Suggested Answer is at the end.)

Radiation

IN THIS SECTION...

- Non-ionising radiation can be categorised as: ultraviolet (UV), visible, infrared (IR), microwave and radiowaves.
- UV, visible and IR radiation can cause eye and skin damage; microwaves and radiowaves cause internal heating.
- The control of exposure to non-ionising radiation is by use of clothing and PPE or by maintaining a safe distance from the source and by isolation, SSW and permits.
- Ionising radiation comes in five forms: alpha particles, beta particles, X-rays, gamma-rays and neutrons.
- Exposure to ionising radiation can cause acute radiation sickness and can have chronic health effects, such as increased risk of cancer.
- The control of exposure to ionising radiation is based on the principles time, distance and shielding. Dose limits apply.
- Radon is an alpha particle-emitting form of radioactive gas that can build up to hazardous levels in certain premises. Radon gas levels can be measured and appropriate controls implemented to prevent harmful exposures.

The Types of Radiation and their Health Effects

DEFINITIONS

NON-IONISING RADIATION

Radiation that does not cause ionisation in the material that absorbs it.

IONISING RADIATION

Radiation that causes ionisation in the material that absorbs it.

Radiation is energy that is emitted by a source. Radiation can be categorised into many different types, but all of these types belong to two main classes: **non-ionising** and **ionising**.

Non-Ionising Radiation

Types of Non-Ionising Radiation

There are five different types of non-ionising radiation:

- **Ultraviolet (UV)** - high-frequency electromagnetic radiation (light) emitted by white-hot materials, such as the arc produced during arc-welding.
- **Visible light** - electromagnetic radiation between the UV and IR frequencies and visible to the human eye.
- **Infrared (IR)** - lower-frequency electromagnetic radiation (light) emitted by red-hot materials, such as molten metal being poured into castings.
- **Microwaves** - lower-frequency electromagnetic radiation emitted by a microwave generator.
- **Radiowaves** - lower-frequency electromagnetic radiation emitted by an antenna.

HINTS AND TIPS

Note that for exam purposes you do not need to know technical details, but you do need to remember the names of the types of radiation.

(Note that microwaves can be categorised as a subset of radiowaves.)

Lasers are sources of non-ionising radiation and can operate at UV, visible and IR frequencies. Note that those operating at IR and UV frequencies would not be visible to the eye. Laser light is very coherent (the light waves are all aligned with one another) and the beam does not diverge (spread out) over distance. Laser beams are therefore capable of carrying power over a distance.

Health Effects

The health effects of exposure to non-ionising radiation depend on the type of radiation in question:

- **UV** - this can cause redness and burns to the skin, (e.g. sunburn), pain and inflammation to the surface of the eye leading to temporary blindness (often called 'arc-eye' or 'snow-blindness'), increased risk of skin cancer and premature aging of the skin.
- **Visible light** - this can cause temporary blindness if intense (disability glare) and permanent eye damage and skin burns if very intense, (e.g. a high-powered laser).
- **IR** - this can cause redness and burns to the skin and development of eye cataracts over time.
- **Microwaves** - these are absorbed and cause internal heating. High doses cause internal organ damage and could be fatal.
- **Radiowaves** - these are absorbed and cause internal heating in the same way as microwaves.

Lasers are classified according to intrinsic safety and power output. A Class 1 laser presents little risk to workers, but a Class 4 laser can cause instant skin and tissue burns and irreversible eye damage.

Typical Occupational Sources of Non-Ionising Radiation

Non-ionising radiation is present in most workplaces and is used for various applications. Typical occupational sources include:

- **UV** - sunlight and arc-welding.
- **IR** - red-hot steel in a rolling mill and glass manufacture.
- **Visible light** - laser levelling device and laser pointer.
- **Microwaves** - industrial microwave oven in a food factory and telecommunications equipment, (e.g. mobile phone antenna).
- **Radiowaves** - radio, TV or radar antenna.

Fire-fighters will be exposed to high levels of infrared radiation

Controlling Exposure to Non-Ionising Radiation

The basic methods for controlling exposure to non-ionising radiation vary depending on the type of radiation involved:

- **UV** - enclose the source, cover exposed skin and protect the eyes. For example, a welder should shield their work area so that passers-by are not exposed to stray UV light, and wear overalls with full-length sleeves to cover the forearms, gauntlets, and a full-face welding visor with dark filter to protect the eyes from UV and intense visible light.

- **IR** - enclose the source, cover exposed skin and protect the eyes. For example, a metal worker should wear overalls, gauntlets and a face visor, goggles or safety spectacles to protect the eyes.
- **Microwaves and radiowaves** - since these types of radiation can be absorbed internally, the control of exposure is achieved by:
  - **Enclosing** the source as far as is possible. For example, a microwave oven is designed as a box to contain the microwave radiation and prevent its escape.
  - Maintaining a **safe distance** from the source of the radiation (generator or antenna). These types of radiation obey the inverse square law, so intensity levels drop off very rapidly as distance from the source is increased.
  - **Isolating** (disconnect power) and locking off the source if workers have to approach inside safe distances. This is achieved by the use of SSW and permit-to-work systems and by interlocking sources so that power has to be isolated in order to open access gates/guards.
- **Lasers** - the degree of protection will depend on class of laser. Little needs to be done for a low-class laser other than to avoid shining it into people's eyes. For high-class lasers, protection includes fully enclosing the light source where possible, eye protection (dark goggles), shielding to prevent escape of the beam and use of non-reflective surfaces.

Workwear and PPE covers all exposed skin, with a dark visor to protect the face and eyes from UV, visible and IR radiations generated during oxy-acetylene cutting

Where work potentially exposes people to non-ionising radiation, it may be necessary to assess the dose of radiation received. Legislation may set dose limits on exposure to optical non-ionising radiation. For example, in the EU, this is done through two directives that target both optical and radiofrequency radiation. In the UK, these directives were transposed as:

- The **Control of Artificial Optical Radiation at Work Regulations 2010** - which set dose limits on exposure to optical radiation (UV, visible and IR).
- The **Control of Electromagnetic Fields at Work Regulations 2016** - which set dose limits on exposure to microwave and radiofrequency radiation.

Both sets of regulations require that a risk assessment be carried out by a competent person. It may be necessary to appoint a Laser Protection Adviser (LPA) and/or Laser Protection Supervisor (LPS) where high-power laser sources are used at work.

Ionising Radiation

Types of Ionising Radiation

There are five different types of ionising radiation:

- **Alpha particles** - these are emitted by radioactive material but cannot travel very far through air or thin materials such as paper or ski, but not very penetrating.
- **Beta particles** - these are emitted by radioactive materials and are more penetrating.
- **X-rays** - a ray of high-energy electromagnetic radiation (light) emitted by an X-ray set (generator). They are very penetrating.
- **Gamma-rays** - a ray of very high-energy electromagnetic energy (light) emitted by some radioactive substances and are very penetrating.
- **Neutrons** - these particles are emitted by certain types of radioactive material and are very penetrating.

Health Effects

Acute effects of exposure to high doses of ionising radiation include:

- Sickness and diarrhoea.
- Hair loss.
- Anaemia, due to red blood cell damage.
- Reduced immune system due to white blood cell damage.

All of the cells of the body are affected by the radiation, but some more than others. If the dose is large enough, then death will follow in weeks, days or hours.

Chronic effects of exposure to ionising radiation include:

- Cancer.
- Genetic mutations.
- Birth defects.

Chronic effects can arise following exposure to high or low doses of radiation. There is no known safe level of exposure below which no chronic effects might occur - instead, there is a clear relationship between dose and the **risk** of these chronic effects (i.e. the larger the dose, the greater the risk).

Typical Occupational Sources of Ionising Radiation

Ionising radiation is present in a wide variety of workplaces and is used for various applications. Nuclear power stations, scientific laboratories and hospitals are just three typical workplaces where various forms would be encountered.

Typical occupational sources include:

- Alpha particles - smoke detectors and science labs.
- Beta particles - science labs and thickness gauges.
- X-rays - medical radiography and baggage security scanners.
- Gamma-rays - industrial radiography for non-destructive testing of metal and welds.
- Neutrons - nuclear power stations.

Basic Means of Controlling Exposure to Ionising Radiation

Protection from ionising radiation can be achieved using three simple principles:

- **Time** - minimise the duration of exposure. Like noise and vibration, the dose of radiation received is directly proportional to the duration of exposure: halve the duration, halve the dose.
- **Distance** - the greater the distance from the radiation source to the exposed worker, the lower the dose of radiation received. Alpha and beta particles cannot travel long distances through air, so a relatively small separation distance can have a significant effect.
- **Shielding** - the type required will be determined by the type of radiation. Relatively thin shields can be used to contain alpha and beta particle radiation; X- and gamma-rays require thicker, denser material, such as lead.

Where work potentially exposes people to ionising radiation, it may be necessary to assess the dose of radiation received. International Recommendations established by the International Commission on Radiological Protection (ICRP) set dose limits on exposure to ionising radiation. These are then translated into legal standards, e.g. in the EU, Euratom establishes directives on radiological protection. In the UK, the **Ionising Radiations Regulations 2017** set the following dose limits on exposure to ionising radiation:

- The general public shall not be exposed to more than 1mSv (milliSievert) per year.
- Occupational exposure shall not exceed 20mSv per year.

The Regulations require that a risk assessment be carried out. This should be done by a competent person - a Radiation Protection Adviser and Radiation Protection Supervisors will need to be appointed.

TOPIC FOCUS

Radon Gas

The Nature of Radon and the Health Risk

Radon gas is a naturally occurring gas that seeps from the ground. High levels of radon gas are found in certain parts of the world (due to the geology in these areas), e.g. in the UK, the Derbyshire Peak District and Dartmoor in Devon.

Radon is a radioactive gas - it emits ionising radiation; it is not a type of radiation, it is a source of radiation. Specifically, radon gas emits alpha particle radiation. The health risk associated with radon gas exposure is an **increased risk of lung cancer**.

Outside and in well-ventilated workplaces, the radon levels are unlikely to be high enough to cause concern. But, in certain areas where radon levels are naturally high and in poorly ventilated, enclosed workplaces (especially basements and other sub-ground level locations), radon levels can become high enough to represent a significant risk to health.

Typical Occupational Sources of Radon Gas

Workers who spend significant amounts of time in sub-ground spaces in areas where radon levels are recognised to be high are at risk of radon exposure. Examples would include:

- Workers in a basement office.
- Miners.
- Construction workers involved in tunnelling.

(Continued)

TOPIC FOCUS

Control Measures

Controlling the risk presented by radon gas involves the following:

- Undertaking a survey of radon gas levels to determine if the levels are acceptable or require action.
- Where radon levels are shown to be high, it will be necessary to reduce employee exposure. In the UK, the action level for radon gas is 400 Bq/m^3 (Becquerels per cubic metre).
- Appointing a Radiation Protection Adviser to carry out a risk assessment.
- Engineering solutions to high radon levels can often be applied, such as:
  - Installing positive pressure air fans to prevent the radon gas from seeping from the ground up into the workplace.
  - Installing radon sumps and extraction systems to draw radon out of the ground at low-level before it can seep into buildings.

Basic Radiation Protection Strategies

Whether the type of radiation that workers are potentially exposed to is non-ionising or ionising, there are some basic protection strategies that apply in all cases:

- Radiation exposure should be **eliminated** so far as is reasonably practicable.
- Where this is not possible, then exposure should be **reduced to the lowest level reasonably practicable**.
- Employee exposure must not exceed the relevant radiation **dose limits**.
- Exposure must be **risk-assessed** by a competent person.
- **Training and information** must be given to the potentially affected employees.
- **Health surveillance** may be necessary for exposed employees.

Though the technical detail in the legislation varies, the basic principles outlined above are relevant to both ionising radiation (**Ionising Radiations Regulations 2017**) and non-ionising radiation **(Control of Artificial Optical Radiation at Work Regulations 2010** and **Control of Electromagnetic Fields at Work Regulations 2016)**.

Role of Monitoring and Health Surveillance

Workers who are exposed to radiation are at risk of health effects arising from exposure, so it may be necessary to carry out monitoring of their radiation dose and health surveillance.

Monitoring can be carried out if there is a need to estimate the worker's exposure to radiation. This is usually done by the use of a dosimeter which consists of a plastic badge or ring that is worn by the worker and is sent to a laboratory for analysis. It can also be done using electronic radiation detectors.

Circumstances requiring health surveillance may include:

- Before working as a classified worker (someone who is exposed to radiation over a specified national limit).
- During periodic health reviews, e.g. annually.

- Special surveillance if a dose limit has been exceeded.
- After ceasing work as a classified worker.

Special consideration may also be required for classified workers who are pregnant or breastfeeding.

In the health surveillance, the following types of examination may be carried out:

- Skin checks - to identify lesions which could allow radioactive materials to enter the body.
- Respiratory checks - to ensure that workers who may be required to wear respiratory protection are fit and able to do so.
- Reference to exposure records - checks of the employee's records to determine if dose limits have been exceeded.
- Reference to sickness records - examination of the employee's general health and absence history.

MORE...

The following websites contain more details on the subject of radiation at work:

www.hse.gov.uk/radiation/index.htm

www.gov.uk/topic/health-protection/radiation

National General Certificate Legal Standards	International General Certificate Standards
• Control of Artificial Optical Radiation at Work Regulations 2010. • Control of Artificial Optical Radiation at Work Regulations (Northern Ireland) 2010. • Control of Electromagnetic Fields at Work Regulations 2016. • Control of Electromagnetic Fields at Work Regulations (Northern Ireland) 2016. • Ionising Radiation Regulations 2017. • Ionising Radiations Regulations (Northern Ireland) 2017.	• ILO C155 - Occupational Safety and Health Convention, 1981 (No. 155). • ILO R164 - Occupational Safety and Health Recommendation, 1981 (No. 164). • ILO C115 - Radiation Protection Convention, 1960 (No. 115). • ILO R114 - Radiation Protection Recommendation, 1960 (No. 114).

STUDY QUESTIONS

4. What type of non-ionising radiation is given off by the following pieces of equipment?
   (a) Radio transmitter.
   (b) Hot plate in a kitchen.
   (c) Arc welder in operation.
   (d) Red-light laser pointer.
5. What are the health risks of visible radiation?

(Suggested Answers are at the end.)

Stress

IN THIS SECTION...

- Stress is an adverse reaction to excessive pressure. It can cause various psychological, physical and behavioural effects, and serious ill health if prolonged.
- Stress can be caused by six work-related factors: unreasonable demands, lack of control, lack of support, poor working relationships, an ill-defined role and change.
- To minimise the risk of serious ill health caused by stress, the employer should establish a management framework for these six factors: demands, control, support, relationships, role and change.

The Meaning of 'Work-Related Stress'

Stress is not a disease, but a natural **reaction** to pressure.

Pressure is an inherent part of work, whether it is a deadline that must not be missed, or a rate of output that must be maintained. Pressure does not necessarily lead to stress because, in many circumstances, people are able to cope with the pressure they are under. In fact, in many situations, pressure results in a positive performance, e.g. athletes tend to produce their very best performances under the pressure of competition, not in training.

However, in some instances, people find themselves **unable to cope with the pressure** that they are under. This leads to a **negative reaction**, rather than a positive one; this is stress.

DEFINITION

STRESS

The adverse reaction that people have to excessive pressure or other demands placed on them.

If the pressure is short-term, then there will be little consequence for the person other than a few sleepless nights. But if the pressure continues or increases, then the relatively minor symptoms of stress can escalate into psychological illness and physical ill health.

Effects of Stress

Stress can have many effects, some of which will depend on the individual concerned. These effects can be classified as:

- **Psychological**: anxiety, low self-esteem, depression.
- **Physical**: sweating, fast heartbeat, high blood pressure, skin rashes, muscle tension, headache, dizziness.
- **Behavioural**: sleeplessness, inability to concentrate, poor decision-making ability, mood swings, irritability, increased alcohol consumption, drug misuse, increased absence from the workplace.

If stress is prolonged and relentless, these effects can lead to the complete physical and mental breakdown of the individual. The consequences for the individual concerned can be extreme: job loss, divorce, alcoholism, drug addiction, etc. The consequences for the employer include increased absenteeism, poor relationships, conflict and higher staff turnover as well as potential civil law action.

Causes and Control Measures

Causes of Workplace Stress

We can look at the causes of work-related stress under six headings:

Excessive workload can be a cause of stress

- **Demands** - excessive demands of the job in terms of workload (too much or too little), speed of work and deadlines, as well as working hours (excessively long) and work patterns, (e.g. changing shift patterns).

  Also consider the nature of the job - some jobs are inherently difficult, (e.g. air traffic control) and some expose workers to highly emotional situations, (e.g. social work).

- **Control** - lack of control over work, especially where the work is demanding. Control means control over what work is to be done, how it is to be done, the priorities involved and even simple things like control over the working environment (light levels, temperature, background noise, etc.).
- **Support** - lack of support in terms of information, instruction and training to do the work and having no-one to turn to when pressure increases.
- **Relationships** - poor quality workplace relationships and, in particular, bullying and harassment (whether by managers, peers or even subordinates).
- **Role** - lack of clarity about an individual's role, what responsibilities and authority they have, and how they fit into the larger organisational structure.
- **Change** - the threat of change and the change process itself, whether it is a change that affects just one worker, (e.g. demotion, re-assignment) or the whole organisation, (e.g. redundancies, management take-over). This can create huge anxiety and insecurity.

A very significant cause that does not appear in the list above is non-work-related factors. Individuals will go through many difficult times in their lives, (e.g. bereavement, separation, family illness) that have nothing to do with their work. Also, some individuals will be predisposed to anxiety and the negative effects of pressure. Though these factors are not work-related, they still have effects in the workplace and so they do need to be considered.

Stress Control Measures

Since it is not usually possible to remove pressure from the workplace (there will always be deadlines to meet), prevention strategies should focus on providing a basic management framework that takes into account the six factors that cause stress:

- **Demands** - these (in terms of workload, speed of work and deadlines, etc.) should be reasonable and, where possible, set in consultation with workers. Working hours and work patterns should be carefully selected with reference to guidance and worker preference. Flexible working should be allowed where possible. The nature of the job should also be considered and workers selected on the basis of their competence, skills and ability to cope with difficult or emotionally demanding work. Arrangements should be made to allow workers to recover from high-stress situations without fear of punishment.

- **Control** - workers should be given as much control of their work as possible, especially where the work is demanding, i.e. they should be encouraged to take control over:
  - what and how work is to be done,
  - priorities, and
  - control over their working environment, where possible.
- **Support** - workers should be provided with adequate information, instruction and training; they should have access to additional support when they need it (such as access to a counselling service).
- **Relationships** - clear policies should exist concerning acceptable standards of behaviour in the workplace; bullying and harassment should not be tolerated.
- **Role** - the organisation should be clear about what an individual's role actually is, their responsibilities and authority, and how they fit into the larger organisational structure. This should be clearly communicated to the workers and to others across the organisation.
- **Change** - there should be careful planning and preparation of the change process. The reasons for change should be clearly explained and workers consulted where possible. In some situations, change is best done gradually to allow workers to adapt; in others, it is better to implement change quickly to minimise the impact of uncertainty.

Many employers provide a confidential counselling service for employees, which can be provided in-house (by trained employees) or outsourced. This service can be useful to employees in dealing with both work-related and non-work-related matters.

MORE...

More information on work-related stress can be found here:

www.hse.gov.uk/stress

National General Certificate Legal Standards	International General Certificate Standards
• Health and Safety at Work, etc. Act 1974. • Management of Health and Safety at Work Regulations 1999. • Health and Safety at Work (Northern Ireland) Order 1978. • Management of Health and Safety at Work Regulations (Northern Ireland) 2000.	• LO C155 - Occupational Safety and Health Convention, 1981 (No. 155). • ILO R164 - Occupational Safety and Health Recommendation, 1981 (No. 164).

STUDY QUESTION

6. Identify the six work-related causes of stress and, for each, give one example of a preventive measure.

(Suggested Answer is at the end.)

Summary

This element has dealt with some of the health hazards and controls relevant to noise, vibration, radiation and work-related stress.

In particular, this element has:

- Explained the effects of exposure to excessive noise, noise exposure standards and basic principles of noise assessment.
- Outlined the control of exposure to noise by reducing the noise at source (elimination, substituting, modifying the process, maintenance, damping, silencing), interrupting the pathway from source to receiver (acoustic enclosures, isolation, absorption), and protecting the receiver using engineering controls/PPE (acoustic havens, and hearing protection).
- Discussed the effects of exposure to excessive hand-arm and whole-body vibration, the exposure standards and the basic principles of vibration assessment.
- Outlined the control of vibration exposure by reducing the vibration at source (elimination, substitution, changing techniques, maintenance), interrupting the pathway from source to receiver (isolation), and limiting the duration of exposure.
- Described the types of non-ionising and ionising radiation, their health effects, and control of exposure (including radon).
- Outlined the effects of work-related stress, the causes and preventive measures.

Exam Skills

QUESTION 1

(a) **Outline** the possible effects on health from exposure to high levels of noise. **(6)**

(b) **Outline TWO** noise control techniques that would benefit all workers. **(2)**

Approaching Question 1

Think about the steps you would take to answer the question:

Step 1. The first step is to **read** the question carefully. In both parts of this question, you are asked to 'outline' - that gives you an indication of the level of depth required. You should aim to produce a sentence or two about each issue, rather than just a word or two.

Step 2. Now highlight the **key words**. In this case, they might look like this:

(a) **Outline** the possible **effects on health** from exposure to high levels of **noise**. **(6)**

(b) **Outline TWO noise control techniques** that would benefit **all** workers. **(2)**

Step 3. Next, consider the **marks** available. You should aim to provide a piece of information for every mark allocated, with six in part (a) and two in part (b).

Step 4. **Read** the question again to make sure you understand about noise and its effects, and possible control measures. (Re-read your notes if you have to.)

Step 5. The next stage is to develop a **plan** - you are now familiar with how to do this. The answer plan will take the form of a bullet-pointed list that you need to develop into a full answer based on the key words that you have highlighted.

Now have a go at the question. Draw up an answer plan, and then use it as the basis to write out an answer as you would in the exam.

HINTS AND TIPS

Look carefully at part (b) - be very clear as to what controls it is asking you to think about!

When you have finished, compare your plan and full answer to those that follow.

Suggested Answer Outline

Health Effects of Noise
• Temporary threshold shift. • Tinnitus (may be permanent). • Permanent threshold shift (NIHL). • Physical damage to ear due to peak noise exposure. • All results in stress and fatigue.
Controls
• Individual (not required for this question) include hearing protection. • Collective include reduction at source through use of absorbent enclosures around equipment, use of damping to absorb vibration energy, isolation of equipment.

Example of How the Question Could be Answered

(a) *On exposure to high levels of noise, there is a range of health effects which the worker can experience. The cilia (hair cells) in the cochlea can become temporarily damaged, resulting initially in a temporary loss of hearing (a temporary threshold shift) with a possibility of tinnitus (ringing in the ears). This effect could ease once the worker leaves the noisy environment. However, repeated exposure could result in this damage becoming permanent and irreversible (permanent threshold shift) and this is what we understand as noise-induced hearing loss, with permanent tinnitus also possible. Workers in noisy environments may also experience stress and fatigue, as their sensory systems are overloaded and they may struggle to concentrate. If the noise is very loud (e.g. gunfire, explosive cartridges, etc.) there is a risk of physical damage to the eardrum and conductive bones in the inner ear.*

(b) *One possible noise control that would benefit all workers is the use of sound-absorbing enclosures around the equipment which use sound absorbing materials built into the inner walls of the enclosure to prevent transmission to the workers.*

Another is the use of isolating anti-vibration matting or mounts (often springs) placed underneath equipment to absorb energy and prevent vibrations from being transmitted to the surrounding structure, generating noise. These are commonly used underneath pumps and motors.

Reasons for Poor Marks Achieved by Candidates in Exam

- In part (a), giving 'deafness' as a response - this wouldn't gain the six marks available!
- In part (b), the examiner would be looking specifically for controls which benefit all workers, therefore individual controls such as PPE would not be awarded marks.

QUESTION 2

An organisation has identified it must measure noise levels in its workplace.

(a) **Give** the meaning of the following terms:

(i) Frequency. **(2)**

(ii) Decibel (dB). **(2)**

(iii) A-weighting. **(2)**

(b) **Identify TWO** benefits of health surveillance for noise. **(2)**

Approaching Question 2

Think now about the steps you would take to answer the question:

Step 1. The first step is to **read** the question carefully. The question is looking to see if candidates understand the meaning of key terminology used in noise measurement, together with audiometry. This question has been selected as the examiners commented that the responses to a similar question were disappointing - studying tricky questions like this helps understand the topic and also the exam requirements.

Step 2. Now, highlight the **key words**. In this case, they might look like this:

An organisation has identified it must measure **noise** levels in its workplace.

(a) **Give** the **meaning** of the following terms:

(i) **Frequency**. **(2)**

(ii) **Decibel (dB)**. **(2)**

(iii) **A-weighting**. **(2)**

(b) **Identify TWO** benefits of health surveillance for noise. **(2)**

Step 3. Next, consider the **marks** available. In part (a), you are asked to give the meaning of three terms - for two marks, a sentence or so for each term would be expected. In part (b), you are specifically asked for two pieces of information, therefore only two benefits of audiometry should be provided. The question should take around eight minutes in total.

Step 4. **Read** the question again to make sure you understand it and have a clear understanding of noise terminology and measurement. (Re-read your notes if you need to.)

Step 5. The next stage is to develop a **plan** - the answer to part (a) should follow the three subsections given. You may decide to use the plan to make brief notes on each of the three terms you have to tackle.

For part (b), you are required to identify two benefits. When you see the command word 'identify', you need to provide brief detail on the measurement techniques, which is more than simply creating a list.

Suggested Answer Outline

(a) Terms Used in Noise
• Frequency, also known as pitch, measured in Hertz.
• Decibel (dB) is a measure of the volume or intensity.
• A-weighting is way of mimicking the response of the human ear to sound.
(b) Benefits (Two required)
• Provides a baseline.
• Triggers an investigation.

Example of How the Question Could be Answered

(a) (i) 'Frequency' is a measure of the number of sound waves per second and is measured in Hertz (Hz). The higher the frequency, the higher the pitch.

(ii) The 'decibel' is a measurement of the intensity or 'loudness' of sound. The decibel scale is a logarithmic scale, which means that a small increase in decibels results in a large increase in sound intensity.

(iii) The human ear responds to some frequencies of sound more than others. In order to take this into account, when carrying out noise measurements, an 'A-weighting' filter is used on monitoring equipment, giving a reading quoted as dB(A). This corrects for the sensitivity of the human ear.

(b) One benefit of health surveillance for noise (audiometry) is that it can be used to provide a baseline when a worker first starts to work in a high-noise environment that their subsequent tests can be compared back to.

Another benefit is that detecting hearing problems in one worker can trigger an investigation into whether there is a bigger problem in the workplace - this allows other workers to be further protected.

Reasons for Poor Marks Achieved by Candidates in Exam

- Not understanding noise terminology so not giving the meaning of the terms required.
- Providing a list rather than the required level of answer, so failing to gain good marks.

Revision and Examination

The Last Hurdle

Now that you have worked your way through the course material, this section will help you prepare for your NEBOSH examination. This guide contains useful advice on how to approach your revision and the exam itself.

Your NEBOSH Examination

The NEBOSH Unit GC2 examination will consist of one question paper which contains one 20-mark question and ten 8-mark questions. You are allowed two hours in which to complete the exam paper and you should answer all the questions.

To pass the exam, you must obtain a minimum of 45% of the total marks available.

If your performance is less than the pass mark then you will be 'referred'. This means you may re-sit the examination provided you do so within five years of the original sitting. You may re-sit as many times as you want within that five-year timescale.

Be Prepared

It may be some time since you last took an exam. Remember, success in an exam depends mainly on:

- **revision** - you have to be able to remember, recall and apply the information contained in your course material; and
- **exam technique** - you have to be able to understand the questions and write good answers in the time available. Revision and exam technique are skills that can be learnt. We will now look at both of these skills so that you can prepare yourself for the exam. There is a saying that "proper planning and preparation prevents a poor performance". This was never truer than in an exam.

Revision Tips

Using the RRC Course Material

You should read through all of the topics at least once before beginning your revision in earnest. This first read-through should be done slowly and carefully.

Having completed this first revision reading of the course materials, consider briefly reviewing all of it again to check that you understand all of the elements and the important principles that they contain. At this stage, you are not trying to memorise information but simply checking your understanding of the concepts. Make sure that you resolve any outstanding queries with your tutor.

Remember that understanding the information, and being able to remember and recall it are two different things. As you read the course material you should **understand** it; in the exam, you have to be able to **remember**, **recall** and **apply** it. To do this successfully, most people have to go back over the material repeatedly.

Re-read the course material and make notes that summarise important information from each element. **You could use index cards** and create a portable, quick and easy revision aid.

Check your basic knowledge of the content of each element by reading the Summary. The Summary should help you recall the ideas contained in the text. If it does not, then you may need to re-visit the appropriate sections of the element.

Using the Syllabus Guide

We recommend that you download a copy of the NEBOSH Guide to this course, which contains the syllabus for your exam. If a topic is in the syllabus then it is possible that there will be an examination question on that topic.

Map your level of knowledge and recall against the syllabus guide. Look at the content listed for each element in the syllabus guide. Ask yourself the following question:

If there is a question in the exam about that topic, could I answer it?

You can even score your current level of knowledge for each topic in each element of the syllabus guide and then use your scores as an indication of your personal strengths and weaknesses. For example, if you scored yourself 5 out of 5 for a topic in Element 1, then obviously you don't have much work to do on that subject as you approach the exam. But if you scored yourself 2 out of 5 for a topic in Element 3, then you have identified an area of weakness. Having identified your strengths and weaknesses in this way, you can use this information to decide on the topic areas that you need to concentrate on as you revise for the exam.

You could also annotate or highlight sections of the text that you think are important.

Another way of using the syllabus guide is as an active revision aid:

- Pick a topic at random from any of the elements.
- Write down as many facts and ideas that you can recall that are relevant to that particular topic. Go back to your course material and see what you missed, and fill in the missing areas.

Exam Hints

Success in the exam depends on scoring approximately half of the available marks for the entire exam paper. You do not need to score half of the available marks for each individual question. You can score very poorly, or even zero, on some questions and, as long as you score well enough on other questions to bring the overall score up to 45%, still pass.

Marks are awarded for setting down ideas that are relevant **to the question asked** and demonstrating that you understand what you are talking about. If you have studied your course material thoroughly, then this should not be a problem.

One common mistake in answering questions is to go into too much detail on specific topics and fail to deal with the wider issues. If you only cover half the relevant issues, you can only achieve half the available marks. Try to give as wide an answer as you can, without stepping outside the subject matter of the question altogether. Make sure that you cover each issue in appropriate detail in order to demonstrate that you have the relevant knowledge. Giving relevant 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 one of the words you might find at the beginning of an exam question (such as 'explain' or 'identify' or 'outline') in front of the syllabus topic areas. In this way, you can produce a whole range of questions similar to those used in the exam.

Before the Exam

You should:

- Know where the exam is to take place.
- Arrive in good time.
- Bring your examination entry voucher, which includes your candidate number, photographic proof of identity, pens, pencils, ruler, etc. (Remember, these must be in a clear plastic bag or wallet.)
- Bring water to drink and sweets to suck, if you want to.

During the Exam

You should:

- Read through the whole exam paper before starting work, if that will help settle your nerves. Start with the question of your choice.
- Manage your time. The exam is two hours long. You should attempt to answer all 11 questions in the two hours. To do this, you might spend:
  – 25-30 minutes answering Question 1 (worth 20 marks), and then
  – 8-9 minutes on each of the ten remaining 8-mark questions.
- Check the clock regularly as you write your answers. You should always know exactly where you are, with regard to time.
- As you start each question, read the question carefully. Pay particular attention to the wording of the question to make sure you understand what the examiner is looking for. Note the verbs (command words), such as 'describe', 'explain', 'identify', or 'outline' that are used in the question. These indicate the amount of depth and detail required in your answer. As a general guide:
  – 'Explain' and 'describe' mean give an understanding of/a detailed account of something.
  – 'Outline' means give the key features of something.
  – 'Identify' means give a reference to something (could be name or title).
- Pay close attention to the number of marks available for each question, or part of a question - this usually indicates how many key pieces of information the examiner expects to see in your answer.
- Give examples wherever possible, based either on your own personal experience, or things you have read about. An example can be used to illustrate an idea and demonstrate that you understand what you are saying.
- If you start to run out of time, write your answers in bullet-point or checklist style, rather than failing to answer a question at all.
- Keep your handwriting under control; if the examiner cannot read what you have written, then he or she cannot mark it.
- You will not be penalised for poor grammar or spelling, as long as your answers are clear and can be understood. However, you may lose marks if the examiner cannot make sense of the sentence that you have written.

Unit GC3

Health and Safety Practical Application

Introduction

The aim of this unit is to help you prepare for your NEBOSH National or International General Certificate Unit GC3: Health and Safety Practical Application assessment. This guidance is heavily based on the Guidelines for Candidates published on the NEBOSH website. Candidates should download this NEBOSH guidance and read it carefully in conjunction with the guidance published here.

To gain your NEBOSH Certificate qualification, you have to pass both of the Unit 1 and 2 exams. The minimum pass mark for each unit exam is 45%. You also have to pass the Unit GC3 practical assessment. **The pass mark for Unit GC3 is 60%.**

Some people think that this unit is simple, don't bother to prepare themselves properly, and fail as a result. Make sure you don't fall into this trap! While the process you have to work through is straightforward, in order to succeed, you need to understand what NEBOSH expect. If you work carefully through these notes, we are confident that you'll be a successful candidate!

Note: Tutors are unable to comment on your practical assessment before submission or marking. Please read the guidance carefully before submitting.

Contents

Aim of the Practical Assessment

The aim of the practical assessment is to test your ability to carry out two activities:

A safety inspection of your workplace:

- What are the poorly controlled hazards?
- What consequences might these hazards create?
- What short- and long-term remedial action is required?
- What timescales apply?

A written report to management:

- What are the most significant findings of your inspection?
- Explain why action needs to be taken on these findings?
- Include references to possible breaches of standards.
- What do management need to do to resolve the issues, and what are the cost implications?

NEBOSH advise that the whole assessment should be completed within two hours, although **there is no time limit**. The inspection should take approximately one hour and the report should be written immediately afterwards and should be completed in one hour.

This practical assessment is a formal, mandatory part of your Certificate course and therefore certain rules must be obeyed. **You must not, under any circumstances, copy any part of your assessment from anyone else or any other source. You must not work together with anyone else when undertaking the inspection nor when writing your report. All submitted parts of the assessment must be your own work. Any copying or collusion would be treated by NEBOSH as malpractice and would be subject to investigation and penalty.** This assessment is 'open book' and therefore you are able to look things up in your textbooks or online, e.g. to check the correct name of a legal standard. But you must not copy sections of text from your textbooks or any other sources.

The assessment does not have to be supervised or invigilated in any way. You are free to undertake the assessment at a time and workplace of your own choosing (as long as you do so between the dates indicated by your course provider - the assessment must be carried out no earlier than 10 working days prior to the exam date and five working days after).

Please note that the date that appears on all parts of your practical assessment (both the Observation Forms and Management Report) **must be within the specific dates** dictated by your course provider - these are determined by the exam date - no earlier than 10 working days prior to the exam date and five working days after.

Let's look at the two stages in detail, starting with the workplace inspection.

Workplace Inspection

For this assessment, you have to show NEBOSH that you can competently complete an inspection of a workplace, identifying any uncontrolled hazards or unsafe practices, their consequences, what needs to be done about them, and how quickly action should be taken.

You will have already covered the types of hazards you are likely to come across in the workplace in Unit GC2 of your course, so we will not go into the detail of those here. Instead, we are going to concentrate on how you should approach the inspection to give you the best chance of success.

So, what do you need to do?

The stages you need to work through are shown in the diagram below; let's take a look at each stage in a little more detail.

Select a suitable area of your workplace for inspection that is large enough to provide a sufficient range of hazards but contained enough that you can comfortably walk around the entire area in a reasonable period of time (say one hour) making notes as you go.

↓

Identify poorly controlled hazards, unsafe practices and good practice. Walk around the area and look carefully at the working environment and activities to identify poorly controlled hazards, unsafe practices and two examples of good practice. These might include physical, chemical, ergonomic and biological hazards.

↓

Complete the NEBOSH Observation Forms. You need to note down all of your observations on the correct NEBOSH form. You must record the right things in the right places and your notes must be detailed enough to allow the examiner to understand your meaning. You'll use these notes to help you write your management report in the next stage of the assessment and the examiner will use them to check that your report is accurate, so make sure they are clear and legible!

Inspection Area

In order to complete this assessment, you have to select an area of your workplace that will be suitable. To be suitable, your workplace should be large enough to provide a sufficient range of hazards, but contained enough that you can practically walk around the area making and writing observations within one hour or less. **Big enough to be interesting; small enough to be manageable in the time**.

If your workplace is very large, think about limiting your inspection area to one part, e.g. a large open-plan office with its associated welfare rooms, or one workshop within an engineering company. Do not try to inspect every floor of a three-storey factory. Do not pick the broom cupboard under the stairs.

If you read through the rest of this guidance, you will see the types of hazards that you will be expected to cover in the assessment. Your area must have a range of hazard types, such as fire, electricity, chemicals, manual handling, slips and trips, machinery. It must not contain only one hazard type.

Bear in mind that you should consult the management of the premises to ensure that they are happy for you to complete your assessment there, and so they can ensure that you can carry out the inspection without endangering your own health and safety.

Please note that this assessment is completed for educational purposes only. You can anonymise your workplace to protect confidentiality either by omitting the organisation's name or by giving a fictitious organisation name (e.g. XYZ company).

Completing the NEBOSH Observation Forms

So, you have selected your workplace area and you are ready to begin your inspection - where do you start? The first things you will need are some blank NEBOSH Candidate Observation Forms (available to download from the NEBOSH website), a clipboard and pen.

HINTS AND TIPS

Start by taking a good look at your surroundings. Some hazards may leap out at you immediately, but try to take a minute or two just to survey the whole area first. It's important that you show a wide range of hazards (rather than four or five of the same 'type') so, before you start noting things down, think about the area environment as a whole to get a feel for the sorts of hazards and unsafe practices you should be looking for.

As you carry out your inspection, you need to complete the NEBOSH Candidate Observation Forms. You must use the standard NEBOSH form and not some other form from any other source. You can handwrite your observations onto the form as you walk around and submit these as your final version. Or, you can use them as rough notes to fill in the final version of the observations using a word processor. If you have poor handwriting then word processing the form will help the examiner read your work. **Remember that these Observation Forms will be submitted to your examiner, who will award them marks alongside your management report, so they must be clear and legible**!

The Observation Form has three columns:

Observations	Control measures	Timescale
Hazards and consequences	Immediate and longer-term actions	

As you can see, NEBOSH have already given you a big clue as to what to include in each of the columns.

Observations Column

Identifying Hazards and Consequences

You need to outline the **poorly controlled hazards** in the area. You are not interested in things that are right; you are interested in things that are wrong.

To score well, you should aim to identify at least 20 examples of poorly uncontrolled hazards and unsafe practices. NEBOSH recommend that you identify **more than 20**, **but no more than 30**, to avoid duplication, or inappropriate hazards being identified. So try, as a minimum, to find at least 25 hazards.

As well as identifying hazards, it is very important that you also state the **consequences** of exposure to each hazard. In other words, **you should indicate the risk that the hazard will create**. For example, you may have identified, 'Boxes stored in pedestrian walkways' as a hazard. This will not be enough for any marks - you must also state the consequences. So, your entry in this column might be 'Boxes stored in pedestrian walkways - obstruction of access and egress and risk of trips and falls causing injury such as broken bones'.

You need to make sure that these hazards cover a range of different topics (at least five different types of hazard). Try to picture in your mind all the various topics you have studied in your course (some of which are covered below) and attempt to cover as many of them as possible in your observations. If you repeat a hazard (e.g. if you reference three items of electrical equipment that all require portable appliance testing), you will only score one mark!

Poorly Controlled Hazards

In almost any workplace, you should be able to find a **range** of poorly controlled hazards, such as:

- A pothole in the floor (or trailing wires/cables), creating the risk of slips, trips and falls.
- An unguarded pedestal drill, creating the risk of entanglement and severe hand injury.
- Poorly stored combustible waste, creating a fire risk.

These above examples are three hazards from three different hazard types or categories (slips/trips; machinery and fire). If you've studied your course notes thoroughly, you should be aware of lots of other such examples.

For the purposes of completing your inspection, it is important that you **outline** the hazard you have identified. So, it is not enough to just say "defective floor" or "fire risk"; you must include enough information so that the examiner can understand what the hazard was, where it was and what the consequences of exposure to the hazard might be. So, on your Observation Form, rather than "defective floor", you will need to say, "Potholes in the floor outside the workshop door create a risk of slips and trips"; and instead of "fire risk", put, "Fire exit route at rear of archive room partially obstructed by build-up of heavy boxes; risk of being trapped in the event of fire".

Unsafe Practices

As well as poorly controlled hazards, you can also make comments about unsafe practices.

Again, in almost every workplace, these should be fairly easy to spot and could include:

- Careless forklift-truck driving, creating a risk of collision with workers, buildings and other vehicles.
- Workers smoking in designated 'No Smoking' areas, creating a fire risk.
- A ladder in use against a wall at the wrong angle, creating a risk of falling from height.

Remember to **outline the hazard and the consequences** so the examiner can understand the issue and award good marks.

Good Practices

As well as poorly controlled hazards and unsafe practices, note down **two examples of good practice**, such as the provision of good welfare facilities. However, it is best not to include more than one or two examples of good practice, as the main point of the exercise is to assess your ability to identify poorly controlled hazards and unsafe practices - there is only one mark available for all good practice comments! So, it is not possible to pass this assessment by only identifying good practices alone.

Remember that **this is an inspection, not an audit**. So, you must look at the physical workplace in front of you; the area, the equipment and the activities. You must not get distracted by looking at company policy documents, procedures or training records.

HINTS AND TIPS

Identifying Legal Standards

You do not need to record legal standards on your Observation Forms. You will not be awarded any marks for identifying any legal standards on your Observation Forms.

Possible breaches of laws or standards should be outlined in your Management Report instead.

Control Measures Column

Here, you need to state the action required to eliminate or control each hazard or unsafe working practice. You should outline the **short-term action to immediately control the risk** from each of your hazards **AND** outline the **longer-term actions to address the root cause** of the problem.

One- or two-word statements, such as 'fit a guard' or 'segregate area', are not enough; although you need to be concise, you still need to give the examiner more detail, so it becomes clear what your recommendations are. For example, you might say:

- 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.
- Employees should be trained in the correct use of ladders and supervised where such work is carried out.
- The level of lighting in the storage area should be increased.
- A planned preventive maintenance system should be introduced.

Most hazards will have **more than one recommended action** - an immediate action to make the hazard safe and another, longer-term action or actions that fix the underlying problem (the root cause). The examiner wants to see that you understand the difference between the symptoms and the root cause. So, for example:

Machine being used without the appropriate guard

IMMEDIATE ACTION → Take machine out of use and inform supervisor

LONGER-TERM ACTION → Replace guard and supervise to ensure the guard continues to be used

If adequate controls are already in place, remember to think about whether any measures are required to maintain this level of control.

Remember to avoid using generic phrases such as 'monitor' or 'train staff'. Let the examiner know what needs to be monitored and how, or the type of training that will be required and who needs to be trained.

The examiner must be able to see that the control measure that you have outlined will address the hazard. It must appear to be realistic and practical. If you state that fire extinguisher training needs to be provided to workers because there is a key left in the ignition of a forklift truck, that does not make sense - the control measure does not address the hazard. Similarly, if you state that a new forklift needs to be purchased because the old one has worn tyres, the control measure seems overly expensive when changing the tyres might be more practical and realistic.

Timescale Column

Here, you need to indicate how quickly action needs to be taken - the higher the risk, the more urgent it is likely to be, while longer-term actions may take much longer to put in place.

This is where you need to pause and think carefully. It is tempting to treat everything as requiring immediate action, but NEBOSH want to see that you can realistically identify what is of the highest risk and prioritise your actions accordingly, so you have to think carefully before making your decisions. The following table should give you some helpful hints.

Immediate	Where there is a risk of serious or imminent danger, or where there is a flagrant breach of legal requirements. This can also be used for actions that can be done quickly at no cost.
Longer term	Where hazards cannot be eliminated or controlled without the need for capital expenditure and where there is no serious or imminent danger present; or Where there may be a need, e.g. to provide information, instruction and training, to write a safe system of work or to introduce health surveillance.

Timescale is best indicated by using words such as immediate, 24 hours, one day, two days, one week, one month, three months, etc. You can use whatever timescale you feel is appropriate to the circumstances. Clearly, the timescale needs to look right given the nature of the risk and the control measure that is being applied. Timescales that seem wrong or impractical and unrealistic will not attract marks.

So, for example, if you state that an unguarded machine creating a risk of amputation was seen in use should be taken out of use immediately; it sounds right. If you state the timescale as three weeks the timescale does not match the risk level. If you state that it will take one day to construct and commission a new LEV system in a workshop, that does not sound very realistic.

You must recognise short-term remedial action that can be done **immediately or within two days** that addresses the immediate risk, followed by a longer-term action that addresses the root cause or fixes the problem properly.

Criteria for Assessment of Observation/Inspection Stage

The following marking matrix should give you a good idea of what you need to do to achieve maximum marks in each of these areas:

<table>
<tr><th colspan="5">Marks to be awarded</th></tr>
<tr><td rowspan="4">Completion of observation sheets</td><td></td><td>11-15</td><td>6-10</td><td>1-5</td></tr>
<tr><td>Range and outline of hazards and consequences</td><td>• 4-5 different types of hazards identified
• 14-20 uncontrolled hazards/consequences outlined</td><td>• 2-3 different types of hazards identified
• 7-13 uncontrolled hazards/ consequences outlined</td><td>• 1 type of hazard identified
• 1-6 uncontrolled hazards/ consequences outlined</td></tr>
<tr><td></td><td>11-15</td><td>6-10</td><td>1-5</td></tr>
<tr><td>Identification of suitable control measures and timescales</td><td>• Immediate and longer-term actions identified for majority of hazards
• Majority of recommended actions effective in reducing risk and realistic in terms of timescales</td><td>• Identification of immediate and longer-term actions for some of the identified hazards
• Some recommended actions generally effective in reducing risk and realistic in terms of timescales</td><td>• Reference to immediate actions only
• Recommended actions in reducing risk and unrealistic in terms of timescales</td></tr>
</table>

Example of a Completed Observation Form

Now we know the theory, let's see what your completed form should look like in practice.

NEBOSH NATIONAL GENERAL CERTIFICATE

UNIT GC3 - HEALTH AND SAFETY PRACTICAL APPLICATION

Candidate's observation sheet

Sheet Number of

Student Name Student Number

Place inspected Engineer's workshop & store Date of inspection / /

Observations	Control Measures	Timescale
Hazards and Consequences	**Immediate and Longer-Term Action**	
Engineer's workshop Storage of flammable substances on the bench. Risk of fire causing premises damage and potential loss of life.	All flammable items to be stored in the fireproof cabinet.	Immediate
	Toolbox talk on fire safety for all staff.	1 week
	Routine inspection to be undertaken by area supervisors.	2 weeks
Fire exit obstructed by oil drum. Risk of being unable to evacuate quickly in an emergency. Leading to crush injuries and potential loss of life.	Drum to be removed and exit kept clear at all times.	Immediate
	Toolbox talk on fire safety for all staff.	1 week
	Routine inspection to be undertaken by area supervisors.	2 weeks
Oil spillages on the floor under the radial arm drilling machine. Risk of slipping and falling causing broken bones.	Introduce cleaning regime for each machine, e.g. assign a designated employee to each machine for the end of day clean down.	1 week
	Conduct inspection to check adequacy of cleaning.	1 month
Good general lighting with task lighting on machinery where needed.	Good practice to be maintained. Monitor light level as part of inspection regime.	Monthly
Oil fired warm air heating unit provides a comfortable working temperature.	Good practice to be maintained. Monitor light level as part of inspection regime.	Monthly
Drinks being made on a dirty bench. Risk of ingesting hazardous substances, leading to ill health.	This practice should be prohibited.	Immediate
	Adapt unused office for temporary use as rest area.	1 day
	Provide permanent rest area with sink, fridge and facilities to make hot drinks.	1 month
Inadequate/poor ventilation. Increased risk of fatigue and discomfort caused by thermal stress.	Provide desk fans.	Within 1 week
	Mechanical ventilation capable of achieving 10 air changes per hour should be installed.	3 months

Overhead gantry crane does not have its Safe Working Load marked. Risk of overloading and consequent failure of crane leading to damage to equipment, premises and severe/fatal injury to people in the area.	Contact manufacturers to enquire about SWL. Ensure SWL is not exceeded.	1 day
	Mark crane with SWL.	1 week
	Inspect and examine crane.	1 month
	Ensure that statutory examination takes place.	12 months
Operator not wearing visor provided when using an abrasive wheel. Risk of eye trauma caused by ejected debris.	Use of visor should be enforced.	Immediate
	Training on use of PPE for all staff.	1 week
	Behavioural survey in area.	1 month
Overloaded storage racking. Risk of crushing injury from falling items and damage to racking, items stores and adjacent items.	Storage racking should be reorganised.	1 week
	Further racking should be installed.	Within 14-28 days
Operators observed not lifting heavy items correctly. Risk of musculoskeletal disorders such as lower back injury.	Training in safe manual handling should be provided.	2 weeks
	Posters depicting correct techniques should be displayed.	1 week
Flex on the 230V electric drill on fitters bench is damaged showing internal conductors. Risk of potentially fatal electric shock.	The drill should be removed from service.	Immediate
	The flex and/or drill should be replaced.	24 hours
	Reminder about visual inspection regime for all portable hand tools.	Within 1 week
	PAT testing to be carried out on all untested items.	1 month
Lack of a fixed front guard to the metal-cutting guillotine. Risk of amputation of fingers.	Guillotine should be removed from service.	Immediate
	A fixed guard should be installed.	24 hours
	Guarding to be added to regular inspection checklist.	1 month
Wooden ladder stored in the corner of the workshop adjacent to the fire exit has missing bracing and signs of rot. Risk of failure in use and falls from height.	The wooden ladder should be destroyed.	Immediate
	Replace with a new ladder.	1 week
	Implement ladder inspection regime.	2 weeks
	Train staff in ladder safety.	1 month
Flammable refuse stored in plastic sacks. Risk of fire leading to property damage and potential loss of life.	A metal container with close fitting lid and suitably marked for such storage should be provided.	48 hours
	Training for staff in area about fire safety and refuse disposal.	2 weeks
The sanitation and washing area at the rear of the workshop is in a dirty condition. Risk of exposure to biological agents leading to disease.	This area should be cleaned.	24 hours
	Regular cleaning routine to be introduced.	1 week

No facilities are provided for the storage of clothing not worn during working hours. Possible risk of cross-contamination of personal clothing.	As an interim, provide a secure office area for storage of personal clothing.	2 days
	Provide personal lockers.	1 month
Store The standard of housekeeping is very poor, creating numerous fire, tripping and contact hazards.	The store should be cleared and unwanted items disposed of.	1 week
	Further racking and shelves to be installed.	1 month
Storage of chemicals in unmarked mineral water bottles. Risk of ingesting contents or using incorrect chemical leading to ill health.	Dispose of bottles and contents safely.	Immediate
	Investigate with users reasons for use of these containers/chemicals. If necessary provide properly labelled alternative containers.	1 month
	Train staff in safe storage of chemical substances.	6-8 weeks
Oxy-acetylene welding gas cylinders stored indoors. Risk of fire and explosion leading to property damage and potential multiple fatalities.	The cylinders should be removed to a well-ventilated secure outdoor location.	Immediate
	Provide a purpose-built outside enclosure.	2 months
Key left in chuck of pillar drill. Risk of impact/puncture injury from chuck key being ejected upon machine start-up.	Remove chuck key.	Immediate
	Toolbox talk on safe operation of pillar drill and, in particular, removing chuck key after use.	1 week
	Replace all chuck keys with spring-loaded type.	28 days
Seat used at supervisors' shared DSE workstation set too low. Ergonomic hazard, with risk of lower back pain or upper limb disorders.	Give users instruction and training in correct seat adjustment.	1 week
	Carry out DSE assessment for all users of this workstation and act on the findings.	1 month
Bandsaw blade guard too high. Increased risk of contact with blade and consequent amputation of fingers.	Adjust bandsaw guard to cover exposed blade.	Immediate
	Toolbox talk on safe operation of bandsaw, and in particular, correct adjustment of guard. Brief supervisors to ensure all guards used correctly.	1 week
Good provision and storage of appropriate eye protection for the range of hazards in the workshop.	Continue to provide and maintain.	Ongoing
	Monitor through behavioural audit programme.	Monthly

Report to Management

Hopefully you've now got a good understanding of what you need to do in the workplace inspection, but your work is not yet finished! Once you've completed the inspection, you need to write a report to management that successfully persuades them to take appropriate action. To do this, you'll need to explain why action is needed and identify the remedial measures that should be implemented.

HINTS AND TIPS

The report can be typed or written on lined paper in your own handwriting. It should be approximately 700-1,000 words in length, which is equivalent to two or three handwritten sides of A4 paper. There is no penalty if you go over 1,000 words.

You can consult reference books when preparing the report but be sure not to plagiarise. Your report should not contain photographs or any other extra material.

This is supposed to be a report to management so **it should not just duplicate your observation sheets**. You need to think carefully about the issues you need to bring to the management's attention and only concentrate on those. It is recommended that you pick **five key topics from your observation sheets** and discuss those five key topics. One key topic might be based on one single observation from the inspection. Another key topic might relate to two or three observations that all fall within the same hazard type. For example:

- You might identify one single electrical safety issue during the inspection that is so significant that 'electrical safety' becomes one of the key topics of your report.
- You might identify three fire safety issues during the inspection that are all discussed in the report under the key topic heading of 'fire safety'.

The report must give management sufficient information to allow them to take reasonable action based on the facts you have presented to them and, crucially, persuade them of the need to take that action.

Structuring your Report

You will need to structure your report using the following headings:

- **Title**

  Give your report a title and format it as a title on the page. Use the format for the report that is provided on the NEBOSH website as a standard template.

- **Introduction, including overview of area inspected and activities taking place**

  In this section, you should explain **where and when** the inspection was carried out. There must be a clear **description of the chosen area** and a **description of the activities** taking place there at the time of the inspection. Include information about **numbers of workers present** and any **equipment or machinery** in use.

- **Executive Summary**

  This should be written after you have completed the rest of the report but should be inserted after the Introduction. The aim of this section is to provide a concise **overview** of the important points and **summarise your main conclusions and recommendations**.

Here, you will need to convince a busy manager of the need to read your full report and, crucially, act on your recommendations.

- **Main Findings of the Inspection**

  The report should clearly identify what **the most significant issues** were arising from the inspection, along with a **balanced argument** that outlines **why corrective action is necessary**. The consequences to the organisation, and to individuals, of not taking corrective action need to be explained.

  Legal references should be included. This needs to be done by correctly identifying the specific legal standard that is being breached in each case, with an outline of how or why this breach is occurring. At least five breaches of law should be identified.

  You need to explain **why** management needs to take action, with clear references to the moral, **legal and economic** reasons for health and safety. The possible cost of not taking action should be included. You should explain the **beneficial effect** the actions would have on the standard of health and safety at the workplace and the possible effects on the business overall.

  The main findings section might be broken up into five sub-sections where each key topic is discussed under each sub-section heading. The issue that was identified during the inspection should be explained. The consequence of failing to address the issue should be explained. The law that is being breached should be identified with an outline of how the breach is occurring. The benefits of taking corrective action should be explained by reference to the moral, legal and financial arguments. This should be done in a concise logical and balanced way.

HINTS AND TIPS

Using Legal Standards

National General Certificate candidates must identify the relevant legal standards that apply in their part of the UK. They should therefore identify which part of the UK the workplace is in as a part of the Introduction section of the Management Report.

International General Certificate candidates must identify the relevant legal standards that apply in their country. They should therefore identify which country the workplace is in as a part of the Introduction section of the Management Report.

It is not appropriate in the Management Report to refer to GB legal standards if those are not the standards that apply in the country within which the workplace is based.

Reference to international standards is acceptable provided the correct standard relevant to the hazard is used.

- **Conclusions and Recommendations**

  The conclusions must **summarise the main findings** identified in the main body and should persuade management to take action. You should not introduce any new issues at this stage. The conclusions should only summarise the main findings of the report and not all of the findings of the inspection. When writing the conclusions, it is useful to review the main findings of the report to ensure that each main finding has been identified/summarised in the conclusions section.

  Recommendations must **follow on logically from your conclusions**. So, each issue summarised in the Conclusions section must have at least one recommendation that addresses the issue. In this way, the reader can cross-reference from the recommendations back to the conclusions and from the conclusions back to the main findings of the report.

You should use the following table to set out your recommendations. All recommendations must be sensible and realistic, appropriately prioritised and have appropriate resource implications.

Likely resource implications should refer to approximate costs of each recommendation. Precise costs are not required - approximate figures only. If an action does not have a direct financial cost associated with it, then the amount of time allocated should be used instead.

Prioritisation of recommendations should be done on the basis of risk - high-risk issues need to be given high priority; low-risk issues can be given low priority.

Target dates must reflect the priority and also the practicality of taking the action. High-priority issues need to happen sooner rather than later. But, similarly, things that are quick and easy to do should have a short timescale.

Recommendations	Likely Resource Implications	Priority	Target Date

Remember, these conclusions need to convince your manager of the need to take action.

The report should be **signed and dated**.

As a general note, the report should be written in **concise**, **formal language**. It should be factual and avoid technical jargon as far as possible. Your report should not contain photographs, printed text (e.g. policies or extracts from textbooks), or other extraneous material.

Criteria for Assessment of the Report to Management

The following marking matrix should give you a good idea of what you need to do to achieve maximum marks in each of these areas:

<table>
<tr><th colspan="5">Marks to be awarded</th></tr>
<tr><td></td><td></td><td>4-5</td><td>2-3</td><td>1</td></tr>
<tr><td rowspan="4">Management Report -
Introduction and Executive Summary</td><td>Introduction providing an overview of the chosen area</td><td>• Clear and appropriate description of the chosen area and of the activities occurring in the area</td><td>• Description of the chosen area and of the activities in that area</td><td>• Limited description of the chosen area
• Lack of details of the activities taking place in the area</td></tr>
<tr><td></td><td>4-5</td><td>2-3</td><td>1</td></tr>
<tr><td>Executive Summary</td><td>• Concise overview of important points and main conclusions/ recommendations</td><td>• Overview of some important points and some conclusions/ recommendations</td><td>• Limited overview</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Management Report -
Main findings of the inspection</td><td></td><td>11-15</td><td>6-10</td><td>1-5</td></tr>
<tr><td>Quality of interpretation of findings</td><td>• Logical progression from the observation sheets
• Does not duplicate observation sheets
• Majority of key issues identified in the observation sheets have been appropriately selected and discussed</td><td>• Logical progression from the observation sheets but some duplication of observation sheets
• Some key issues identified in observation sheets have been appropriately selected and discussed</td><td>• Limited progression from the observation sheets and duplication of observation sheets
• Minority of key issues identified in the observation sheets have been appropriately selected and discussed</td></tr>
</table>

<table>
<tr><th colspan="6">Marks to be awarded</th></tr>
<tr><td rowspan="2">Identification of possible breaches of legislation and/or international standards</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td></tr>
<tr><td>Appropriate references to 5 possible breaches with a clear understanding of the reasons for the breaches</td><td>Appropriate references to 4 possible breaches with a clear understanding of the reasons for the breaches</td><td>Appropriate references to 3 possible breaches with a clear understanding of the reasons for the breaches</td><td>Appropriate references to 2 possible breaches with a clear understanding of the reasons for the breaches</td><td>A list of international standards with no explanation of how the international standards were breached, or how they relate to the hazards, unsafe conditions or work practices selected</td></tr>
</table>

Marks to be awarded				
		8-10	**4-7**	**1-3**
Management Report - **Main findings of the inspection**	**Persuasiveness/ conciseness/ technical content**	• Clear legal, moral and financial arguments • Convinces management to take action • Report is well structured and appropriate length	• Some legal, moral and financial arguments • Some persuasion in management action • Report is reasonably well structured	• Limited legal, moral and financial arguments • Limited persuasiveness in management action • Report is poorly structured
Management Report - **Conclusions and Recommendations**		**11-15**	**6-10**	**1-5**
	Clear and concise conclusions which are clearly related to report findings and are effective in convincing management to take actions	• Findings identified in report summarised clearly and concisely • Relevant and appropriate information provided to persuade management to take actions	• Logical progression from the report • Some key issues identified in report have been appropriately discussed	• Limited progression from the report • Limited discussion of the key issues identified in the report
	Recommendations which present realistic actions to improve health and safety in the chosen area	• Recommendations based upon conclusions • Realistic recommendations and target dates • Appropriately prioritised recommendations • Appropriate resource implications for all recommendations	• Most recommendations follow on from the conclusions • Most recommendations are realistic • Some attempt at prioritisation • Appropriate resource implications for most recommendations	• Limited progression from conclusions • Recommendations not all realistic • No prioritisation • Limited resource implications

TABLE 1			
Range of issues identified and number of hazards			
Issues description	**Topic (✓ if covered)**	**Number of hazards identified within that topic**	**Comments**
Electricity			
Ergonomics			
Falling objects			
Fire			
First aid			
Good practice			
Hazardous substances			
Housekeeping			
Information			
Machinery			
Manual handling			
Noise			
Obstructions/ trailing cables			
Personal protective equipment			
Signage			
Vehicles/routes			
Vibration			
Welfare/hygiene			
Work at height			
Work environment			
Any other appropriate			
TOTAL			

Example of a Completed Report to Management

Report on an Inspection of the Engineer's Workshop and Store

Introduction

This report presents the main findings of a safety inspection carried out in the Engineering Workshop B and store at 9:30am on 01/08/2016. The engineer's workshop and store are part of a manufacturing unit making parts for refrigeration equipment. They comprise:

- A workshop area with typical machine tools, welding equipment and use of oils and solvents.
- A storage area for materials.
- A supervisor's area with a computer workstation.

The work carried out is tool-making, e.g. tools/dies for power presses, plus general repair and maintenance of premises, plant and machinery. Ten fitters were working here at the time of the inspection. Equipment in use included one lathe, the CNC grinder and one gas welding set. Manual handling of stock metal was observed, along with some forklift movements.

Executive Summary

This report focuses on five principal areas where improvements are required. These are listed below in order of importance. More detailed coverage is provided in the main body of this report, which includes timescales and approximate costs.

Fire Safety

Fire risks arising from inadequate storage of flammable substances, rubbish and welding gases should be controlled through improved management and provision of a separate gas cylinder storage area.

Housekeeping

Inadequate space in the store resulting in poor housekeeping and blocked fire escape routes should be addressed by completely clearing the store and providing extra racking.

Machinery Safety

The risks of injury from the guillotine should be controlled by removing the machine from service immediately and not using it until the guard is replaced.

Working Practices

Examples of lack of safety awareness by staff identified during the inspection of the workshop should be addressed by all staff attending a one-day training course on workshop safety.

Welfare Provision

Inadequate toilet and hand-washing facilities. Storage for clothing, rest areas and meal-taking provisions should be improved by refurbishment.

Failure to take action on this report could lead to possible enforcement action on breaches of legislation, claims for compensation and associated financial implications of each. Most of the recommendations outlined in this report can be actioned by in-house staff at relatively little cost. It is certainly true to say that the costs of not implementing these recommendations will be greater.

Main Findings of the Inspection

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.

These represent possible breaches of the Regulatory Reform (Fire Safety Order) 2005, which require that fire risk must be managed and that means of escape must be available for use at all times, and the Dangerous Substances and Explosive Atmospheres Regulations 2002, which require that dangerous substances (such as flammable liquids and gases) be stored in appropriately constructed containers and facilities. The organisation has a moral duty to prevent fatalities that may arise from fire risks. The action to reduce the risk is simple to introduce and low cost.

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. The organisation has a clear duty of care to prevent these injuries happening.

These represent possible breaches of the Workplace (Health, Safety and Welfare) Regulations 1992, which require that traffic routes are free of slip and trip hazards, and the Provision and Use of Work Equipment Regulations 1998, which require work equipment to be suitable for its intended purpose.

Machinery and Equipment

Several items of machinery and equipment are in a dangerous state due to the absence of guarding, badly adjusted guarding, and poor use and 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. The possibility of a life-changing injury to one of our employees must be prevented. The cost of prevention is minimal compared to the harm that may be caused.

These represent possible breaches of the Provision and Use of Work Equipment Regulations 1998, which require that dangerous parts of machinery are safeguarded to prevent injury.

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 drinks on a dirty workbench, failure to wear full face protection whilst welding, unsafe manual handling practices and the storage of chemicals in unmarked mineral water bottles. All these practices can be associated with poor supervision and a lack of training in safe working practices. This is a possible breach of Section 2 of the Health and Safety at Work, etc. Act 1974, which requires the provision of safe systems of work and adequate supervision, and the Management of Health and Safety at Work Regulations 1999, which require the provision of appropriate training to staff.

Welfare Amenity Provisions

The toilet and hand-washing area is in a particularly dirty state and requires urgent cleaning and re-decoration. It was also noted that there is no provision made for the storage and changing of clothing, for rest and for taking meals. Clean washing and toilet facilities are a basic human need. Lack of clean facilities is likely to cause our employees to have increased incidence of absence due to infections. The remedy is simple and we can prevent our employees falling ill and boost morale with clean toilet facilities.

These represent possible breaches of Workplace (Health, Safety and Welfare) Regulations 1992, which require the provision of adequate welfare facilities.

In summary, failure to take action on these issues could lead to possible enforcement action on breaches of legislation, claims for compensation and associated financial implications of each. In addition, should a serious accident occur, the company is liable to receive adverse publicity, resulting in reputational damage which may make it hard to win contracts in the future. Making improvements in these areas will reduce the risk of accidents and ill health in the workshop and lead to a happier and better motivated workforce. This will have the effect of improving both efficiency and productivity and will help to reduce costs associated with re-training of staff, accident investigation, insurance premiums and so on.

Conclusions

On balance, the workshop is well run, with some clear examples of good practice having been observed. The most significant hazards identified in this report relate to:

- Fire safety - fire risks arising from inadequate storage of flammable substances, rubbish and welding gases.
- Housekeeping - inadequate space in the store resulting in poor housekeeping and blocked fire escape routes.
- Machinery safety - the risks of injury from the guillotine.
- Working practices - examples of lack of safety awareness by staff.
- Welfare provision - inadequate toilet and hand-washing facilities and storage for clothing, rest areas and meal-taking provisions.

The report has identified a number of breaches of health and safety law, which, if left could lead to improvement or prohibition notices being issued by the enforcing authority. It is estimated that remedial action should only cost a few hundred pounds, which is likely to be significantly less than the total cost of loss of production, etc. caused by having to deal with notices.

As well as helping us to meet our legal obligations, implementation of the recommendations made in this report will help to reduce the potential for accidents, as a result of which costs associated with accidents and ill health will decrease. This will help to improve workforce morale and should result in a happier and more productive organisation.

Recommendations

Recommendation	Likely Resource Implications	Priority	Target Date
Fire Hazards			
Provide a separate gas cylinder storage area.	The estimated immediate cost is £700.	High	1 month
Housekeeping			
Ensure that the store is cleared and extra racking provided to permit storage off the floor (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.	No external cost although this may take an hour of maintenance's time.	High	At next scheduled shutdown in August 2XXX
Machinery and Equipment			
The guillotine should be removed from service immediately and not used until the guard is replaced.	The estimated immediate cost is £40.	High	1 week
The ladder is destroyed and replaced with a new one.	The estimated cost is £60.	High	2 weeks
All staff are 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.	1/2 an hour of management's time.	High	1 week
Working Practices			
All staff attend a one-day training course on workshop safety in the near future. The contents of the course would be agreed with the Managing Director.	The estimated cost would be £150 per person (although it may be possible to run this in-house which would only incur the cost of a trainer and employee time).	High	1 month
Welfare Amenity Provisions			
The toilets and washing facilities are cleaned immediately by the contracted cleaners. The Maintenance Manager should seek out suitable contractors and obtain quotes.	The estimated cost would be £500.	Medium	2 weeks 1 month

Signed *A. Smith* **Dated** *1/8/2016*

Submitting your Completed Assessment

Once completed, your assessment should include the following:

- **Your completed observation sheets** showing between 20 and 30 uncontrolled hazards and their consequences, together with at least one example of good practice. Remember that these should cover a wide variety of different types of hazard (multiple examples of the same type of hazard will only be marked once).
- **Your completed management report**, following the structure laid down by NEBOSH earlier in this guidance. Look at the marking schemes provided to check that you have given yourself the best chance of getting as high a grade as possible.
- **Your signed declaration** confirming to NEBOSH that this assessment is all your own work. Don't forget to include this - NEBOSH will not accept your assessment without it!
- **Your Practical Assessment must be completed and received by RRC within the following timescales**:
  - no more than two weeks before your nominated exam date and;
  - no more than one week after your nominated exam date.

  Any Practical Assessments received outside of this timeframe will not be submitted to NEBOSH for marking. RRC will confirm these deadlines nearer the time.

  If you do not meet these deadlines, NEBOSH will not accept your Practical Assessment and additional costs will be incurred for re-submission.

Once you have completed your assessment and are happy for it to be marked, send it into our Exams department at the following address:

Exams

RRC International

27-37 St George's Road

London

SW19 4DS

We suggest that you make a copy of your assessment before you send it off to us (just in case it gets lost in the post) and send it to us by trackable means.

Final Reminders

<table>
<tr><th colspan="2">Workplace Inspection</th><th colspan="2">Report to Management</th></tr>
<tr><td>✓</td><td>Start by taking a good look at your surroundings. Try to get a feel for the sorts of hazards and unsafe practices you should be looking for.</td><td>✓</td><td>Keep in mind that the report to management has to successfully persuade management to take appropriate action.</td></tr>
<tr><td>✓</td><td>Identify between 20 and 30 uncontrolled hazards and their consequences, as well as some good practices, and explain them in enough detail. Ideally aim for 25.</td><td>✓</td><td>The report should be approx. 700-1000 words in length, which is equivalent to two or three sides of A4 paper.</td></tr>
<tr><td>✓</td><td>Ensure you include hazards under a range of different topics (at least 4 or 5). Two separate examples of a training need will only get you 1 mark!</td><td>✓</td><td>The report needs to be structured appropriately, as follows:
Title
Introduction
Executive Summary
Main Findings
Conclusions
Recommendations
Date and Signature
The report should be written in concise, formal language and be broken down into distinct sections.</td></tr>
<tr><td>✓</td><td>Give more than one recommended action for each hazard - an immediate action to make the hazard safe and another longer-term action that fixes the underlying problem.</td><td>✓</td><td>The report should clearly identify what the main findings of the inspection were, with sufficient detail to allow the examiner to understand what was observed, what the risks were and what breaches have occurred.</td></tr>
<tr><td>✓</td><td>When explaining what action is required to eliminate or control each hazard or unsafe working practice, be concise but give the examiner enough detail.</td><td>✓</td><td>The report should clearly identify what corrective actions must be taken, with an indication of cost implications and some explanation of why this corrective action is necessary.</td></tr>
<tr><td>✓</td><td>Remember to include timescales. You need to show you can differentiate between them.</td><td rowspan="2">✓</td><td rowspan="2">Keep in mind the areas that the examiner is going to be looking at when marking your report:
Introduction - 0-5 marks
Executive summary - 0-5 marks
Interpretation of findings/quality of interpretation of findings - 0-15 marks
Identification of breaches of legislation - 0-5 marks
Persuasiveness/conciseness/technical content - 0-10 marks
Conclusions - 0-15 marks
Recommendations - 0-15 marks
You need to score well in each of these areas to pass.</td></tr>
<tr><td>✓</td><td>Keep in mind the areas that the examiner is going to be looking at when marking your inspection:
Range and number of issues identified - 0-15 marks
Identification of suitable control measures - 0-15 marks
You need to score well in each of these areas to pass.</td></tr>
<tr><td>✓</td><td colspan="3">Remember to include everything when you submit the practical assessment for marking, including:
Your completed observation sheets
Your completed report (laid out in the required structure)
A signed declaration that the submission is your own work (if this is missing, your result may be declared void!)</td></tr>
</table>

Common Mistakes

These are some of the most common mistakes that candidates make when completing and submitting their GC3 practical assessments. These mistakes either lead to instant failure or very poor marks that mean the assessment falls below the 60% pass mark:

- Missing declaration form (see Appendix 1 of the NEBOSH Guidance).
- Assignment dated outside of the 'two week, one week' criteria (assignment must be carried out no earlier than two weeks prior to, and no more than one week after, the exam date).
- Missing elements (i.e. observation sheets or report).
- Not using NEBOSH templates (see Appendix 3 and 4 of the NEBOSH Guidance).
- Using incorrect templates (e.g. one for the NEBOSH Award instead of Certificate).
- Not identifying enough uncontrolled hazards.
- Consequences not listed in Observation Sheets.
- Identifying unacceptable timescales for immediate action (more than two days).
- Lack of moral/legal/financial argument in the report.
- Duplication of observation sheets within the report.
- Limited progression from report to conclusions.
- Recommendations that do not follow on from the conclusions.
- Inappropriate timescales in the recommendations table.

All of these mistakes are easily put right. So check this list and **do not let it happen to you!**

Suggested Answers

No Peeking!

Once you have worked your way through the study questions in this book, use the suggested answers on the following pages to find out where you went wrong (and what you got right), and as a resource to improve your knowledge and question-answering technique.

Element 1: Workplace Hazards and Risk Control

Question 1

The six main welfare requirements in any workplace are: suitable and sufficient WCs, washing facilities, changing rooms, accommodation for clothing, rest and eating facilities, and access to drinking water.

Question 2

The protective measures to be used for working in conditions of extreme heat include:

- Providing good workplace ventilation - moving air has a cooling effect.
- Insulating heat sources - by lagging hot pipes.
- Shielding heat sources - to control radiant heat and prevent contact burns.
- Providing cool refuges - where workers can escape the heat.
- Providing easy access to drinking water.
- Providing frequent breaks and job rotation.
- Providing appropriate clothing.

Question 3

Occupations at risk of violence at work are:

- Hospital accident and emergency staff.
- Police.
- Social workers.
- Bus and taxi drivers.
- Fire-fighters and paramedics.
- Traffic wardens.
- Railway staff.
- Teachers.

Question 4

The strategy will depend on the nature of the work and, in particular, whether employees are located in a fixed building or out in the community:

- General strategy: clear policy, zero tolerance, training for all staff at risk (handling aggression and violence, diffusing situations, break away/self-defence).
- Fixed workplace: security guards, security doors, CCTV, screens, panic buttons.
- Out in the community: customer-vetting, visit-logging, safe system of work, remote supervision, communications.

Question 5

Symptoms might include: lateness, absenteeism, poor quality of work, reduced work rate, theft, dishonesty, irritability and mood swings, poor working relationships.

Question 6

Three from: falls from height; being struck by moving, flying or falling objects; being struck by vehicle; striking against stationary objects.

Question 7

The main hazards causing slips, trips and falls on the same level are wet, glossy or slippery floors; uneven or loose surfaces; obstacles on the surface.

Question 8

Four factors from:

- Normal patterns of movement.
- Predictable abnormal movements, such as emergency evacuations.
- Accident history.
- Possible adverse weather conditions, e.g. ice.
- Maintenance requirements.

Question 9

A designated walkway is an area that is specially protected from hazards by segregating people from vehicles, and within which pedestrians should be reasonably safe from harm.

Question 10

Eight control measures from: adequate lighting; use of appropriate footwear with good grip; level floor surfaces; non-slip floor surfaces; good drainage; spill control; use of designated walkways; provision of handrails to steps and stairs; maintenance and repair of defects; use of high-visibility clothing.

Question 11

The safe method of working on a fragile roof includes 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.

Question 12

The main risks of using ladders are:

- Falling from the ladder.
- Tipping or toppling sideways.
- The ladder slipping away from the wall it is propped against.
- Falling objects.
- Contact with live electrical services.

Question 13

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.
- Using leashes or lanyard attached to tools.

Question 14

(a) 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 perpendicular (at right angles) to the face of the building.

(b) Tying secures the scaffolding to the building, whereas bracing is used to stiffen the framework by joining the framework diagonally.

Question 15

Precautions for the use of MEWPs include:

- Firm, level ground for the vehicle to stand on.
- Sufficient clearance from any building or obstacle.
- Avoidance of live overhead cables.
- Barriers in place to provide an exclusion zone, which also prevents collisions with the equipment.
- Adequate edge protection for the cradle.
- Use of harness and lanyard when in the cradle.
- Vehicle not moved with the cradle raised unless it is designed for that purpose.
- No overloading.
- Use must be restricted to trained, authorised staff.

Question 16

The angle at which ladders should be positioned is 75° to the horizontal (1 out: 4 up ratio).

Question 17

Scaffolding should be inspected 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).

Question 18

- Hazards associated with the work environment, such as extreme outdoor temperatures.
- Hazards associated with safe movement through the temporary work site.
- Working at height.
- Vehicle hazards.
- Manual handling.
- Lifting operation hazards.
- Tools and equipment hazards.
- Fire hazards associated with work activities and flammable liquid and gas use.
- Excavations.
- Demolition hazards.
- Chemical and biological hazards.
- Noise and vibration hazards.

Question 19

Any five management controls from:

- Risk assessment.
- Communication and co-operation between those undertaking construction work.
- Appointment of competent people to manage and undertake the work.
- Effective segregation of sites.
- Emergency procedures.
- Adequate welfare provision.

Element 2: Transport Hazards and Risk Control

Question 1

The main types of risk associated with vehicle operations are loss of control, overturning, and collisions with other vehicles, pedestrians or fixed objects.

Question 2

Several unsafe practices may be involved, including:

- Driving too fast.
- Traversing across a slope.
- Driving with the load raised up.
- Sudden heavy braking.
- Uneven tyre pressures.
- Cornering too fast.
- Driving into potholes or over kerbs.

Question 3

Management of vehicle operations and movements includes the following measures:

- Restricting vehicle use to qualified, authorised staff only.
- Safe systems of work.
- Speed limits.
- Designated vehicle parking places.
- Signs and markings.
- Signalling and use of banksmen.
- Loading and unloading procedures.
- General rules to make sure vehicles do not become hazards.

Question 4

The equipment that might be fitted to vehicles to protect drivers are seat belts, protective cages or Roll-Over Protective Structures (ROPS), and guards to protect the driver in the event of falling objects - Falling Object Protective Structures (FOPS).

Question 5

Warning lights and alarms are used to alert pedestrians and other drivers of the approach of a vehicle. They are particularly important at blind corners, junctions and doorways, and when reversing.

Question 6

There are three main means of separation:

- Barriers and/or clear surface markings to mark separate routes for pedestrians and vehicles. Kerbed pavements for outdoor roadways.
- Designated crossing points for pedestrians to use when crossing vehicle routes.
- Separate doorways and access points for pedestrians.

Question 7

The first option to consider when controlling driving risk is elimination of the need to travel, e.g. by the use of video conference calling rather than face-to-face meeting.

Question 8

The three main areas of concern that can be managed by the risk assessment process are the driver of the vehicle, the vehicle and the journey to be made.

Question 9

Three from: the route to be taken, the schedule for the journey, the time allowed for the journey, the distance to be travelled and any adverse weather conditions.

Element 3: Musculoskeletal Hazards and Risk Control

Question 1

Aim of ergonomics is adapting the workplace to suit the worker.

Question 2

The categories of health risks arising from poor task and workstation design are physical stress resulting in musculoskeletal injury, plus general fatigue, eye strain, aches and pains, and mental stress.

Question 3

The risk factors involved include posture, forces involved, repetition, duration, twisting, equipment design, environment and recovery time.

Question 4

The key requirements are:

(a) 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 DSE for viewing at a comfortable distance without cramping the work surface in front of it.

(b) 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.

(c) A work chair must have an adjustable seat back, good lumbar support and be adjustable in height to suit the user. DSE chairs usually have a five-point base for good stability with wheels to allow the chair to be moved close to the desk.

(d) 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.

Question 5

The main injuries associated with manual handling are:

- Back injuries, such as a prolapsed disc.
- Work-related upper limb disorders.
- Muscle tears/strains.
- Tendon and ligament injuries/tears/strains.
- Hernias.
- Cuts, burns, dislocation and broken bones.

(Note that 'musculoskeletal disorders' is rather too general an answer and covers most of the specific injuries listed above.)

Question 6

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.

Question 7

The characteristics of a load which constitute a hazard are its weight, size, shape, 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.

Question 8

The main hazards in the working environment are:

- Space restrictions on movement and posture.
- Conditions of floors and other surfaces.
- Variations in levels.
- Temperature and humidity.
- Strong air movements.
- Lighting conditions.

Question 9

The hazards of manual handling can be minimised through the elimination of risk by automation, or the use of mechanical lifting equipment.

Question 10

The sort of individuals who might be more prone to manual handling injury:

- Pregnant women and new mothers.
- Young people.
- People with pre-existing health conditions, such as back injuries.

Question 11

(a) The most common hazard of forklift 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.

(b) The main hazards of sack trucks are overloading, instability of the load, tipping when moving over uneven ground or on slopes, and careless stowage.

(c) The main hazards 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.

(d) The main hazards associated with cranes are the hazards of them becoming unbalanced and toppling over, the arm of the crane swinging out of control, or the load striking something while being moved horizontally or falling.

Question 12

(a) The appropriate PPE for working with pallet trucks is safety footwear, and perhaps gloves for hand protection while handling loads.

(b) The appropriate PPE for working with cranes is safety footwear, hard hat, gloves and high-visibility clothing.

Question 13

The typical safety precautions for safe use of a mobile crane:

- Assessment of the ground conditions before siting the crane.
- Using the outriggers.
- Ensuring that the driver is qualified and competent.
- Ensuring that the crane has been maintained and has an in-date report of thorough examination.
- Using a banksman (signaller) to direct the lifting operation.
- Ensuring that the load is within the lifting capabilities of the crane.
- Making use of any warning devices or indicators fitted to the crane, such as the radius gauge and overload alarm.
- Not using the crane in adverse weather, particularly in high winds.
- Never lifting over a person.

Element 4: Work Equipment Hazards and Risk Control

Question 1

Maintenance workers are sometimes at greater risk than operators when working on machinery because:

- Guards have to be removed.
- Safety devices have to be disabled.
- Power sources may be exposed.
- Stored power may be released.
- Access may be difficult.
- Manual handling may be difficult.
- New hazards may be introduced.

Question 2

The general health and safety responsibilities of machine operators are to:

- Only operate equipment they are authorised to use.
- Operate equipment in accordance with instruction and training.
- Only use equipment for its intended purpose.
- Carry out all necessary safety checks before using equipment.
- Not use the equipment if it is unsafe.
- Report defects immediately.
- Not use equipment under the influence of drugs or alcohol (including some medication that causes drowsiness).
- Ensure equipment is clean and maintained in safe working order.

Question 3

(a) Three likely causes of accidents involving the use of hand tools arise from operator error, misuse and improper maintenance.

(b) 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.

Question 4

Power tools are marked to identify them for inspection purposes as part of a routine maintenance system, e.g. if the tool is electrically operated, it should be given a periodic, thorough inspection and test.

Question 5

The non-mechanical hazards arising from the use of machinery are noise; vibration; electricity; extreme temperatures; hazardous substances; radiation (both ionising and non-ionising); fire and explosion; slips, trips and falls, and ergonomics.

Question 6

Drawing-in injuries occur where a part of the body is caught between two moving parts and drawn into the machine, e.g. drawn in between two counter-rotating rollers in a printing press.

Question 7

The hierarchy of protective measures is as follows:

- Fixed enclosed guards.
- Other types of guard such as interlocked guards.
- Protection devices.
- Protection appliances.
- The provision of information, instruction, training and supervision.

Question 8

Interlocked guards:

- stop the machine immediately when the guard is opened, or
- will not allow the guard to be opened until the machine has fully stopped, and
- will not allow the machine to re-start until the guard has been properly closed.

Question 9

A trip device is a device which stops the motion of a machine when a person enters the hazard area.

Question 10

There are three potentially serious limitations, which are that they:

- Do not completely prevent access to dangerous parts.
- Can easily be defeated or not used.
- Rely upon operators being entirely vigilant in providing for their own safety.

Question 11

Protective appliances are hand-held tools or devices that 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 workpiece whilst not coming into contact with the hazardous parts of the machine. They include push-sticks, jigs and other types of holder.

Question 12

Operators are required to be trained in the use of safety equipment before using the tools or machinery.

Question 13

Two people can override the system by each holding one handle/operating one button.

Question 14

Five requirements for any guarding system are that they should:

1. Be compatible with the process.
2. Be of adequate strength.
3. Be properly maintained.
4. Not increase risk.
5. Not be easily bypassed or disabled.

Question 15

(a)
- Abrasion on contact with rotating abrasive wheel.
- Drawing in at nip-point between wheel and tool rest.
- Ejection of parts of the wheel during normal use, or if it bursts.
- Entanglement with the spindle on which the wheel is mounted.
- Electricity.
- Hot parts caused by friction (especially the workpiece being ground).
- Health hazard from dust.
- Noise and vibration.

(b)
- Cutting on contact with moving blade.
- Entanglement with moving blade.
- Drawing in at nip-point between blade and casing.
- Puncture by ejected parts (especially broken blade fragments).
- Burns from the hot exhaust system.
- Noise.
- Vibration (into the hands).
- Fire and explosion from petrol (fuel).
- Ergonomic from handling.
- Health hazards from dust, fumes and lubricating oils.

(c)
- Cutting on contact with blade.
- Entanglement with drive motor.
- Drawing in at nip points between motor and drive belt.
- Ejection of workpiece during cutting.
- Electricity.
- Noise.
- Health hazard from inhalation of wood dust.

Question 16

PPE that should be worn when using a chainsaw includes:

- Face visor/eye protection.
- Ear defenders.
- Hard hat.
- Stout gloves.
- Boots with good grip and steel-toe caps.
- Cut-resistant trousers or chaps.
- Stout shirt.

Element 5: Electrical Safety

Question 1

The relationship between current, resistance and voltage in a simple circuit is given by Ohm's law: Voltage = Current × Resistance, or V = I × R

Question 2

An electric shock results in muscle tremor and contractions (often violent). The muscle contractions can cause the inability to let go, and may cause the respiratory system to fail as the casualty cannot breathe. It can result in the heart beating spasmodically (ventricular fibrillation), or cardiac arrest. It can also result in burns, especially to the skin at the point of entry and exit.

Question 3

(a) I = V/R = 230/10,000 = 23mA. This will cause strong muscle contraction and possibly breathing difficulties.

(b) I = V/R = 110/10,000 = 11mA. This will be painful and there will be some muscle contraction.

(c) I = V/R = 50/10,000 = 5mA. Perhaps some mild tingling will be felt.

Please note that you will not be asked to do any calculations in the Certificate exam!

Question 4

Arcing is the passage of electrical current through air from one conductor to another or to earth. If the arc is connected to a person, the victim may be subject to a 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.

Question 5

Earthing provides a safe path for any fault current to be dispersed to earth through a low-resistance conductor.

Question 6

A cord grip restricts movement at the point of entry of the flexible cable sheath into the plug, preventing abrasion of the cable. It also prevents the conductors being pulled loose from their terminals.

Question 7

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 an electromechanical device in the form of a switch that automatically opens if the circuit is overloaded.

Question 8

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.

Question 9

Reduced low-voltage circuits reduce the effect of any shock received from making contact with part of the circuit because of the relationship between voltage and current. If resistance stays the same, then less voltage means less current.

Question 10

If mains-supplied electric hand tools cannot be powered by battery, then a residual current device should be used.

Question 11

The user should visually check for signs that the equipment is in good condition. They should look for:

- Damage to the cable sheaths, joints or plugs.
- Evidence that the equipment has been subjected to conditions for which it is not suitable, e.g. it is wet or excessively contaminated.
- Damage to the external casing of the equipment or loose parts or screws.

Question 12

The first action should be to break any continuing contact between the victim and the current.

However, before this can be done, the area must be assessed to ensure it is safe to approach the casualty and the location they are in.

Element 6: Fire Safety

Question 1

(a) 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.

(b) 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 obstructing the air intake into the heater.

Question 2

If you open a window to release the dense smoke in a room created by a fire, 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.

Question 3

(a) Class C - fires involving gases.

(b) Class B - fires involving flammable liquids.

(c) Class A - fires involving solid, mainly carbonaceous, materials (here, most likely paper and furniture, etc.).

Question 4

(a) Convection.

(b) Radiation.

(c) Conduction.

Question 5

Direct burning.

Question 6

The five steps of fire risk assessment:

1. Identify the fire hazards:
   - Sources of fuel.
   - Sources of ignition.
   - Sources of oxygen.
2. Identify the people who might be at risk:
   - People in the premises.
   - Vulnerable people.
3. Evaluate the risks and identify and implement the fire precautions required:
   - Fire prevention.
   - Prevention of the spread of smoke and flames.
   - Fire detection and alarm.

- Fire-fighting equipment.
- Means of escape.
- Signs and notices.
- Lighting.

4. Record findings, plan and train:
   - Emergency plans.
   - Information and instruction.
   - Training.
5. Review and revise the assessment as necessary.

Question 7

Fire risk can be minimised in a woodworking area 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.

Question 8

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.

Question 9

The steel 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.

Question 10

Typical characteristics of a fire door:

- Rated to withstand fire for a minimum period of time.
- Fitted with a self-closing device.
- Fitted with an intumescent strip.
- Vision panel of fire-resistant glass.
- Clearly labelled.

Question 11

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.

Question 12

Two main types of automatic fire detector are smoke detectors (both ionising and optical) and heat detectors (both fixed temperature and rate of rise).

Question 13

The main points to be covered in training in the use of fire extinguishers includes:

- General understanding of how extinguishers operate.
- 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.

Question 14

The three ways of extinguishing a fire are: starvation (removing the fuel), smothering (removing the oxygen) and cooling (removing the heat).

Question 15

(a) Water - Class A.

(b) Carbon dioxide - Class B and fires involving electrical equipment.

(c) Dry powder - suitable for Classes A, B, C, D and fires involving electrical equipment (but messy!).

(d) Foam - Class A and B.

(e) Fire blankets - small fires and high temperature fat fires (Class F).

Question 16

The purpose of signs used on escape routes is to direct occupants to the means by which they can safely leave the premises.

Question 17

The escape route should be as straight as possible direct to the assembly point, clear of obstruction, free of materials that could pose a fire hazard, and be wide enough throughout (including at doorways and openings) to provide for the unrestricted flow of people.

Question 18

An assembly point should be a place of total safety (outside the building, in the open air, away from any further danger from the fire). A refuge or a place of relative safety is a fire-protected area that is not outside in the open air away from any further fire danger, where people can wait for a short time.

Question 19

The responsibilities of fire marshals during a fire evacuation include:

- 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 service on arrival and informing them of all relevant details.

Question 20

There should be a roll call to ensure that all people in the affected area are present.

Element 7: Chemical and Biological Health Hazards and Risk Control

Question 1

The physical forms of chemicals that may exist in the workplace are solids, liquids, gases, vapours, mists, fumes, dusts and fibres.

Question 2

Any five health hazard classifications of chemicals from:

Acute toxicity, skin corrosion/irritation, serious eye damage/eye irritation, respiratory or skin sensitisation, germ cell mutagenicity, carcinogenicity, reproductive toxicity, specific target organ toxicity (single and repeat exposure), aspiration hazard.

Question 3

Acute means that the substance has short-term effects (usually occurring after a large over-exposure over a short duration of time).

Chronic means that the substance has long-term health effects (usually occurring after repeated low-level exposures over a long duration of time).

Question 4

The routes of entry of chemical and biological agents into the body are inhalation, ingestion, absorption, and injection (plus aspiration).

Question 5

The label on a substance which is dangerous for supply generally gives the following information:

- The name of the substance/mixture.
- The name(s) of the hazardous constituents.
- The indication(s) of danger and the corresponding symbols/warning phrases.
- Some basic precautions to take.
- Name, address and telephone number of the supplier.

Question 6

Safety data sheets are intended to provide users with sufficient information about the hazards of the substance, or mixture 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. They provide much more in-depth information than that found on labels.

Question 7

Workplace exposure limits are maximum concentrations of airborne contaminants, measured across a reference period of time, to which employees may be exposed by inhalation.

Two reference periods are used:

- Short-Term Exposure Limits (STELs) over a 15-minute time period.
- Long-Term Exposure Limits (LTELs) over an eight-hour time period.

Question 8

The limitations of WELs are that (any two from the following):

- 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 may be invalidated by changes in temperature, humidity or pressure.
- Employees may be working with ineffective controls.
- The monitoring equipment may become contaminated.
- Some limits do not consider all possible health effects of a substance.

Question 9

(a) Substitution.

(b) Work process change.

(c) Reduced time exposure.

(d) Elimination.

Question 10

Local exhaust ventilation 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.

Question 11

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 are a problem because non-moving air is not being mixed and diluted with fresh air and so high levels of hazardous substance can exist in these dead areas.

Question 12

The main types of respirator are filtering facepiece respirators, half-mask respirators, full-face respirators and powered visor respirators. For breathing apparatus, the two main types are compressed airlines and self-contained systems.

Question 13

The key criteria in the selection of the appropriate respirator to use are the type of hazard (dust, gas, vapour, etc.) and the category of danger, contaminant concentration levels and wearer acceptability.

Question 14

The main purpose of 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.

Question 15

Carbon monoxide (CO) is an asphyxiant gas, i.e. when inhaled, it reduces the oxygen available to the body. The presence of CO in air causes asphyxiation when the CO combines with haemoglobin to form carboxy-haemoglobin, a compound which prevents oxygen transport by the blood. This causes headache, drowsiness, unconsciousness and death at relatively low concentrations.

Question 16

Three from:

- **Asbestosis** - asbestos fibres lodge deep in the lungs and cause scar tissue formation. If enough of the lung is scarred then severe breathing difficulties occur. Can prove fatal. Increases risk of cancer.
- **Lung cancer** - asbestos fibres in the lung trigger the development of cancerous growths in the lung tissue. Usually fatal.
- **Mesothelioma** - asbestos fibres in the lung migrate through the lung tissue and into the cavities around the lung and trigger the development of cancerous growths in the lining tissue. Always fatal.
- **Diffuse pleural thickening** - thickening of the lining tissue of the lung (sometimes known as pleural plaques) that causes breathing difficulties. Not fatal.

Question 17

The harmful effects of cement on health include:

- Irritation or corrosive burns to the eyes.
- Irritation of the respiratory tract.
- Irritant dermatitis on skin contact.
- Allergic dermatitis on repeated skin contact.
- Corrosive burns to the skin on prolonged contact.

Question 18

Hazards that might arise when handling and storing waste for disposal (any six from the following):

- Any manual handling of the waste.
- Mechanical hazards arising from any handling equipment, such as trucks or compactors.
- Fire hazard associated with storing combustible materials, especially if stored outside and accessible to trespassers.
- Health hazards arising from the chemical nature of the waste, e.g. toxic substances.
- Hazards arising from the mixture of incompatible chemicals that might react together to form harmful products or even cause fire.
- Biological hazards that might arise from disposal of organic waste, such as food waste and the pests, (e.g. rats) that might be associated.
- Environmental hazards which arise due to uncontrolled releases such as leaks or spills which can contaminate the ground or drains.

Element 8: Physical and Psychological Health Hazards and Risk Control

Question 1

This refers to a daily personal exposure to noise at a level of 85 dB(A) over the course of a working day (eight hours), or an equivalent exposure over a longer or shorter period. This represents the upper exposure action value at and above which action must be taken to reduce employee exposure. 'dB' refers to decibel - the sound pressure level. 'A' refers to the A-weighting matrix, which takes into account the sensitivity of the human ear to noise at different frequencies.

Question 2

One limitation of ear defenders is that the seal between the ear and the protective device may be less than perfect due to long hair, spectacle frames and jewellery, incorrect fitting or the wearing of helmets or face shields. They may become uncomfortable during use and be removed. They also need a dedicated storage facility.

Limitations of ear plugs are that they offer less noise reduction at high-noise levels, they are more difficult to see and therefore enforce, and they can be a source of contamination into the ear if hygiene practices are poor.

Question 3

Symptoms of hand-arm vibration syndrome include:

- Tingling and numbness in the fingers and hands.
- Blanching (whitening) of the fingers on exposure to cold conditions.
- Reddening and pain of the fingers after a blanching attack.
- Loss of finger dexterity.
- Loss of grip strength.

Question 4

The type of non-ionising radiation given off are:

(a) Radiofrequency.

(b) Infrared radiation.

(c) Ultraviolet and infrared.

(d) Visible radiation.

Question 5

Visible radiation is particularly dangerous to the eyes if it is intense (from a laser). Temporary or permanent blindness can be caused by intense visible light. If very intense, it can cause burns to exposed skin tissue.

Question 6

The six work-related causes of stress, and an example of a preventive measure for each, are:

- Demands - ensuring that there are sufficient resources available to do the work required and that priorities and deadlines are negotiated and reasonable.
- Control - encouraging workers to plan their work, and make decisions about how it is completed and how problems will be tackled.
- Support - providing positive feedback, and focusing on performance, not on personality.
- Relationships - clear standards of conduct and policies to tackle harassment and bullying.
- Role - clear work objectives, job descriptions and reporting responsibilities.
- Change - consultation and involvement of staff in determining processes.