NEBOSH INTERNATIONAL DIPLOMA UNIT IA

Managing Health and Safety Part 1

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NEBOSH INTERNATIONAL DIPLOMA

UNIT IA: MANAGING HEALTH AND SAFETY - PART 1

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Element IA3: Loss Causation and Incident Investigation

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Element IA5: The Assessment and Evaluation of Risk

Suggested Answers

Course Structure

This textbook has been designed to provide the reader with the core knowledge needed to successfully complete the NEBOSH International Diploma in Occupational Health and Safety, as well as providing a useful overview of health and safety management. It follows the structure and content of the NEBOSH syllabus.

The NEBOSH International Diploma consists of four units of study. When you successfully complete any of the units you will receive a Unit Certificate, but to achieve a complete NEBOSH Diploma qualification you need to pass the 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).

Assessment

Unit IA is assessed by a two-part, three-hour exam. Section A consists of six 10-mark compulsory questions, and Section B consists of five 20-mark questions, of which you must choose three.

NEBOSH set and mark this exam paper.

More Information

As you work your way through this book, always remember to relate your own experiences in the workplace to the topics you study. An appreciation of the practical application and significance of health and safety will help you understand the topics.

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/newsletters.aspx to access these updates.

Unit IA: Managing Health and Safety	
Element IA1	Principles of Health and Safety Management
Element IA2	Regulating Health and Safety
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Element IA4	Measuring and Reviewing Health and Safety Performance
Element IA5	The Assessment and Evaluation of Risk
Element IA6	Risk Control
Element IA7	Organisational Factors
Element IA8	Human Factors
Element IA9	The Role of the Health and Safety Practitioner (Please note that Element IA9 will **NOT** be examined in the Unit A exam, but only assessed as part of the Unit DNI assessment.)

Element IA1

Principles of Health and Safety Management

Learning Outcomes

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

1. Explain the moral, legal and economic reasons for the effective management of health and safety.
2. Outline the societal factors which influence an organisation's health and safety standards and priorities.
3. Outline the uses of, and the reasons for, introducing a health and safety management system.
4. Explain the principles and content of an effective health and safety management system including the reasons for integration with other management systems.

Contents

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Reasons for Effective Management of Health and Safety

IN THIS SECTION...

There are three fundamental reasons for organisations to manage health and safety risk:

- Moral – as human beings, we should feel obliged to look after each other's safety.
- Legal – there are strict legal obligations imposed on employers and employees relating to the safety of employees and others affected by the business.
- Economic – businesses that address health and safety risk are invariably more successful than those that do not. Loss events, such as accidents or ill health lead to significant direct and indirect costs.

Moral

It is widely accepted that moral reasons should be the prime motivator for managing risk, although whether this is actually the case is open to debate in some cases.

There is a need to maintain a moral code within our society. Without it, employers may be tempted to treat the health and safety of the workforce as being of less importance than financial profit.

Moral reasons are based on the concept of an employer owing a **duty of reasonable care** to his employees. A person does not expect to risk life and limb, or physical health, as a condition of employment.

Many moral obligations have been turned into legal ones

Society expects every employer to demonstrate a correct attitude to health and safety to his workforce. It is unacceptable to place employees in situations where their health and safety is at risk. Statistics relating to accidents/incidents and ill health help to reinforce the message that health and safety should be effectively managed. The statistics also demonstrate that proportionately, those who work for small businesses are at significantly greater risk than those who work for large organisations. This is clearly morally wrong.

In addition to the obvious duties owed by an employer to his workers, he also has a moral obligation to protect other people whose health and safety may be affected by his undertaking, e.g. contractors or members of the public.

Legal

In an ideal world, organisations would all "self regulate" or "self police", so that they identified and enforced the most appropriate health and safety standards for their activities. This has several advantages, two of which are that each business is in the best position to regulate its own activities and it would also avoid the need to have a separate (and costly) regulator. Unfortunately, not all organisations are sufficiently motivated or enlightened. Over the years many moral obligations have been turned into health and safety law. For example, the International Labour Organisation's (ILO) **Occupational Safety and Health Convention 1981, C155**, identifies some basic general legal duties of employers towards their employees in Article 16:

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

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

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

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There are strong legal reasons for employers to manage risk:

- **Preventive** - enforcement notices (improvement or prohibition) can be issued by enforcement inspectors.
- **Punitive** - where the criminal courts impose fines and imprisonment for breaches of legal duties. These punishments can be given to the company or to individuals within the company.
- **Compensatory** - where employees are able to sue in the civil courts for compensation.

Economic

Accidents and ill health are costly. These costs are variously categorised as direct and indirect, insured and uninsured. **Direct costs** are the calculable costs arising directly from the accident, e.g. sick pay, repairs to damaged equipment, fines, and legal fees. **Indirect costs** are consequential but do not generally involve the actual payment of monies, e.g. lost orders, business interruption. Indirect costs, though largely difficult to calculate, are often substantially more than direct costs.

Accidents and ill health are costly

All employers are required to have certain types of insurance against accidents, ill health or other problems, such as:

- Employers' liability insurance.
- Public liability insurance.
- Motor vehicle insurance.

These insurances will cover some of the costs of accidents and ill health, e.g. compensation claims from employees and damage to motor vehicles.

Employers can take out insurance policies to cover many losses and it is a matter of the insurance company deciding the size of the premium that it wishes to charge. However, fines from criminal prosecutions cannot be insured against on the principle that a defendant cannot benefit from having committed a crime.

Some losses are of indeterminate value. This underlines the difficulty an organisation may have in actually attempting to find out the true cost of accidents to the business. The company may not have enough people with the correct level of expertise and time to perform the analysis. They may not even appreciate that some costs exist and so miss them entirely. The culture of the organisation might mean that many incidents are never reported and so never find their way into statistics used as a basis for costing. Some costs may not be known accurately for a considerable length of time – such as where a civil case is on-going and there is likely to be a substantial compensation award. Obtaining realistic cost estimates of the impact of more subtle items, such as loss of morale (leading to lower productivity) and loss of goodwill/public image (resulting in lower sales), may be virtually impossible.

There are clearly financial benefits to be gained from effective health and safety management. Employers with good health and safety management systems in place are likely to save substantial sums on the costs of accidents that would otherwise have happened.

STUDY QUESTION

1. Explain the three reasons why organisations should manage health and safety.

(Suggested Answer is at the end.)

Societal Factors Which Influence an Organisation's Health and Safety Standards and Priorities

IN THIS SECTION...

Certain societal factors influence an organisation's health and safety standards, particularly:

- Economic climate - wealthy countries can afford to give occupational health and safety a higher priority.
- Government policy - those who work tend to be healthier than those who are unemployed. Improving workers' health will help keep people at work, who can then contribute financially to society.
- Risk profile - higher-risk activities demand greater standards than those for lower-risk activities.
- Globalisation - businesses that operate across the world may adopt different standards, depending on the requirements of the host countries.
- Migrant workers - in recent years, immigration policies have increased the proportion of migrant workers.
- Societal expectations of equality.

Significant Factors

Economic Climate

The wealthiest countries of the world, where individuals have access to the basic necessities for life, such as food, clean water and shelter, have the funding to create and enforce good Occupational Health and Safety (OHS) standards. In countries where individuals do not have these resources, it is inevitable that OHS is given a relatively lower priority.

OHS is often a higher priority in wealthier countries

Government Policy and Initiatives

The government has a major influence on OHS policy through its ability to create legislation. In 2008, the UK government published a document entitled *Working for a Healthier Tomorrow* which made the following points:

- Life expectancy in the UK is higher than ever, yet millions of working days are lost to work-related illness.
- Evidence suggests that the working population is healthier than those who do not work. Families without a working member are likely to suffer persistent low income and poverty.
- Improving the health of the working age population is critically important for everyone to secure higher economic growth and its associated benefits.

Industry/Business Risk Profile

Not surprisingly, higher-risk work activities require higher standards of control than those that create lower risks. For example, nuclear power stations each operate under a site licence and demand very rigorous OHS standards.

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Globalisation of Business

Many businesses of all sizes operate both nationally and internationally, yet the standards demanded in the UK may be very different to those required by the overseas environment. Resolving differences in culture and communication may create different expectations and standards.

Globalisation of business

Migrant Workers

As a result of more flexible immigration policies, the proportion of migrant workers in workforces is generally increasing and cultural and communication issues may influence OHS standards.

Level of Sickness Absence

In the UK, sickness absence has gradually reduced, but is still substantial, with around 150 million days lost to sickness absence each year. Employment and Support Allowances (which are replacing incapacity benefits) are paid to those who are unable to work because of ill health or disability.

Societal Expectations of Equality

Health and safety standards and priorities can be determined by changes in societies' expectations of equality.

In the UK, the **Equality Act 2010** aims to protect disabled people and prevent disability discrimination. The Equality Act provides legal rights for disabled people in the area of employment, requiring employers to make reasonable adjustments to the workplace to accommodate workers with disabilities. Consequently, acceptable access and egress to a workplace may need to include provision of ramps and lifts in order to comply with these expectations of equality and the legal obligations associated with them.

STUDY QUESTION

2. Outline five societal factors that influence health and safety standards.

(Suggested Answer is at the end.)

Uses of, and the Reasons for, Introducing a Health and Safety Management System

IN THIS SECTION...

Management systems are important to the functioning of an organisation:

- What is a management system?
- Why do organisations have a health and safety management system?

What is a Management System?

TOPIC FOCUS

All management systems, whether they are designed to manage health and safety or any other function, have the same common elements:

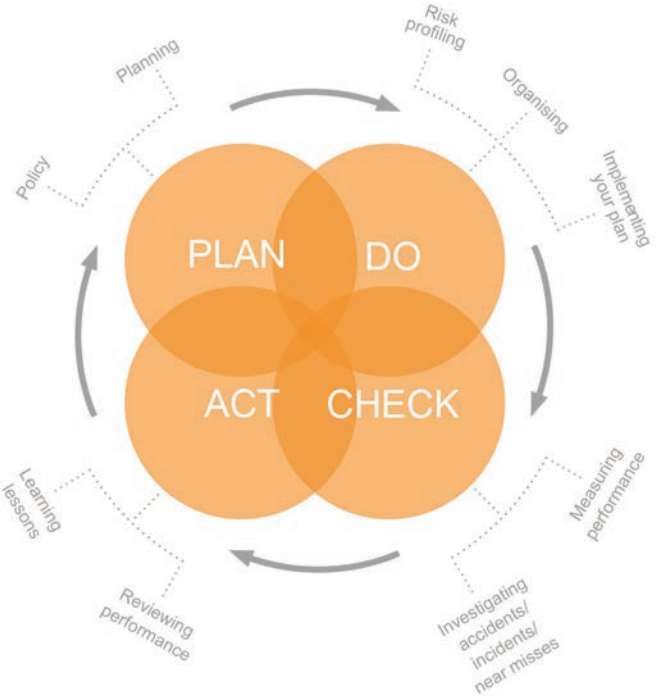
- Plan – implies having a considered policy.
- Do – concerns the arrangements for putting the plan into practice.
- Check – means it is necessary to assess or monitor performance.
- Act – means performance should be reviewed leading to continuous improvement in the management system.

Notice how each of these elements is described in the models we look at.

Health and Safety Management Models

Most organisations have management systems for one or more aspects of management. In relation to safety, two good sources of advice are BS OHSAS 18001:2007 *Occupational Health and Safety Management Systems - Requirements* and the UK's Health and Safety Executive's publication *HSG65 Managing for Health and Safety (2013).* A characteristic of these management models is that they view the organisation as a system with inputs, internal processes and outputs.

The general principles of the guidance are illustrated in the figure:



The Plan, Do, Check, Act cycle based on the approach in HSG65

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Application of the PDCA Cycle

The Plan, Do, Check, Act cycle achieves a balance between the systems and behavioural aspects of management, and treats health and safety as an integral part of good management rather than as a stand-alone system.

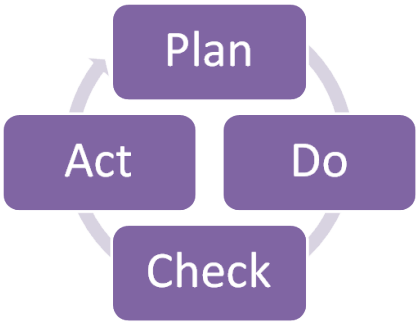
The cycle starts with a planning process to control risks which is implemented through risk assessment, checked by measuring performance, and reviewed so that action is taken to improve.

Plan

- Status review of where you are now and where you need to be.
- Policy and planning to establish:
  - What you want to achieve.
  - Who will be responsible for what.
  - How to achieve your aims.
  - How to measure your success.
- Establish how to measure performance (leading as well as lagging indicators).

Do

- Identify your risk profile:
  - Assess your risks.
  - Identify what could cause harm in your workplace.
  - Establish who it could harm and how.
  - Decide what to do to manage the risk.
  - Decide what the priorities are and identify the biggest risks.
- Organise your activities to deliver your plan:
  - Involve workers and communicate.
  - Provide adequate resources, including competent advice.
- Implement your plan:
  - Decide on the preventive and protective measures you need and put them in place.
  - Provide the right tools and equipment to do the job and keep them maintained.
  - Train and instruct, to ensure everyone is competent to carry out their work.
  - Supervise to make sure that arrangements are followed.



Check

- Measure your performance:
  - Assess how well your risks are being controlled.
  - Investigate the causes of accidents, incidents or near misses.

Act

- Review your performance:
  - Learn from accidents and incidents, ill-health data, errors and relevant experience including from other organisations.
  - Re-visit plans, policy documents and risk assessments to see if they need updating.
- Take action on lessons learnt, including from audit and inspection reports.

Reasons for the Introduction of Health and Safety Management Systems

Management system models offer a framework for management to focus on in order to manage health and safety.

Management involves:

- Policy-making.
- Setting objectives and performance standards.
- Providing resources.
- Making judgments - considering alternatives.
- Coming to decisions.
- Taking action.
- Accountability.
- Monitoring and control.

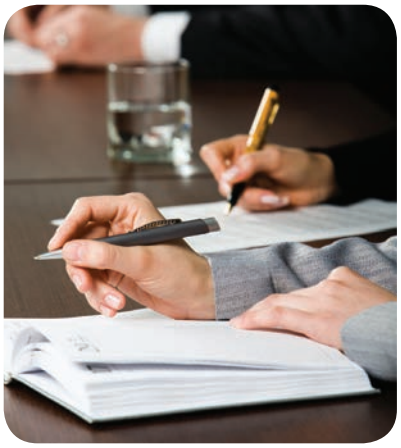
Health and safety management is no different, and a health and safety management system is designed to deliver these elements of management. Safety regulatory requirements place on management the major responsibility for the health and safety of workers and others on a company's premises. While most of these **duties** cannot be delegated, day-to-day **activities** can be and a management system provides a framework to co-ordinate these activities to deliver the agreed objectives.

The following are key issues that a health and safety management system is required to deliver:

- ## Appropriate Allocation of Resources

  The provision of both financial (for equipment, training, consultancy, etc.) and manpower (enough and with the right skills) resources is essential in the management of health and safety. Risk assessment is a powerful tool for identifying priorities for which resources need to be allocated. However, management expects that the benefits will outweigh the costs because accidents and compensation for occupational illness can be very expensive items. Costs of accident and ill-health prevention need to be carefully and effectively controlled.

  An important factor in this is that the costs of accident prevention have a 'lead time'. Money has to be spent in advance of the benefits being felt. Safety training, which may also be a requirement of legislation, shows results some time after the expenditure has been incurred. The safety practitioner needs to think very carefully about how to calculate the cost of accidents and ill health, so that there are definite figures available to demonstrate the benefits of any accident reduction which has been achieved.



Financial and manpower resources should be considered

- ## Appropriate Allocation of Responsibilities

  Part of management control is making sure that responsibilities for specific tasks and roles are allocated to individuals within the organisation.

  Responsibilities must be:

  – Clear, so people know what they are responsible for.
  – Allocated to individuals who have the necessary competence.

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- Supported with necessary resources.
- Linked to accountability.

Everyone will have responsibility for health and safety to some extent but some individuals will have specific additional responsibilities, such as:

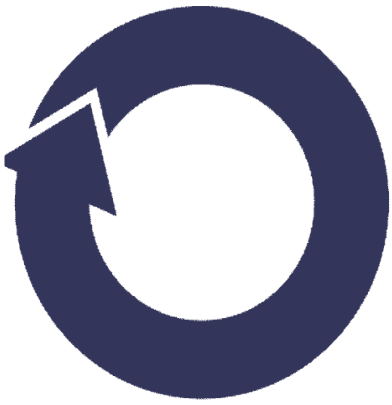
- Preparing plans to implement the health and safety policy.
- Carrying out risk assessments in accordance with specific regulations.
- Periodic monitoring of health and safety performance.
- Providing training.
- Checking contractors' health and safety performance before awarding contracts.

- ## Setting and Monitoring Performance Standards

In order to determine how well an organisation is performing in any function you need to have something to measure. It is important to ensure that everybody knows what is expected of them in controlling risks within the organisation. Performance standards should ensure that the intentions of the safety policy are transferred into action. Standards should be measurable, achievable and realistic.

Standards should:

- Set out clearly what people need to do to contribute to an environment which is free of injuries, ill health and loss.
- Help identify the competencies which individuals need to fulfil their responsibilities.
- Form the basis for measuring individual, group and organisational performance.



Feedback loop

Responsibilities should be linked to specific outputs. Good performance standards should identify:

- **Who is responsible** - either by name or position. Those given responsibilities should be competent to carry out the tasks.
- **What they are responsible for** - what needs to be done and how it is to be done.
- **When the work should be done** - is it a regular occurrence, such as a monthly inspection, or irregular and only when certain tasks are carried out?
- **What the expected result is** - do any legal requirements have to be satisfied, such as attaining a certain level of noise? The result may, alternatively, be the achievement of a specified organisational output, such as training.

To ensure that the standards are being achieved, it is important to monitor them. This will allow shortcomings to be identified and action taken to correct them. Monitoring should be seen as an integral part of the management system and not as 'checking up' on individuals.

- ## Feedback and Implementation of Corrective Action

For any system to be effective, it must have a complete loop that allows for action to be taken where discrepancies are identified. By feeding back information obtained during monitoring and audit processes to the appropriate people within the organisation, suitable corrective action can be implemented. Without this important function, the whole management system will fail to develop and become a paper exercise with no discernible improvement in safety.

1.3 Uses of, and the Reasons for, Introducing a Health and Safety Management System

A health and safety management system provides an organised framework to prevent accidents, incidents and occupational ill health through better risk management. The more strategic reason for having such a system is to improve the health and safety culture of the organisation but, in practical terms, effective risk management and improvement in health and safety culture both stem from a sound health and safety management system.

A simple justification for introducing a health and safety management system is to improve the business through:

- Better health and safety performance, which will reduce the costs from accidents and incidents.
- Greater awareness of legal requirements, which will reduce the chances of committing an offence.
- Improved relations and morale as employees see that their health and safety is being looked after.
- Improved image and positive public relations from a publicly responsible attitude towards employees.
- Greater business efficiency which will reduce costs.
- Reduced insurance premiums, by demonstrating more effective risk control.
- Greater confidence from banks and investors by showing more effective risk management systems.

STUDY QUESTION

3. Outline four benefits to a business that might arise from introducing a health and safety management system.

(Suggested Answer is at the end.)

Principles and Content of Effective Health and Safety Management Systems

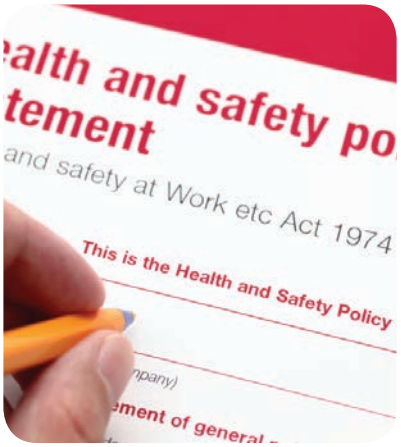
IN THIS SECTION...

- An effective health and safety management system should include a comprehensive health and safety policy.
- Most organisations have management systems for one or more aspects of management and two important models are:
  - ILO-OSH-2001 Guidelines on Occupational Health and Safety Management Systems (ILO, 2001).
  - OHSAS 18001 Occupational Health and Safety Management Systems: Specification (British Standards Institution, 2007).
- There are advantages and limitations when an organisation integrates their quality, environmental and health and safety management systems.

Health and Safety Policy

Health and Safety Management Systems

The health and safety policy sets the whole framework of the Safety Management System (SMS). From an SMS point of view, the policy is just a statement of intent – a demonstration of commitment. It frames the company vision on health and safety. The policy should state the overall health and safety objectives of the organisation and express commitment to improving health and safety performance; to demonstrate that commitment, it should be authorised by top management. The policy should commit the organisation to continual improvement and compliance with legislation, and should be communicated to all employees and other interested parties and kept up to date by periodic review.



The safety policy is a key document

Communication of Health and Safety Information

A health and safety policy:

- Tells people about a company's approach to managing health and safety.
- Communicates the organisation's commitment to health and safety to existing employees (preferably by means of their own copy).
- Can be used:
  - In the induction of new employees (to stress the importance of safety).
  - To involve workforce representatives in writing and amending the policy when necessary.
  - At regular briefing sessions to communicate information relating to different sections of the policy.

Requirements for a Written Health and Safety Policy

A health and safety policy may be a requirement of national legislation in some regions. Even if it is not a legal requirement, it is required by ILO-OSH 2001 (which supports ILO conventions) and OHSAS 18001.

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The policy should be documented (paper or electronic) and authorised by top management (e.g. chief executive officer). The policy is meaningless on its own; it needs to be implemented through "organisation" and "arrangements" within a safety management system.

General Principles and Objectives of a Health and Safety Policy Document

The principle of the health and safety policy document is that, in simple terms, it sets out:

- What needs to be done.
- Who needs to do it.
- How it is going to be achieved.

The policy is therefore usually made up of:

- A statement of intent that sets out the aims and objectives of the organisation regarding health and safety.
- An organisational structure that details the people with health and safety responsibilities and their duties.
- The systems and procedures in place to manage risks.

Policy management meeting

The objectives of the policy will be stated in different ways for different organisations but two very crude and simplistic objectives could be zero accidents and total legal compliance - they may be deemed to be unachievable but they represent a best practice target to aim for.

More practical objectives might be expressed in relation to the contribution made to business performance such as:

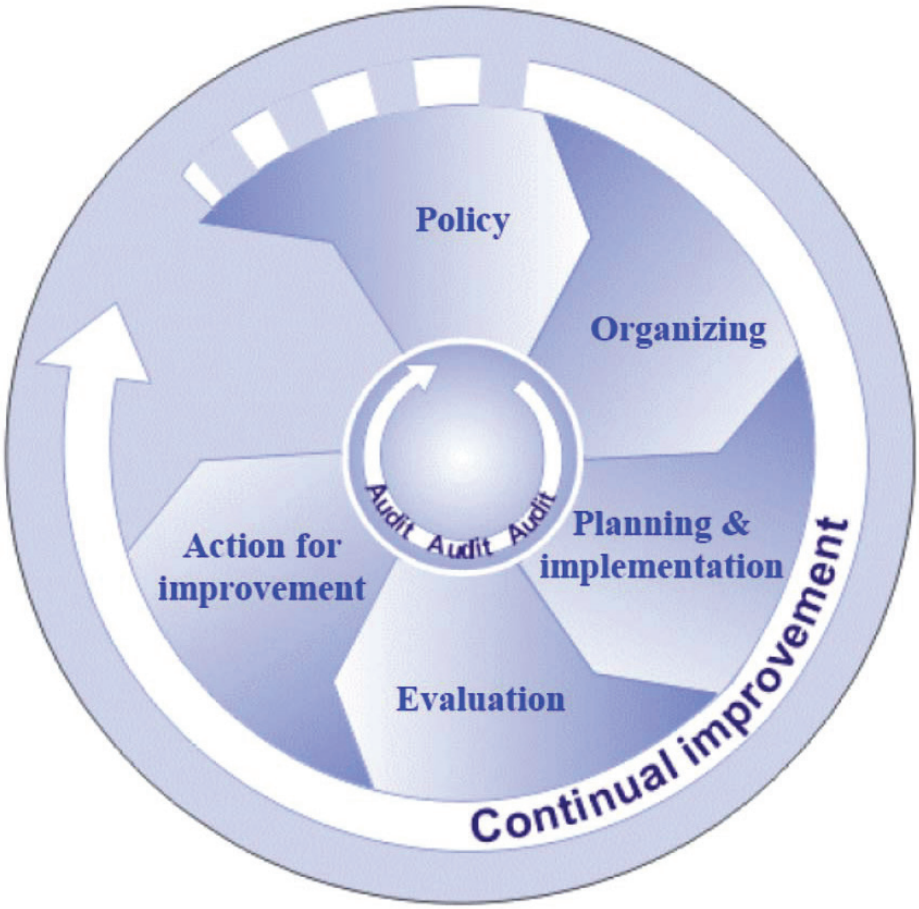
- Supporting human resource development.
- Minimising the financial losses which arise from avoidable unplanned events.
- Recognising that accidents, ill health and incidents result from failings in management control and are not necessarily the fault of individual employees.
- Recognising that the development of a culture supportive of health and safety is necessary to achieve adequate control over risks.
- Ensuring a systematic approach to the identification of risks and the allocation of resources to control them.
- Supporting quality initiatives aimed at continuous improvement.

These objectives align better with the general business objectives of the organisation and serve to integrate health and safety into the general management of the organisation.

Key Elements of a Health and Safety Management System

ILO-OSH-2001 Guidelines on Occupational Health and Safety Management Systems

The figure below illustrates the elements of this system and is reproduced by kind permission of the International Labour Organisation (ILO). Note that the basic elements are very similar to OHSAS 18001 in concept (see below). It is intended that the safety management system should be compatible with, or integrated into, other management systems within the organisation.



Model Health and Safety Management System (ILO-OSH-2001)
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Policy

Developed in consultation with workers, this should be signed by a senior member of the organisation. It should commit the organisation to protecting the health and safety of employees, compliance with applicable laws and guidance, consultation with employees and their participation, and continuous improvement. The guidance stresses forcefully the importance of employee consultation and participation in all elements of the safety management system for it to be effective. As such the ILO-OSH guidelines strongly recommend the establishment of a health and safety committee and the recognition of safety representatives.

Organising

Whilst the employer retains overall responsibility for health and safety, specific roles should be delegated/allocated throughout the organisation, including delegation of responsibility, accountability and authority. The structure and processes need to be in place to, amongst other things:

- Actively promote **co-operation** and effective two-way **communication** in order to implement the safety management system.
- Establish arrangements to identify and control workplace risks.
- Provide supervision.
- Provide adequate resources, etc.

Particularly recommended is the appointment of a senior individual to oversee the development and maintenance of the occupational health and safety management system elements as a whole, promoting participation and periodic performance reporting.

Competence and **training** are stressed as key elements needed to implement such a programme. Occupational health and safety management system documentation (policy, objectives, key roles/responsibilities, significant hazards and methods of prevention/control, procedures, etc.) should be created and maintained. Additionally, records should be kept, e.g. accident data, health surveillance and other monitoring data.

Planning and Implementation

This should start with an initial review to understand the organisation's current position. It should: identify applicable laws, standards, guidelines; assess health and safety risks to the organisation; determine if existing (or planned) controls are adequate; analyse health surveillance data, etc. This initial review provides the baseline for future continuous improvement.

The next stage is the planning, development and implementation of the safety management system (based on the results of initial or subsequent reviews). This should involve the setting of realistic, achievable objectives and the creation of a plan to meet those objectives, as well as selecting appropriate measurement criteria which will later be used to see if the objectives have been met and for the allocation of resources.

Planning, development and implementation of the safety management system

Preventive and protective measures should be planned and implemented to eliminate and/or control risks to health and safety. These should follow the general hierarchy of control: eliminate; control at source (using engineering and organisational measures); minimise (safe systems of work, including administrative controls); and PPE if risks cannot be adequately controlled by collective measures.

Management of change is also important. Changes may occur internally (new processes, staff, etc.), as well as externally (legal changes, mergers, etc.), and it is important to manage those changes in a systematic way. Risk assessment is a key part of that, as well as ensuring that people are consulted and that any proposed changes are properly communicated to those likely to be affected.

Plans should also cover foreseeable emergencies (prevention, preparedness and response aspects), such as fire and first aid.

Procurement procedures should make sure that health and safety requirements (national and organisational) are an integral part of purchasing and leasing specifications.

You should also ensure that the organisation's health and safety requirements are applied to contractors (including contractor selection and their work on site (hazard awareness, training, co-ordination and communication, accident reporting, site rules, compliance monitoring, etc.)).

Evaluation

Procedures need to be in place to monitor, measure and record the performance of the health and safety system. You should use a mixture of qualitative and quantitative and active and reactive performance measures, and not just rely on accident rate data! Active monitoring includes things such as inspections, surveillance, compliance with laws, achievement of plans, etc. Reactive monitoring includes reporting and investigation of accidents/ill-health and occupational health and safety system failures. Accidents, etc. should be properly investigated to determine the root cause failures in the system. Investigations should be properly documented and remedial action implemented to prevent recurrence. The organisation should have an **audit** policy (scope, competency, frequency, methodology, etc.).

Audits seek to evaluate the performance of the occupational health and safety management system elements (or a sub-set) and should at least cover: policy; worker participation; responsibility/accountability; competence and training; documentation; communication; planning, development, implementation; preventive and control measures; management of change; emergency preparedness; procurement; contracting; performance monitoring/measurement; accident investigations; audits; management review; preventive and corrective action; and continuous improvement.

Like audits conducted under OHSAS 18001 (see below), audits under ILO-OSH-2001 can be internal or external although, unlike OHSAS 18001, external audits are not mandatory. In the case of ILO-OSH-2001, external audits are not conducted by a certification body, since there is no certification requirement. Instead, if the company wants one, independent auditors who are specifically commissioned for the task can carry them out. The audit should ultimately make conclusions about the effectiveness of the occupational health and safety management system.

A **management review** should evaluate the overall occupational health and safety management system and progress towards the organisation's goals. It will use data from monitoring, measuring and auditing of the system as well as take account of other factors (including organisational changes) that may influence the system in the future. It will establish if changes are needed to the system (or components of it). The results need to be recorded and communicated.

Action for Improvement

Occupational health and safety management system performance monitoring, audits and management reviews will necessarily create a list of corrective actions. You must ensure that, firstly you establish the root causes of the problems requiring correction, and secondly, there is a system in place for making sure that actions are carried out (and checks made on their effectiveness).

Continual Improvement

The organisation should strive to continually improve. It should compare itself with other similar organisations.

BS OHSAS 18001:2007 - Occupational Health and Safety Management Systems

OHSAS 18001 is a certifiable health and safety management system standard that was introduced in 1999 and revised in 2007. Its purpose is to help organisations create management systems that their stakeholders can see have required characteristics. Although published in the UK by BSI, OHSAS 18001 was also subject to separate international negotiation and agreement. Compliance with certifiable standards is demonstrated through audit by a certifying body, which itself should be accredited by the UK Accreditation Service (UKAS).

The following figure is based on that included in the OHSAS 18001 standard.

Occupational Health and Safety Assessment Series 18001 (OHSAS 18001): health and safety management model

This model is based on ISO 14001 and HSG65 (a health and safety management system favoured by the UK HSE) and requires an organisation to determine its existing health and safety activities, and to develop programmes and systems that focus on the elimination of risk to staff and other parties. These processes are then developed into a management system that aims to ensure that health and safety performance is continuously monitored and improved.

Companies cannot simply claim that they have a standard that meets the requirements of OHSAS 18001 – they have to go through a certification process, overseen by an independent external certification body such as BSI or LRQA, which sends an auditor to verify that the company's system meets the OHSAS 18001 standard. This is a major difference when compared with ILO-OSH-2001, which does not require such external certification.

DEFINITIONS

CERTIFICATION

The process by which a company wishing to move to, say, a safety management system based on OHSAS 18001 gets certified, registered or approved to that standard.

CERTIFICATION BODY

An organisation such as the British Standards Institution (BSI) or (LRQA) Lloyd's Register Quality Assurance which carries out the certification process.

ACCREDITATION

The process by which certification bodies have their processes assessed to see if they meet the Regulatory Authority's (or Accreditation Body's) standards (in the UK, this is the United Kingdom Accreditation Service (UKAS)).

So, an individual organisation gets certification to a standard like OHSAS 18001; the certifying body that awards that standard (e.g. LRQA) can do so because it has accreditation from UKAS.

Occupational Health and Safety Policy

This should state the overall health and safety objectives of the organisation and express commitment to improving health and safety performance. To demonstrate that commitment, the policy should be authorised by top management. The policy should commit the organisation to continual improvement and compliance with legislation. It should be communicated to all employees and other interested parties and kept up to date by periodic review. It should also be documented.

Planning

This is needed for the effective identification of hazards and assessment and control of risks. This means that the organisation needs procedures to cover risks in all activities, and for identifying any applicable law. The organisation should establish health and safety objectives consistent with the health and safety policy and establish a management programme to achieve those objectives. The management programme will include designation of roles/responsibilities, timescales, etc.

Implementation and Operation

The necessary organisational structure and resources need to be put in place to implement the plans, though top management retain ultimate responsibility. People should be competent to perform their designated roles, and this may involve training and maintaining awareness. The organisation requires systems in place to make sure that health and safety information is communicated to/from employees. Employees should also be consulted on health and safety matters and be involved in the development and review of policies and procedures.

It is important to document the systems and exercise control over those documents (so that they are accessible, periodically reviewed, kept up to date (version control), retained (e.g. legal requirements for document retention)). There should be documented procedures where necessary to control risks arising from the range of operations within the organisation. In particular, there should be plans and procedures (which should be regularly tested) to cover potential emergencies.

Checking and Corrective Action

The organisation needs procedures to ensure that it regularly measures and monitors health and safety performance (proactive, reactive, qualitative, quantitative). Procedures should also be in place to record and investigate accidents/non-conformances and to make sure that remedial actions are implemented and that such actions have been effective. Occupational health and safety data (including audit and review results) should be recorded. There should be an audit programme to identify whether the occupational health and safety management system is operating as planned and is effective.

Company employees can conduct audits. These are known as internal audits and are a method of self-regulation, which enable the company to assess its own performance against the standard. External audits are conducted by people from outside the company and give a valuable third-party viewpoint, which many people see as being more impartial. The certification body will be one such external organisation and will conduct audits when certification to a particular standard is about to expire.

Procedures should be in place to record and investigate accidents, etc.

Management Review

This is the job of top management. The whole system should be periodically reviewed to make sure it continues to be effective. This relies on results gathered during the "checking and corrective action" stage. The review may, in turn, lead to changes in the policy, objectives and other elements of the management system. It should, like everything else, be documented.

Benefits and Limitations of Integration of Quality, Environmental, and Health and Safety Management Systems

For organisations wishing to have control over more than one aspect of risk management, e.g. safety, environment and quality, it may be possible to implement an Integrated Management System (IMS) rather than individual systems. Though it may make sense in theory, implementing an IMS is not an easy task, and there is a number of factors to be taken into account.

TOPIC FOCUS

Arguments for integration:

- A well-planned IMS is likely to operate more cost-effectively than separate systems, and facilitate decision-making that best reflects the overall needs of the organisation.
- An IMS offers the prospect of more rewarding career opportunities for specialists in each discipline.
- The objectives and processes of management systems are essentially the same.
- Integration should lead to the avoidance of duplication, e.g. in personnel, meetings, electronic record-keeping software, audits and paperwork.
- Integration should reduce the possibility of resolving problems at the expense of creating new difficulties in other disciplines.

(Continued)

TOPIC FOCUS

- An IMS should involve timely overall system reviews where momentum in one element of an IMS may drive forward other elements that might otherwise stagnate. In contrast, independent systems could develop without regard to other management system elements, leading to increased incompatibility.
- A positive culture in one discipline may be carried over to others.

Arguments against integration:

- Existing systems may work well already. Integration may threaten the coherence and consistency of current arrangements that have the support of everyone involved.
- Relevant specialists may continue to concentrate on the area of their core expertise and further specialist training may not be needed.
- Uncertainties regarding key terms – already a problem in health and safety – would be exacerbated in an IMS.
- System requirements may vary across topics covered, e.g. an organisation may require a simple quality system, but a more complex health and safety or environmental performance system. An IMS could introduce unreasonable bureaucracy into, in this case, quality management.
- Health, safety and environmental performance are underpinned by legislation and standards, but quality management system requirements are largely determined by customer specification.
- Regulators and single-topic auditors may have difficulty evaluating their part of the IMS when it is interwoven with other parts of no concern to the evaluator.
- A powerful, integrated team may reduce the ownership of the topics by line management.
- A negative culture in one topic may unwittingly be carried over to others.

STUDY QUESTIONS

4. List the elements in the following safety management systems:

   (a) ILO-OSH-2001 Guidelines on Occupational Health and Safety Systems.

   (b) BS OHSAS 18001 Occupational Health and Safety Management Systems.

5. Identify two advantages and two limitations of integrating management systems.

(Suggested Answers are at the end.)

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Summary

Reasons for the Effective Management of Health and Safety

This element has introduced you to the general principles of health and safety management. We have looked at the reasons for managing risk and seen that they fall into three categories - moral, legal and economic.

Societal Factors Which Influence an Organisation's Health and Safety Standards and Priorities

We have identified:

- Economic climate.
- Government policy and initiatives.
- Sickness absence.
- Industry/business risk profile.
- Globalisation.
- Migrant workers.
- Societal expectations of equality.

Uses of, and the Reasons for, Introducing a Health and Safety Management System

We have identified:

- What a management system is.
- The reasons for the introduction of health and safety management systems.

Principles and Content of Effective Health and Safety Management Systems

We have considered:

- The health and safety policy including its role, the requirements for it to be written and its general principles and objectives.
- Two specific safety management system models which are conceptually very similar:
  - ILO-OSH-2001.
  - OHSAS 18001.
- The benefits and limitations of integration of quality, environmental, and health and safety management systems.

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Exam Skills

Introduction

It should go without saying that to achieve the NEBOSH International Diploma you will need to work carefully through your course materials; but you also need to perform when it really matters - in the exam.

Working through this course will help you build up your confidence in preparation for the exam day.

Before we go any further, let's just look at some basic information about the exam itself:

- You have three hours, plus 10 minutes' reading time.
- There are two sections:
  - Section A: **six** compulsory questions (10 marks each).
  - Section B: you can choose to answer **three** questions from five (20 marks per question).
- So 120 marks are available in total.

The exam questions require you to demonstrate your knowledge and understanding of the elements you have studied as part of your course – and to show that you can apply your knowledge and understanding to both familiar and unfamiliar situations.

That might sound daunting, but basic exam technique is really quite simple (as long as you know the required information, of course!). Essentially, what you need to do is:

Step 1: Read the question carefully.

Step 2: Review the marks available (consider how long you should spend on the question and how many points of information you need to include).

Step 3: Highlight the key action words.

Step 4: Read the question again.

Step 5: Plan your answer (using mind maps, bullet points, etc.) so that you have a structure to work to.

Step 6: Answer the question in full, keeping a close eye on the time (allow 15 minutes for a Section A, 10-mark question, and 30 minutes for a Section B, 20-mark question).

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Command Word	Meaning
Analyse	To divide or break down the subject matter or topic into parts, reasons, aspects, etc. and then examine their nature and relationship.
Assess	To present judgments of the factors raised, their significance, importance and why they are important and/or significant.
Calculate	To ascertain or determine by mathematical processes.
Comment	To give opinions (with justification) on an issue or statement by considering the issues relevant to it.
Compare and contrast	To provide a point-by-point account of the similarities and differences between two sets of information or two areas.
Consider	To offer some detail about an issue or event and to deliberate about the value of that issue/event.
Define	To give the meaning of a word, phrase or concept, determine or fix the boundaries or extent of. A relatively short answer, usually one or two sentences, where there is a generally recognised or accepted expression.
Demonstrate	To prove or make clear by reasoning or evidence how some relationship or event has occurred.
Describe	To give a detailed written account of the distinctive features of a subject. The account should be factual, without any attempt to explain.
Determine	To come to a decision as the result of investigation or reasoning.
Discuss	To give a critical account of the points involved in the topic.
Distinguish	To present the differences between; to separate into kinds, classes, or categories.
Evaluate	To determine the value or character of something by careful appraisal.
Explain	To provide an understanding. To make an idea or relationship clear.
Give	To provide short, factual answers. NB: Normally a single word, phrase or sentence will be sufficient.
Identify	To give a reference to an item, which could be its name or title.
Justify	To prove or show to be valid, sound, or conforming to fact or reason.
Outline	To indicate the principal features or different parts of.
Recommend	To bring forward as being fit or worthy; to indicate as being one's choice for something.
Review	To make a survey of; examine, look over carefully and give a critical account.

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.

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QUESTION

An organisation is proposing to move from a health and safety management system based on the ILO-OSH-2001 model to one that aligns itself with BS OHSAS 18001. **Outline** the possible advantages and disadvantages of such a change. **(10)**

Approaching the Question

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

Step 1: Read the question carefully.

Step 2: Next, consider the marks available. This question is worth 10 marks, requires an explanation to answer it, and should take around 15 minutes to answer.

Step 3: Now, highlight the key words. In this case the question might look like this:

Explain why organisations often identify the costs of health and safety control measures much more easily than they identify the costs that can arise from poor health and safety standards. **(10)**

Step 4: Read the question again to make sure you understand it and have a clear understanding of the two costs it is asking about. (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. A common approach is to consider the information needed to quantify the capital and running costs of providing control measures and the financial losses that would arise from accidents, incidents and occupational ill-health. Remember that your answer must be based on the key words you have highlighted.

Step 6: Now you are in a position to have a go at answering the question. Set out your answer in bullet points with an explanation of each point. Hint – costing potential accidents, incidents and occupational ill health is not an exact science!

When you have finished, have a look at the following comments and guidance.

The following is an answer that a student might have produced in the examination room.

HINTS AND TIPS

Don't worry too much about the grammar and spelling in your answer, but the examiner MUST be able to understand what you are trying to say. There must be a logical flow to the information you provide and this is where your Answer Plan is so important.

Also remember that the examiner MUST be able to read your handwriting – if they can't read what you have written they can't award you any marks!

Suggested Answer Outline

The examiner would expect you to give an explanation of the relative ease with which the capital and running costs of providing control measures can be quantified compared to the financial losses arising from poor health and safety standards, which are much harder to identify and marks would be available for points similar to the following:

- Costs of control measures:
  - Capital costs of controls are known from expenditure.

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- Running costs can be estimated from past operational data.
- Capital and revenue costs are immediately apparent in the budget.

- **Financial losses from poor health and safety standards:**
  - Savings from reduced accidents and incidents are medium- not short-term.
  - Costs of accidents and ill health are inherently difficult to quantify accurately.
  - Not all loss events are reported.
  - Organisations rarely have effective systems to collect accident costs.
  - To collect accurate cost data on accidents, incidents and occupational ill health requires resources (time and expertise).
  - Financial loss from lost productivity and/or goodwill are even more difficult to estimate.

HINTS AND TIPS

A question that asks you to "outline" something, expects you to indicate the principal features or different parts of something.

Example of How the Question Could be Answered

ILO-OSH-2001 is a model that the regulators have championed for a number of years; one of the advantages of this system is that it is simple and straightforward for all types of companies to implement without too much trouble (which isn't the case for 18001 for smaller companies). The system doesn't need any certification by an outside body and it follows a tried-and-tested system which has been used by quality organisations for a number of years. Moving from ILO-OSH-2001 to BS OHSAS 18001 would mean that the company would need to bring in an external organisation to accredit the system, which will bring additional initial and on-going costs to the organisation – including extra paperwork and activities to source information, procedures, etc. This would strengthen the organisation's image, as accreditation is done by an outside agency, rather than in-house as per ILO-OSH-2001 and by achieving the standard the company would be able to promote its business within the local community and secure orders/work with organisations that require an accredited standard for you to work with them.

If the organisation already has other accredited systems (environmental, quality), they may be able to integrate the systems to save money for the organisation, as well as supporting the organisation embed health and safety into the organisation. Other benefits from moving to this system would involve undertaking the initial review and measuring its current practices, to ascertain where improvements can/should be made and actually measuring the improvements it has made.

The final thing to consider with the new system would be that 18001 looks at continuous improvement as one of its central themes, so the organisation can look at getting better performance over a period of time.

Reasons for Poor Marks Achieved by Candidates in Exam

- Not having a clear understanding of the differences between the two management systems.
- Failing to identify BS OHSAS 18001 as an integrated management system.
- Not outlining the possible advantages and disadvantages of moving from one system to another.
- Providing a description of the components of the systems, rather than answering the question.

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Element IA2

Regulating Health and Safety

Learning Outcomes

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

1. Describe comparative governmental and socio-legal and regulatory models.
2. Outline the purpose of enforcement and laws of contract.
3. Explain the role and limitations of the International Labour Organisation in a global health and safety setting.
4. Explain the role non-governmental bodies and self-regulation has in securing common health and safety standards in a global economy.

Contents

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Comparative Governmental and Socio-Legal Models

IN THIS SECTION...

- Since organisations may not adopt good health and safety standards voluntarily, one way of making sure minimum standards are met is for the government to introduce legislation (the statutes and other legal instruments that have been enacted by the governing body).
- Goal setting legislation sets an objective, but leaves it to the duty holder to decide on the best way of achieving the defined goal.
- Prescriptive legislation defines the standard to be achieved in far more explicit terms.
- Federal systems aim to ensure uniform standards and regulation throughout the country, since if each state can set their own standards, this will inevitably lead to inconsistencies.
- If a worker has a work-related accident or disease this may result in loss to the individual or dependants. There is a number of mechanisms that allow individuals to seek restitution for damages including no fault or fault liability claims.

Role, Function and Limitations of Legislation

It is not realistic to expect organisations to adopt good health and safety standards voluntarily, not least because the benefits of good (and costly) standards may not be immediately obvious to all employers. One way of making sure minimum standards are met, whether they relate to health and safety or other matters to do with the regulation of society, is for the government to introduce legislation.

Examples of legislation relating to occupational health and safety include:

- **Health and Safety at Work, etc. Act 1974** (United Kingdom).
- **Occupational Safety and Health Act 1970** (USA).
- **Work Environment Act 1977** (Sweden).

By defining minimum acceptable standards, legislation at least partly forces organisations to adopt good practice, when otherwise they might be unlikely to do so voluntarily.

Legislation may be introduced that leads to criminal and/or civil consequences. A **crime** is an offence against the state and the consequence of a criminal action is the prosecution of the offender, which may lead to punishment, perhaps a fine or a prison sentence. What behaviour constitutes a criminal offence is largely dependent on the government and can therefore be influenced by political concerns. In contrast, a **civil action** is concerned with an individual who has suffered some loss, such as being injured following a workplace accident. The aim is for the claimant (the one who has suffered the loss) to seek (usually) financial compensation from the defendant as a result of the wrongdoing.

DEFINITION

LEGISLATION

May be defined as the statutes and other legal instruments (documents) that have been enacted by the governing body.

There are, however, limitations to the legislative approach. The first is that there is little incentive for organisations to go beyond the minimum legal requirements; they will comply with what the law says, but not with its spirit. In fact, since good standards often cost a lot of time and money, an organisation which embraces such high standards may be at a competitive disadvantage. If a government introduces legislation then there is a requirement for the legislation to be enforced. This requires a means of identifying those who do not comply with the law. Accordingly, enforcement officers who have defined powers of inspection and investigation (so that breaches of the law can be identified) must be employed and trained.

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There must also be procedures for the prosecution and punishment of organisations and individuals who fail to meet the required standards, i.e. an effective court system. The governments of some countries do not appear to be able to enforce health and safety provisions. Even in wealthy countries with extensive resources, the enforcement of health and safety has to compete with other government priorities.

Nature, Benefits and Limitations of 'Goal-Setting' and 'Prescriptive' Legal Models

Nature

Legislation is sometimes described as being 'goal setting' or 'prescriptive'. **Goal setting legislation** sets an objective but leaves it to the duty holder to decide on the best way of achieving the defined goal. (Note that a duty holder is the person on whom the legal duty is placed, e.g. the employer in the case of most health and safety duties.)

Legislation is described as being 'goal setting' or 'prescriptive'

You can see a good example of goal-setting legislation in the United Kingdom system. The principal Act of Parliament governing health and safety is the **Health and Safety at Work, etc. Act 1974**. The key duty imposed on employers is:

> *"It shall be the duty of every employer to ensure, so far as is reasonably practicable, the health, safety and welfare at work of all his employees."*

The goal to be achieved is to ensure (so far as is reasonably practicable) health and safety, but the Act does not define **how** this should be done. It is up to the employer to identify and evaluate different ways of meeting this requirement and then to choose what is appropriate in the given circumstances. (Note that the phrase "*so far as is reasonably practicable*" is not only a feature of UK legislation, but also of other regions. It generally means that when deciding whether you need to take any action to control a risk, you must compare the risk against the effort, time and money that would be required to bring it under control. So, some judgment is needed.)

In contrast, **prescriptive legislation**, as the name suggests, defines the standard to be achieved in far more explicit terms. One example, again from the UK, is in the **Provision and Use of Work Equipment Regulations 1998**. Regulation 26 is concerned with the provision of information and instruction to users of equipment for use at work preventing mobile work equipment (e.g. forklift trucks) from rolling over. This regulation applies only to such equipment and makes explicit what a duty holder should do to comply.

Regulation 26, Rolling over of mobile work equipment:

> *(1) Every employer shall ensure that where there is a risk to an employee riding on mobile work equipment from its rolling over, it is minimised by:*
>
> *(a) stabilising the work equipment;*
>
> *(b) a structure which ensures that the work equipment does no more than fall on its side;*
>
> *(c) a structure giving sufficient clearance to anyone being carried if it overturns further than that; or*
>
> *(d) a device giving comparable protection.*

In practice, legislation should not be thought of as being entirely goal setting or entirely prescriptive - it more often has the characteristics of both models. One example is Regulation 8 of the **Provision and Use of Work Equipment Regulations 1998** (see above).

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This states:

> *(1) Every employer shall ensure that all persons who use work equipment have available to them adequate health and safety information and, where appropriate, written instructions pertaining to the use of the work equipment.*

This requires that employers provide adequate information for users of work equipment - it has an element of prescription in that there is a duty to provide information; however, what constitutes "adequate" needs to be decided by the employer, which effectively sets a goal.

Benefits and Limitations

TOPIC FOCUS

Prescriptive legislation has clearly defined requirements which are more easily understood by the duty holder and enforced by the regulator. It does not need a higher level of expertise to understand what action is required, and provides a uniform standard to be met by all duty holders.

Limitations - it is inflexible and so depending on the circumstances may lead to an excessively high or low standard. Also it does not take account of the circumstances of the duty holder and may require frequent revision to allow for advances in knowledge and technology.

Goal-setting legislation allows more flexibility in compliance because it is related to the actual risk present in the individual workplace. It is less likely to need frequent revision and can apply to a much wider range of workplaces.

Limitations – it is more difficult to enforce because what is "adequate" or "reasonably practicable" are much more subjective and so open to argument, possibly requiring the intervention of a court to provide a judicial interpretation. Duty holders will also need a higher level of competence in order to interpret such requirements.

Legal Hierarchy of State and Federal Laws

One of the difficulties in federal systems is to ensure uniform standards and regulation throughout the country. If each state can set their own standards, there will inevitably be inconsistencies.

In the USA, the **Occupational Safety and Health Act 1970** was enacted at federal, rather than state level and so the USA does not have significant problems with harmonisation of standards. However, although the Act applies to all states, its enforcement is delegated to the individual states, which leads to inconsistencies in enforcement standards.

There have been many attempts to harmonise occupational health and safety standards in Australia. The Ministers of Labour Advisory Committee, which comprises state, territory and Commonwealth labour ministers, agreed in 1990 that "*as far as practicable, any standards endorsed by the National Occupational Health and Safety Commission (NOHSC) will be accepted as minimum standards and implemented in the state/territory jurisdiction as soon as possible after endorsement*". In 1991 the NOHSC set up a task force to develop a strategy for harmonisation and by 1996 a number of priority areas had been identified (e.g. hazardous substances) and adopted by the states and territories. More recently, states and territories agreed to work with the Commonwealth to implement a model Occupational Health and Safety Act.

DEFINITIONS

FEDERAL LAW

Law created by the federal government of a nation.

FEDERAL GOVERNMENT

Formed when a group of political units, such as states or provinces, merge together in a federation, surrendering their individual sovereignty and many powers to the central government while retaining or reserving other limited powers. Examples: United States of America, Canada, Australia and India.

Within Europe there have been moves to harmonise standards in different countries. This started with the creation of the European Economic Community (EEC) (or the Common Market) which was established by the Treaty of Rome in 1957. This initially applied to six states, i.e. France, West Germany, Italy, Belgium, the Netherlands and Luxembourg. The Common Market then grew substantially and became the European Union in 1993. There are currently 27 member states. In terms of health and safety integration, the **Framework Directive of 1989 (89/391/EEC)** established measures to encourage improvements in the safety and health of workers at work. On joining the Union member states become subject to European Union law and, where applicable, European law supersedes any existing contrary domestic law.

However it is recognised that there are a number of different legal systems within the EU. The EU issues directives which are "*binding as to the result achieved upon each member state to which it is addressed, but shall leave to the national authorities the choice of form and methods*". This allows each member state to introduce its own legislation as long as it achieves the broad objectives contained within the directive. For example, within the UK regulations are made under the enabling **Health and Safety at Work, etc. Act 1974**.

Loss Events in Terms of Failures in the Duty of Care to Protect Individuals and Compensatory Mechanisms that May be Available

If a worker has a work-related accident or contracts a disease as a result of their work, this may result in loss that may include pain and suffering, as well as loss of future income. The accident or ill health may lead to death, which may result in the worker's dependants suffering major financial loss. There are a number of mechanisms that have evolved to provide compensation to the injured worker, or to his or her dependants. Some require the person making the claim to prove that their accident or ill health was a result of the fault of another, such as their employer. This invariably means having to resort to litigation in the courts. Others do not require proof of fault (no fault liability).

Compensatory Schemes

These can be conveniently divided into those schemes where it is **not necessary** to prove that the employer was at fault, and those in which the claimant (the injured person) **has to prove** that the defendant was at fault, e.g. negligence.

No-Fault Compensation Schemes

Although there is no need to prove fault, it is necessary to establish that the harm was caused as a result of the person's employment.

Most no-fault workers' compensation schemes fall into one of two main categories:

- Employers provide the benefits; they pay premiums to insurance companies, who in turn pay compensation to the injured worker.
- The government or a government agency provides the benefits. The system consists of social insurance operated by the government or an agency of the government.

Under both models the worker is required to report the injury or ill health to their respective employer. Most countries require the claim to be made within a specified time, although this is often extended in cases of occupational disease, when the time between exposure to the hazard and the onset of the disease may be considerable.

Monetary compensation

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- Employers' Schemes

  Here the obligation to provide benefits is imposed on employers. The scheme is operated by insurance companies who are paid premiums by employers, and in many jurisdictions this is compulsory. The insurance companies are subject to regulation, usually by an agency of the government. It is usual for all workers in that industry to be covered by the scheme and in some jurisdictions this includes the self-employed. When a claim has been made by the worker or dependants, the initial response is usually made by the insurance company or sometimes by the employer. The decision may be to accept or to reject the worker's claim, although it is common for there to be some negotiation by the two parties concerned. Such schemes are found in the USA and Australia.

- Social Insurance Schemes

  These schemes are administered by government and funded by compulsory contributions made by employers, workers or both, with possible further contributions made from general taxation. These contributions may be at a fixed rate or may be earnings-related. The scheme invariably requires medical examinations to establish the nature of the loss and whether any recovery is likely. Following the decision by the administering government department, the claimant can accept the decision or challenge it. The employer usually has little interest, if any, in the process. If the disability is permanent (e.g. hearing loss), then a pension is usually paid, rather than a lump sum.

  The UK operates an Industrial Injuries Disablement Benefit Scheme. This is funded by National Insurance contributions which are paid by employees and employers and from taxation. The benefit is paid to someone who has suffered a loss of faculty because of an accident at work, or has a prescribed industrial disease associated with the person's occupation. It is paid only to employees and not to the self-employed. An "accident" is an incident or series of identifiable incidents which has resulted in personal injury; a "prescribed disease" is one from a defined list of about 70 diseases.

  The claimant completes a claim form that is evaluated to establish whether the injury was an accident, or in the case of an occupational disease, to check that the claimant has worked in the prescribed occupation. If this is established, a medical examination is required to identify the loss of faculty and the level of disablement. Normally a person's disablement has to be 14% or more to receive benefit, except for certain respiratory diseases, which require a 1% assessment and occupational deafness, which requires a 20% assessment.

Fault Compensation Scheme - Employers' Liability

Most jurisdictions (including the USA, Australia and the UK) have legislation that makes an employer liable for injury or illness to a worker as a result of their occupation. This requires the injured worker (or dependants following a fatal outcome) to bring a civil action against the employer and the need to establish fault on the part of the employer, or one of his or her workers. The claimant usually has to prove that the harm or illness was caused by the negligence of the employer or one of his employees or that there has been a breach of health and safety legislation.

In the UK, the basis of the employer's duty towards his employees stems from the existence of a contract of employment. However, virtually all cases are brought under the law of tort (civil wrongs), in particular the tort of negligence and the tort of breach of statutory duty. The liability of the employer may come about in two ways:

- The employer is responsible for his or her own acts of negligence - often called **primary liability**.
- The employer may be **vicariously liable** for the negligent acts of his or her workers that are committed in the course of their employment.

In an action for **breach of statutory duty** the claimant has to prove:

- The statute places the obligation on the defendant.
- The statutory duty was owed to that claimant (i.e. the claimant must show he is within the class of persons whom the statute was intended to protect).
- The injury was of a type contemplated by the statute.
- The defendant was in breach of that duty.

- The breach of statutory duty caused the injury.

In an action for **negligence** the claimant must prove:

- The defendant owed the claimant a duty of care; it is well established that an employer owes a duty of care to their workers and so if the defendant is an employer this element is unlikely to be contested.
- The defendant was in breach of that duty - most negligence cases hinge on this point. The important point to note is that the standard required of the defendant is an objective one, i.e. it depends on the standard of care which would have been adopted by the reasonable man in the circumstances.
- The claimant suffered damage as a result of the breach.
- The harm was foreseeable.

A claim will often be presented under both headings (negligence and breach of statutory duty) at the same time, although success under both results in only one award of compensation. One of the key features of employers' liability is the extent of the compensation (often called **damages**) awarded in a successful action. The compensation awarded is meant to put the person back into the same position they were in before they suffered the loss. This can amount to considerable sums of money.

An accident can result in a claim for considerable damages

Damages

Damages may be classified as **economic** or **non-economic**. Economic damages represent actual monetary loss, whereas non-economic damages are those which represent pain, suffering, and loss of companionship or amenity.

Damages may also be categorised as **compensatory** and **punitive**. As the name suggests, compensatory damages compensate the claimant, whereas punitive damages are meant to punish the wrongdoer.

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Compensatory Damages

The amount of compensatory damages is meant to reflect the losses the claimant has suffered. The level of award is determined by the court having received evidence as to the extent of the losses.

Such damages can be classified as **special damages** and **general damages**.

- Special Damages

  The key feature of special damages is that they can be relatively easily quantified because they relate to known expenditure up until the trial, such as:

  – Loss of earnings due to the accident or ill health before the trial.
  – Legal costs.
  – Medical costs to date.
  – Building costs, if property has had to be adapted to meet the needs of the injured person.
  – Necessary travel costs associated with the case.

  The feature here is that invoices and receipts can be presented to the court.

(Continued)

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- General Damages
  These include future expenditure and issues which cannot be precisely quantified, such as:
  - Loss of future earnings as a result of the incapacity.
  - Future medical costs.
  - Pain and suffering before and after the trial.
  - Loss of quality of life, e.g. loss of mobility, inability to engage in sports which had been pursued before the loss.
  - Loss of future opportunity, e.g. reduced likelihood of being able to secure suitable employment.

Punitive Damages

Punitive damages are awarded to punish, to signify disapproval, and to deter the defendant and others from carrying out similar conduct to that which harmed the claimant in the future. It is recognised that in certain circumstances, punitive damages (or exemplary damages in the UK) may be awarded where the compensatory damages are considered to be inadequate and are awarded by reference to the defendant's behaviour. Since they usually compensate the claimant's losses beyond provable losses, they are usually only awarded when the conduct of the defendant was particularly oppressive, or where the defendant made a profit from the behaviour.

In the USA, punitive damages are a matter for state law and so there is no consistent application across the country. In some states they are based on statute and in others on case law.

STUDY QUESTIONS

1. What are the limitations of using legislation as a means of ensuring acceptable occupational health and safety standards?
2. Describe the benefits and limitations of prescriptive and goal-setting legislation.
3. Identify and outline the two main no-fault compensation schemes.
4. Describe the two categories of compensatory damages.
5. What are meant by punitive damages?

(Suggested Answers are at the end.)

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Purpose of Enforcement and Laws of Contract

IN THIS SECTION...

- The broad role of a health and safety enforcement agency is to protect people against risks to health and safety arising from work activities.
- The UK HSE's *Enforcement policy statement* (HSE41) describes certain principles of enforcement:
  - Proportionality of enforcement.
  - Consistency of approach.
  - Transparency.
- Contract law has many implications in respect of occupational health and safety including contracts of employment, and establishing the relationship between producer and vendor, vendor and consumer, and client and contractor.

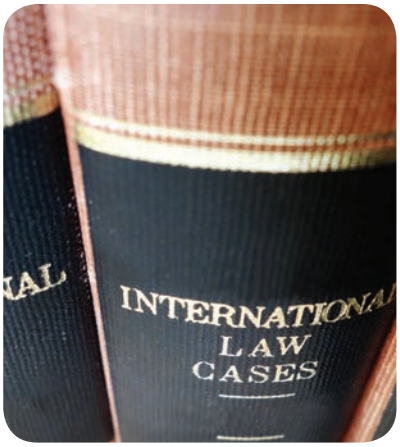
Purpose of Enforcement

The regulation of criminal law on health and safety at work requires an enforcement agency and its broad role is likely to be to protect people against risks to health or safety arising out of work activities.

In order to achieve this, legal compliance must be enforced. The ultimate aim is always prevention but action is needed where there is deliberate flouting of health and safety law.

Enforcement ensures that duty holders:

- Deal immediately with serious risks.
- Comply with the law.
- Are held to account if they fail in their responsibilities.



Legal compliance must be enforced

To enforce compliance with legal requirements there are a several approaches that can be taken, ranging from:

- provision of advice on what changes need to be introduced and how these may be achieved, to
- prosecution under relevant health and safety law that might be imposed on employers.

Following a successful prosecution the penalty could be a fine or possibly imprisonment. The aim is some form of punishment with the purpose of deterring any future non-compliance.

Principles of Enforcement with Reference to the HSE's Enforcement Policy Statement (HSE41)

The UK's HSE aims for firm but fair enforcement of health and safety law and applies the following principles, which are described in its *Enforcement Policy Statement* (HSE41):

- ### Proportionality of Enforcement

  Enforcement action should be in proportion to any risks to health and safety, or to the seriousness of any breach of law. Enforcing authorities should take in to consideration how far the duty holder has fallen short of what the law requires and the extent of the risks to people arising from the breach.

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Some health and safety duties are absolute but others require action '*so far as is reasonably practicable*' which involves judgment. This means taking into account the degree of risk on the one hand, and the sacrifice (money, time or trouble) involved in dealing with the risk on the other. Unless it can be shown that there is gross disproportion between these factors and that the risk is insignificant in relation to the cost, the duty holder must take measures to reduce the risk.

The HSE expects relevant good practice to be followed, but in circumstances where such standards are not clearly established UK law requires duty holders to determine what action needs to be taken to adequately reduce the risks. However, what is reasonably practicable in particular cases is ultimately determined by the courts.

- **Consistency of Approach**

Duty holders managing similar risks expect a consistent approach with regard to advice given, the use of enforcement notices, decisions on whether to prosecute, and the response to incidents. Consequently a similar approach needs to be taken in similar circumstances to achieve similar ends.

The HSE recognises that in practice consistency is not a simple matter, due to a number of factors including:

- The degree of risk.
- The attitude and competence of management.
- History of incidents.
- Previous enforcement action.

It is recognised that decisions on enforcement action involve judgment by the enforcer, but enforcing authorities should have arrangements in place to promote consistency.

- **Transparency**

Duty holders need to understand what is expected of them and what they should expect from the enforcing authorities. They should also be clear about what they have to do and what they don't - this means being clear about statutory requirements that **legally apply**, and **advice or guidance** that is desirable but not compulsory. Transparency also involves ensuring that employees and their representatives are kept informed about any decisions made and actions taken.

Duty holders, employees, their representatives and others also need to know what to expect when an inspector calls and what rights of complaint are open to them. In the UK all enforcing authority inspectors are required to issue the HSE leaflet *What to expect when a health and safety inspector calls* to those they visit. When inspectors offer duty holders information or advice, face to face or in writing, they will explain what has to be done to comply with the law and why. If asked they will write to confirm any advice and to distinguish legal requirements from best practice. If a notice is served the inspector will try to resolve points of difference before serving it and make sure it is clear what needs to be done, why, by when, the breach of the law which has been committed or why any prohibition is necessary.

- **Targeting**

Targeting ensures that resources are directed to those whose activities give rise to the most serious risks or where the hazards are least well controlled. Action needs to be focused on the duty holders who are responsible for the risk and who are best placed to control it, i.e. employers, manufacturers, suppliers or others.

Resources should be targeted where risks are most serious

Enforcing authorities should have systems to prioritise inspections, investigations or other regulatory contacts based on risk. The duty holder's management competence is also important because a poorly managed low hazard site can present a greater risk to workers or the public than a higher hazard site where proper risk control measures are in place.

- Accountability

  Enforcing authorities should have policies and standards in place against which they can be judged, and an effective and accessible procedure for dealing with comments and complaints.

  The leaflet *What to expect when a health and safety inspector calls* sets out HSE guidelines on what takes place during a routine inspection against which the inspector can be judged, and an effective and accessible procedure for dealing with comments and complaints. Enforcing authorities will have their own complaints procedures and details will depend on the individual authority.

Laws of Contract

Contract law is a feature of many jurisdictions including the UK, Australia and America. Contract law has many implications in respect of occupational health and safety. The relationship between an employer and employee or contractors is based on a contract of employment. Similarly, contracts are established between those who manufacture articles or substances and those who buy them.

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Contract

In the legal context, a contract is an exchange of promises, i.e. an agreement between two or more parties which is enforceable in a court of law. There must be a valid **offer** from one party, and a valid **acceptance** before the contract is established. The offer must be communicated by one party to another and may be in **writing**, **verbal** or **by conduct**. Business contracts are usually communicated and accepted in writing because it is much easier to prove that it has been created. When we purchase an item in a shop we enter into a contract with the vendor or seller. The receipt would be proof of the existence of the contract.

The terms of a contract can be **express** or **implied**:

- Express terms are stated by the parties during negotiation, or written into a contractual document so it is clear what is required of each party.
- Implied terms are not explicitly stated in the contract, but are implied by custom, statute or by the courts. For example, in the sale of goods an implied term is that the seller has the right to sell the goods and that in business sales the goods are of satisfactory quality and are fit for purpose.

Principles of Typical Laws of Contract

If a contract is formed, then the parties who formed the contract are legally bound by the terms of the contract - the binding nature of a contract. If, subsequently, one of the parties defaults on the contract then this would constitute a **breach of contract**. It is not possible to bring a legal action against somebody for breach of contract who was not part of the contract. This is called privity of contract. If the person who has caused the breach does not provide a remedy then the person who has suffered a loss as a result of the breach can bring a court action.

When an employer engages an employee, a contract of employment is established.

Employer↔ Employee

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One of the implied terms of such a contract is that the employer will take reasonable care to ensure the health and safety of the employee. Similarly, the employee is required to carry out his or her work with reasonable care and skill. A breach of contract, such as not adhering to the safety rules may constitute a breach of contract resulting in the employer dismissing the employee.

If the contract is breached and there is personal injury then in the UK it is usual to bring a civil action under the common law tort of negligence or breach of statutory duty, rather than for breach of contract.

When articles and substances are manufactured there may be a series of contracts established between the producer (or manufacturer) and the consumer (or end user).

Producer ↔ Vendor ↔ Consumer

For example, if a person purchases a machine of a particular make and model for use at work and the vendor sells a machine that does not meet this specification, then the consumer would be entitled to have the machine replaced with the one ordered, or alternatively receive a full refund of the moneys paid.

Similarly, it is common place for employers to engage contractors for short-term work, particularly in the construction industry.

Employer ↔ Contractor ↔ Subcontractor

The contract chain may be very short or, in the case of articles and substances manufactured in another country, the chain can involve importers and be much longer. Each member engages in contracts with those above and below in the chain. If a contract fails for such matters as failure to supply the correct goods, poor quality work or not completing the work within the time specified by the contract, etc. a civil action for breach of contract may follow. Remember, though, that personal injury cases usually result in civil actions for negligence and breach of statutory duty rather than for breach of contract.

STUDY QUESTIONS

6. Outline the purposes of enforcement.
7. What factors might affect consistency in the enforcement of health and safety legislation?

(Suggested Answers are at the end.)

Role and Limitations of the International Labour Organisation in a Global Health and Safety Setting

IN THIS SECTION...

- The adoption of a convention by the International Labour Conference (ILO) allows governments to ratify it and for it to become a treaty in international law. All adopted ILO conventions are considered international labour standards.
- Recommendations are non-binding guidelines, are not ratified by member countries, and do not have the binding force of conventions.
- ILO codes of practice contain practical recommendations intended for all those with a responsibility for occupational safety and health but are not legally binding instruments and are not intended to replace the provisions of national laws or regulations, or accepted standards.
- **Occupational Safety and Health Recommendation (R164) 1981** sets out the roles and responsibilities of governments, enterprises and workers.
- International conventions can be used as a basis for setting national systems of health and safety legislation.

Role of the United Nations

ILO Role and International Labour Conference

The International Labour Organisation (ILO) is an agency of the United Nations (UN) that is devoted to advancing opportunities for women and men to obtain decent and productive work in conditions of freedom, equity, security and human dignity. The ILO was created in 1919, as part of the Treaty of Versailles that ended World War I. Its main aims are to promote rights at work, encourage decent employment opportunities, enhance social protection and strengthen dialogue in handling work-related issues. The ILO is the only "tripartite" United Nations agency in that it brings together representatives of governments, employers and workers to jointly shape policies and programmes.

The ILO is an agency of the United Nations

The ILO is the global body responsible for drawing up and overseeing international labour standards. Working with its 181 member states, the ILO seeks to ensure that labour standards are respected in practice, as well as principle. Since its early days, the ILO has sought to define and guarantee labour rights and improve conditions for working people by building a system of international labour standards expressed in the form of conventions, recommendations and codes of practice.

The ILO has adopted more than 180 ILO conventions and 190 recommendations covering all aspects of the world of work. Nearly half of all ILO standards are concerned with health and safety matters.

The member states of the ILO meet at the International Labour Conference, held every year in June in Geneva, Switzerland. Each member state is represented by a delegation consisting of two government delegates, an employer delegate, a worker delegate, and their respective advisers. Every delegate has the same rights, and all can express themselves freely and vote as they wish; worker and employer delegates may vote against their government's representatives, or against each other. However, this diversity of viewpoints does not prevent decisions being adopted by very large majorities, or in some cases even unanimously.

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Many of the government representatives are cabinet ministers responsible for labour affairs in their own countries. Heads of state and prime ministers also take the floor at the conference. International organisations, both governmental and others, attend as observers.

The conference allows for the creation of conventions and recommendations - a two-thirds majority is required before they can be adopted.

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ILO Conventions

The adoption of a convention by the International Labour Conference allows governments to ratify it, and when a specified number of governments have done so, the convention becomes a treaty in international law. All adopted ILO conventions are considered international labour standards, irrespective of how many governments have ratified them.

Ratification of a convention imposes a legal obligation to apply its provisions. However, it is voluntary for a country to ratify a convention. If a convention has not been ratified by member states, it has the same legal force as recommendations. Each government is required to submit a report detailing their compliance with the obligations of the conventions they have ratified. Each year the International Labour Conference's Committee on the Application of Standards examines a number of alleged breaches of international labour standards.

An example of a convention is the **Occupational Safety and Health Convention 1981** and its protocol of 2002. This provides for the adoption of a coherent national occupational safety and health policy as well as action to be taken by governments to improve working conditions.

International Labour Conference Provisional Record 20A

Convention Concerning the Promotional Framework for Occupational Safety and Health, ILO, Geneva, 2006

Article 4 sets out the following provisions in respect of a national system.

"1. Each Member shall establish, maintain, progressively develop and periodically review a national system for occupational safety and health, in consultation with the most representative organisations of employers and workers.

2. The national system for occupational safety and health shall include among others:

(a) laws and regulations, collective agreements where appropriate, and any other relevant instruments on occupational safety and health;

(b) an authority or body, or authorities or bodies, responsible for occupational safety and health, designated in accordance with national law and practice;

(c) mechanisms for ensuring compliance with national laws and regulations, including systems of inspection; and

(d) arrangements to promote, at the level of the undertaking, co-operation between management, workers and their representatives as an essential element of workplace-related prevention measures.

3. The national system for occupational safety and health shall include, where appropriate:

(a) a national tripartite advisory body, or bodies, addressing occupational safety and health issues;

(b) information and advisory services on occupational safety and health;

(c) the provision of occupational safety and health training;

(d) occupational health services in accordance with national law and practice;

(e) research on occupational safety and health;

(f) a mechanism for the collection and analysis of data on occupational injuries and diseases, taking into account relevant ILO instruments;

(g) provisions for collaboration with relevant insurance or social security schemes covering occupational injuries and diseases; and

(h) support mechanisms for a progressive improvement of occupational safety and health conditions in micro-enterprises, in small and medium-sized enterprises and in the informal economy."

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Following the adoption of the above convention in 2006, each member of the ILO is required to introduce measures to implement its requirements within their own legislative system.

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ILO Recommendations

Recommendations are non-binding guidelines so are not ratified by member countries and do not have the binding force of conventions. Along with conventions, recommendations are drawn up by representatives of governments, employers and workers, and are adopted at the ILO's annual International Labour Conference. An example is the **Occupational Safety and Health Recommendation R164 1981** which we look at below.

ILO Codes of Practice

ILO codes of practice contain practical recommendations intended for all those with a responsibility for occupational safety and health in both the public and private sectors. Codes of practice are not legally binding instruments and are not intended to replace the provisions of national laws or regulations, or accepted standards. They aim to serve as practical guides for public authorities and services, employers and workers concerned, specialised protection and prevention bodies, enterprises and safety and health committees. Each code is first prepared by the Office (of the ILO) and finalised at a tripartite meeting composed of experts nominated by the Governing Body (of the ILO) in their personal capacity. Codes of practice are submitted to the Governing Body for approval of publication. An example is the **Code of Practice on Safety and Health in the Iron and Steel Industry (2005)**.

Roles and Responsibilities of 'National Governments', 'Enterprises' and 'Workers': R164 Occupational Safety and Health Recommendation 1981

Occupational Safety and Health Recommendation 1981 (R164) sets out the roles and responsibilities of governments, enterprises and workers. The key provisions are as follows.

National governments should:

"(a) issue or approve regulations, codes of practice ... on occupational safety and health and the working environment, account being taken of the links ... between safety and health, ... and hours of work and rest breaks ...;

(b) ... review legislative enactments concerning occupational safety and health and the working environment, ... in the light of experience and advances in science and technology;

(c) undertake or promote studies and research to identify hazards and find means of overcoming them;

(d) provide information and advice, in an appropriate manner, to employers and workers and promote or facilitate co-operation between them and their organisations, with a view to eliminating hazards or reducing them as far as practicable; where appropriate, a special training programme for migrant workers in their mother tongue should be provided;

(e) provide specific measures to prevent catastrophes, and to co-ordinate and make coherent the actions to be taken at different levels, particularly in industrial zones where undertakings with high potential risks for workers and the surrounding population are situated;

(f) secure good liaison with the International Labour Occupational Safety and Health Hazard Alert System set up within the framework of the International Labour Organisation;

(g) provide appropriate measures for handicapped workers."

Enterprises:

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

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

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

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

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

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

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

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

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The measures taken to facilitate the co-operation referred to in Article 20 of the Convention should include, where appropriate, the appointment of workers' safety delegates or representatives of workers' safety and health committees, and/or of joint safety and health committees. In joint safety and health committees, workers should have at least equal representation with employers' representatives.

Delegates and committees should:

"(a) be given adequate information on safety and health matters, enabled to examine factors affecting safety and health, and encouraged to propose measures on the subject;

(b) be consulted when major new safety and health measures are envisaged and before they are carried out, and seek to obtain the support of the workers for such measures;

(c) be consulted in planning alterations of work processes, work content or organisation of work, which may have safety or health implications for the workers;

(d) be given protection from dismissal and other measures prejudicial to them while exercising their functions in the field of occupational safety and health as workers' representatives or as members of safety and health committees;

(e) be able to contribute to the decision-making process at the level of the undertaking regarding matters of safety and health;

(f) have access to all parts of the workplace and be able to communicate with the workers on safety and health matters during working hours at the workplace;

(g) be free to contact labour inspectors;

(h) be able to contribute to negotiations in the undertaking on occupational safety and health matters;

(i) have reasonable time during paid working hours to exercise their safety and health functions and to receive training related to these functions;

(j) have recourse to specialists to advise on particular safety and health problems."

Workers should:

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

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

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

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

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

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Use of International Conventions as a Basis for Setting National Systems of Health and Safety Legislation

ILO standards on occupational safety and health enable governments, employers and workers to establish practices and procedures that aim for the highest level of health and safety performance. The ILO global strategy to improve occupational safety and health involves the promotion of:

- A preventive safety and health culture.
- The development of relevant instruments and technical assistance to establish OHS standards.

International labour standards are legal instruments drawn up by the ILO's constituents (governments, employers and workers) that set out basic principles and rights at work.

As we have noted, they are either:

- Conventions:
  - legally binding international treaties that may be ratified by member states, and
  - lay down the basic principles to be implemented by ratifying countries, OR
- Recommendations:
  - serve as non-binding guidelines,
  - supplement the convention by providing more detailed guidelines on how it could be applied, and
  - can also be autonomous, i.e. not linked to any convention.

Conventions and recommendations are drawn up by representatives of governments, employers and workers and are adopted at the ILO's annual International Labour Conference. Once a standard is adopted, member states are required under the ILO Constitution to submit them for consideration to their competent authority (normally parliament). For conventions this means consideration for ratification, and they generally come into force one year after the date of ratification. Ratifying countries commit themselves to applying the convention in national law and practice and reporting on its application at regular intervals. The ILO provides technical assistance if necessary.

The following are important examples of conventions and associated recommendations.

Occupational Safety and Health Convention (C155) 1981

The purpose of this Convention is to ensure that those member states who ratify it formulate, implement and periodically review a coherent national policy on occupational safety and health in the work environment. This should involve consultation with the most representative organisations of employers and workers. The aim of the policy is to prevent workplace accidents and injury to health by minimising, as far as possible, the causes of hazards inherent in the work environment.

We looked at the associated **Occupational Safety and Health Recommendation (R164) 1981** earlier.

Promotional Framework for Occupational Safety and Health Convention (C187) 2006

This Convention promotes a preventative safety and health culture in order to progressively achieve a safe and healthy working environment. It requires ratifying states to develop, in consultation with the most representative organisations of employers and workers, a national policy, national system and national programme on occupational safety and health. This national policy should be developed in accordance with Article 4 of the **Occupational Safety and Health Convention (C155) 1981**, i.e. aim to prevent accidents and injury to health at work by minimising the causes of hazards inherent in the working environment.

National systems should provide the infrastructure for implementing national policy and programmes on occupational safety and health, such as laws and regulations, authorities or bodies, compliance mechanisms including systems of inspection, and arrangements at the level of the undertaking. National programmes should also include time-bound measures to promote occupational safety and health, enabling a measuring of progress.

The associated **Promotional Framework for Occupational Safety and Health Recommendation (R197) 2006** supplements the convention by providing more detailed guidelines on how it could be applied:

- Provide appropriate measures for the protection of all workers, in particular workers in high-risk sectors, and vulnerable workers such as those in the informal economy and migrant and young workers.
- Take measures to protect the safety and health of workers of both genders, including the protection of their reproductive health.
- Seek to raise workplace and public awareness on occupational safety and health through national campaigns linked with, where appropriate, workplace and international initiatives.
- Promote mechanisms for delivery of occupational safety and health education and training, in particular for management, supervisors, workers and their representatives and government officials responsible for safety and health.
- Introduce occupational safety and health concepts and, where appropriate, competencies, in educational and vocational training programmes.
- Facilitate the exchange of occupational safety and health statistics and data among relevant authorities, employers, workers and their representatives.
- Provide information and advice to employers and workers and their respective organisations and promote or facilitate co-operation among them with a view to eliminating or minimising, so far as is reasonably practicable, work-related hazards and risks.

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- Promote, at the level of the workplace, the establishment of safety and health policies and joint safety and health committees and the designation of workers' occupational safety and health representatives, in accordance with national law and practice.
- Address the constraints of micro-enterprises and small and medium-sized enterprises and contractors in the implementation of occupational safety and health policies and regulations, in accordance with national law and practice.
- Promote a management systems approach to occupational safety and health, such as the approach set out in guidelines on occupational safety and health management systems.

The detail given in the guidelines above is purely for illustration to show how the purpose of the Convention "*to promote a preventative safety and health culture in order to progressively achieving a safe and healthy working environment*" is translated into action through the guidelines given in the Recommendation.

STUDY QUESTIONS

8. Explain the role of the International Labour Organisation in respect of health and safety at work.
9. Explain the difference between an ILO convention and a recommendation.
10. What is an ILO code of practice?
11. What duties are imposed on national governments by R164 Occupational Safety and Health Recommendation 1981?
12. What duties are imposed on enterprises by R164 Occupational Safety and Health Recommendation 1981?
13. What duties are imposed on workers by R164 Occupational Safety and Health Recommendation 1981?

(Suggested Answers are at the end.)

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Role of Non-Governmental Bodies and Health and Safety Standards

IN THIS SECTION...

- The following parties have a key role in influencing health and safety performance: employer bodies; trade associations; trade unions; professional groups; pressure groups; the general public.
- The media play an important role in communicating health and safety issues and can influence changes in attitudes to health and safety.
- There are benefits to be had in schemes which promote co-operation on health and safety between different companies.
- Following any adverse health and safety incident there will be financial implications for the organisation. Some of the losses can be quantified, but there will be a range of indirect costs whose effect cannot be easily determined.
- Organisations have and should accept moral obligations for health and safety standards within their supply chains, and ensure that financial competition between suppliers does not lead to reductions in health and safety standards.
- Self-regulation is the process whereby an organisation monitors its own adherence to health and safety standards, rather than having an outside agency, such as a governmental body, monitoring and enforcing them.
- Corporate governance is the system by which organisations are directed and controlled by their board of directors who make strategic decisions that affect the direction of the organisation. Their area of control should include occupational health and safety as well as other corporate objectives such as being competitive and making a profit.
- For an organisation to effectively manage occupational health and safety it must devise and implement rules and procedures that enable workers to adhere to safe working practices.
- International conventions can be used as a basis for setting national systems of health and safety legislation.

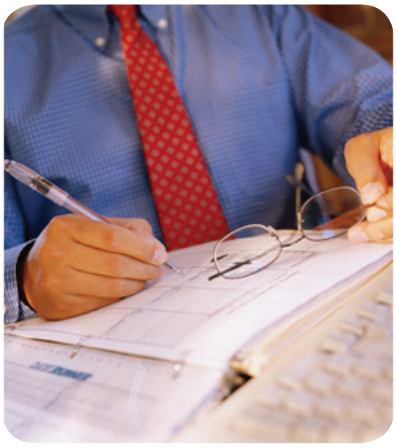
Relevant Influential Parties

Employer Bodies

These represent the interests of employers. In the UK the main body is the Confederation of British Industry (CBI). The CBI helps create and sustain the conditions in which businesses in the United Kingdom can compete and prosper for the benefit of all.

The CBI is the main lobbying organisation for UK business on national and international issues. It works with the UK government, international legislators and policymakers to help UK businesses compete more effectively.

Another well-known active employer organisation is the Chamber of Commerce. You will find branches operating in many countries throughout the world.



Employer bodies represent the interests of employers

Trade Associations

Trade associations are formed from a membership of companies who operate in a particular area of commerce and exist for their benefit. They can promote common interests and improvements in quality, health, safety, environmental and technical standards through various appropriate means, e.g. the publication of guidelines, information notes, codes of practice, and regular briefing notes on technical issues and regulatory developments. Sharing of good practice can be facilitated together with provision of news and events appropriate to their members' areas of activity.

Meetings, workshops and seminars can be arranged depending on an association's membership, both internationally and at a national/regional level, to enable networking and the exchange of information and ideas, e.g. on technical and safety issues.

Safety is of prime importance in any industry and there is usually a system for publicising and circulating safety messages to members on a regular basis.

Membership of a trade association is generally available to companies and organisations active in the relevant industry.

Trade Unions

A trades union is an organisation of workers who have formed together to achieve common goals in key areas, such as wages, hours and working conditions. The trade union negotiates with the employer on behalf of its members. This may include the negotiation of wages, work rules, complaint procedures, rules governing hiring, firing and promotion of workers, benefits, workplace safety and policies. The agreements negotiated by the union leaders are binding on the rank and file members and the employer, and in some cases on other non-member workers. In the UK, unions may appoint safety representatives from amongst the workers who may investigate accidents, conduct inspections and sit on a safety committee.

Professional Groups

A professional group is an organisation of individuals who work in a particular profession and have achieved a defined level of competence. Members typically pay a subscription to join the group and receive a range of benefits. Professional groups may also exist with the sole purpose of certifying practitioners in the safety profession in order to establish and validate technical competency criteria:

- The **Institution of Occupational Safety and Health** (IOSH), based in the UK, has over 30,000 members worldwide, including more than 10,000 Chartered Safety and Health Practitioners. It is an independent, not-for-profit organisation that sets professional standards, supports and develops members, and provides authoritative advice and guidance on health and safety issues. IOSH has increased its international presence in recent years. It has local branches not only in the UK, but also in the Middle East, Hong Kong and the Caribbean. IOSH is formally recognised by the ILO as an international non-governmental organisation.

IOSH - not-for-profit organisation

- The **American Society of Safety Engineers** (ASSE) is a professional safety society that aims to promote the expertise of its members and provide them with professional development and support. It also sets occupational safety, health and environmental standards for excellence and ethics. It is a global association representing more than 36,000 occupational safety professionals worldwide.
- The **Board of Certified Safety Professionals** (BCSP) is a peer certification board. It is not a member organisation and does not provide services usually offered by member organisations but its sole purpose is to certify practitioners in the safety profession. There is a recognised need for safety certification and in the US, in particular, there are numerous laws, regulations and standards that cite the requirement for it.

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Pressure Groups

A pressure group can be described as an organised group of people who have a common interest but, unlike a political party, do not put up candidates for election. However, they seek to influence government policy or legislation. They can also be described as 'interest groups', 'lobby groups' or 'protest groups'.

They carry out research, lobby politicians and so aim to influence public and ultimately, government opinion. One example in the UK is the Centre for Corporate Accountability. This is concerned with the promotion of worker and public safety. Its focus is on the role of state bodies in enforcing health and safety law and investigating work-related deaths and injuries. It was formed following a number of high profile work-related accidents that led to a large number of deaths, and the perception that the companies concerned were not taking safety seriously and that the penalties imposed by the courts were inadequate.

General Public

Individual members of the public can have little influence on the regulation of health and safety unless they can influence others and so form a body of opinion (e.g. a pressure group) that cannot be ignored.

Importance of Print, Broadcast and Social Media in a Global Economy

The media play an important role in communicating health and safety issues and can influence changes in attitudes to health and safety. The media includes print media (e.g. newspapers, books and journals), broadcast media (e.g. radio and television) and of increasing importance Internet-based media, such as the World Wide Web.

No country can successfully compete in a global economy without the use of media as a communication tool. In terms of occupational health and safety the following points indicate some of the ways the media is used:

- Making health and safety guidance easily accessible with minimal cost. Agencies such as OSHA (USA) and the HSE (UK) produce guidance for all categories of duty holders in all types of employment. This is available in hard copy and more commonly in electronic format that can be downloaded. This allows duty holders who have limited expertise to access relevant information and so comply with legal requirements.
- Publicising good and bad health and safety performance, e.g. TV and radio may publicise major accidents, prosecutions and public inquiries. Major disasters may be publicly discussed not only in the country in which they occurred, but internationally. Incidents with lesser consequences may be publicised within the area in which they occurred. Such publicity increases the awareness of occupational health and safety issues and reminds duty holders of the possible consequences of failing to pay attention to these issues.
- Assisting in educating members of the professional body and promoting good health and safety standards by publishing professional journals (e.g. Institution of Occupational Safety and Health (UK)).
- Enabling anyone with an Internet connection access to a huge range of information (good and bad) which would otherwise be much less accessible.

The media can be used to help change attitudes to occupational health and safety; examples of this include:

- Making the public, and in particular duty holders, aware of enforcement action such as prosecutions, convictions and civil actions, through the newspapers, TV/radio and the Internet.
- Enforcement bodies making information on good health and safety practice easily accessible to duty holders.
- Companies publicising good health and safety performance to promote their services and to secure a competitive advantage by being seen as good employers.

Media can be used to change attitudes to health and safety

- Adverse publicity orders are a sanction that the courts may impose against organisations that fail to comply with legal requirements. They will have an adverse effect on the perceived reputation of the organisation.

Benefits of Schemes Which Promote Co-operation on Health and Safety Between Different Companies

Explicit co-operation between companies is not usual because in a free market companies compete with each other for customers and so may be reluctant to share good practices for fear of giving their competitors an advantage. However there are many schemes that have been established that promote co-operation between different companies. Depending on the benefits received by the participants, these may last for a short period, or carry on indefinitely.

The establishment of such schemes may be facilitated and encouraged by government bodies, or they may be set up informally.

An example of such a scheme is the so-called **good neighbour scheme**.

In the UK a number of such schemes have been established to encourage larger organisations to help smaller businesses and contractors with health and safety expertise. Small businesses do not have access to the same health and safety expertise, so if a large organisation can provide advice to a smaller one, then the smaller business will benefit and the larger organisation will be able to demonstrate its public responsibility.

Schemes have also been established between organisations of similar size. They might involve sharing expertise and equipment such as a noise meter. It is much less costly to share such resources and all members of the scheme will benefit.

Supplier auditing is the process by which an organisation establishes that its existing and new suppliers meet their requirements. In the context of health and safety, this would include ensuring that the quality of the products and services it supplies meets legal requirements and other standards. For example, this may include the company sending an auditor to a manufacturer of machines to ensure that it has adopted safe working practices and that the machines are constructed from suitable materials and meet designated safety standards.

Adverse Effects on Business Reputation

Following any adverse health and safety incident, such as an accident or case of occupational ill health, there will be financial implications for the organisation. Even a small incident in which a worker has to receive first aid will invariably cost money, including lost production from the injured person and from those who give first aid and manage the incident. Personal injury cases may involve a claim for damages by the injured person which will again have a financial impact on the organisation. There may be a loss of morale amongst workers in the organisation in the belief that the organisation does not care about their health and safety. This may then lead to key personnel seeking employment elsewhere, even though they may have not suffered any direct loss. Some of the losses already mentioned, e.g. loss of production, can be relatively easily quantified, but there will be a range of indirect costs whose effect cannot easily be determined. One such effect is on the stakeholders of an organisation. These are individuals who have an interest in the organisation and include:

Oil refinery explosion

- Workers who rely on the organisation for employment.
- Other businesses, including suppliers and contractors who trade with the organisation.
- Businesses that benefit indirectly from the presence of an organisation, e.g. local shops.
- Shareholders who own the organisation and wish to see their investment yield a satisfactory financial return.

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An Organisation's Moral Obligations to Raise Standards Within their Supply Chains

Brands should take some responsibility for standards at their suppliers and this is based on the principle that global brands (financially, legally and morally) are in a superior position to make a positive impact on health and safety standards, both within their organisations and throughout their supply chain. Part of this moral argument stems from the fact that competition between potential suppliers to deliver products at the lowest price impacts on the resourcing of health and safety in supply organisations. Global organisations should therefore take some responsibility to ensure that fierce financial competition between suppliers does not result in severe erosion of health and safety standards.

In cases where workers have been injured in serious incidents occurring at suppliers' premises, the moral view has been that the brands involved should take swift action to commit to providing compensation which should be negotiated with the trade unions representing the workers, and be based on international standards. The international buyers bear some responsibility for compensating the victims and this should include loss of income and damages for the injured and families of the dead, medical costs, and educational fees for the children of the deceased with the distribution of payments done in an open way in conjunction with trade unions. It might even be expected that the brands support an independent inquiry into any such incident and be involved in prevention of future similar occurrences.

Meaning of 'Self-Regulation'

The benefit to the organisation of self-regulation is that it can set and maintain its own standards without external interference. Accordingly if problems arise, it can more easily keep its own internal affairs private. It also avoids the significant national expense of establishing an enforcement agency.

In contrast, attempts to self-regulate may fail because individual organisations may believe there is little advantage in establishing good standards if similar organisations choose to ignore them. Workers in a self-regulated organisation may experience poor standards with an increased frequency of accidents and ill health.

Self-regulation of health and safety within a legal framework was one of the recommendations of the Robens Committee, which was established in 1970 in the UK to "*review the provision made for the safety and health of persons in the course of their employment and to consider whether any changes are needed*".

DEFINITION

SELF-REGULATION

The process whereby an organisation monitors its own adherence to health and safety standards, rather than having an outside agency, such as a governmental body, monitoring and enforcing standards.

The Robens report identified that the existing system relied too much on regulation by external government bodies with too little reliance on organisations establishing their own standards. A key recommendation in the report was that those who create the risks of occupational accidents and ill health should be responsible for regulating them. Future legislation should establish conditions for creating more effective self-regulation, rather than relying on more negative regulation by enforcement bodies.

The UK agency the Health and Safety Executive defined self-regulation as "*the purposeful creation and maintenance of standards of health and safety and the accordance of priorities commensurate with the risks generated by the activities of the organisation*".

We mentioned the UK's **Health and Safety at Work, etc. Act 1974** earlier in this element as an example of goal-setting legislation. The Act encourages self-regulation. Section 2 of the Act states: "*It shall be the duty of every employer to ensure, so far as is reasonably practicable, the health, safety and welfare at work of all his employees*". The Act sets out a broad objective, but does not prescribe how it will be achieved. It is for the duty holder (in this case the employer) to decide what is reasonably practicable. This requires an assessment of the magnitude of the risk associated with the hazard in question and the cost of either eliminating or reducing the risk to a level that is at least "tolerable" (but preferably "acceptable"). Accordingly, the onus is shifted towards the employer to assess risks and to identify and implement appropriate control measures.

To achieve self-regulation the Robens Committee recognised the importance of securing worker participation in the implementation and monitoring of health and safety arrangements. In many countries, including the UK, this is achieved through representatives of workplace safety (trade unionised or otherwise) and/or safety committees (which include worker representation).

Role and Function of Corporate Governance in a System of Self-Regulation

Aside from external legislation which may dictate the conduct of the company, an organisation is to a certain extent self-regulating; it sets many of its own objectives and standards and determines how it will achieve them.

The board of an organisation, that comprises its directors, provides this corporate governance which aims to create a successful organisation. Their area of control includes occupational health and safety as well as other corporate objectives, such as being competitive and making a profit.

To ensure good health and safety performance, the board of the organisation generally has to be satisfied that the following matters are dealt with throughout the organisation.

- A demonstration of commitment by senior management to occupational health and safety and an appreciation that it is as important as other business objectives.
- Ensuring that health and safety is reviewed at board level.
- Those in the organisation at all levels have access to, and receive competent advice.
- All staff, including board members, are trained and competent in their health and safety responsibilities.
- Ensuring that the workforce, and in particular health and safety representatives, are adequately consulted and that their concerns reach the right level within the organisation including, where necessary, the board.
- Systems are in place to ensure that health and safety risks are assessed and suitable control measures introduced and maintained.
- An awareness of what activities take place in the organisation, including those of contractors.
- Ensuring regular information is received regarding matters such as accident reports and cases of work-related ill health.
- The setting of targets which allow the organisation to improve standards and to benchmark the organisation's performance against others within the same business sector.
- Ensuring that changes in working arrangements that have significant implications are brought to the attention of the board.

DEFINITION

CORPORATE GOVERNANCE

The system by which organisations are directed and controlled by their board of directors and includes the making of broad strategic decisions that affect the direction of the organisation. It is on a higher level than management, which relates to the regular decisions and subsequent actions needed to effectively run the business.

A report from EU-OSHA, *Leadership and Occupational Safety and Health (OSH) – An Expert Analysis*, looks at corporate leadership factors on which success depends and identifies the following five broad guiding principles:

1. Leaders must take seriously their responsibility for the establishment of a **positive prevention culture** and employ leadership styles which take account of the cultural context in different groups or nations.
2. Leaders should be seen to **prioritise OSH policies above other corporate objectives**, and apply them consistently across the organisation and over time.
3. High-level management must be directly involved in implementing OSH policies which have the **unequivocal commitment of an organisation's board and senior management**.

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4. Leaders should set out to cultivate an **open atmosphere** in which all can express their experience, views and ideas about OSH and which **encourages collaboration** between stakeholders, both internal and external, around delivery of a shared OSH vision.
5. Leaders should show they value their employees, and **promote active worker participation** in the development and implementation of OSH measures.

How Internal Rules and Procedures Regulate Health and Safety Performance

For an organisation to effectively manage occupational health and safety it must devise and implement procedures that enable workers to adhere to safe working practices. This will inevitably include defining rules and procedures that must be reasonably complied with. Merely stipulating rules is not enough. The worker must clearly understand and appreciate the need for the rules as well as have the competence to comply with them. The working conditions must encourage compliance.

For example, a worker required to use a machinery guard in a manufacturing process is less likely to adhere to the rule if the rate at which he can do the work is significantly impaired when the guard is used. Also, of course, if there is a poor safety culture in the workplace and few existing workers comply with the rules, then it cannot be reasonable to expect a new worker to comply.

MORE...

WWW.

The EU-OSHA report, *Leadership and Occupational Safety and Health (OSH) – An Expert Analysis*, looks at corporate leadership factors and analyses the results of 16 case studies from companies across the EU, identifying success factors and examples of good OSH leadership. The report is available at:

https://osha.europa.eu/en/publications/literature_reviews/leadership-and-occupational-safety-and-health-osh-an-expert-analysis/view

For a rule to be effective it has to be enforced by the organisation. This requires monitoring by supervisors and managers who must have the necessary authority to enforce the rules. This may include routine day-to-day monitoring, formal inspections and random spot checks. Failure to comply with internal rules may lead to sanctions imposed by the employer which may include:

- Informal verbal warnings.
- Formal verbal and written warnings.
- Temporary suspension from work.
- Demotion.
- Dismissal.

Such sanctions have to be imposed fairly and must not constitute bullying. They must also comply with the national employment law. Suitable and fairly enforced safety rules will reduce the likelihood of workers violating them, and will create an environment in which safe working becomes the norm. This will accordingly reduce the likelihood of accidents and ill health.

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STUDY QUESTIONS

14. How do employers' bodies influence health and safety practices and standards?
15. How do trade unions influence health and safety practices and standards?
16. Explain the ways in which the media, e.g. TV, Internet, etc. can influence health and safety.
17. What is meant by a "good neighbour scheme"?
18. Explain the meaning of the term "self-regulation".
19. List the functions of the board of an organisation for the effective governance of health and safety.

(Suggested Answers are at the end.)

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Summary

Comparative Governmental and Socio-Legal Models

We have:

- Explained the role of legislation as a means of promoting positive health and safety outcomes.
- Examined the differences between 'goal-setting' and 'prescriptive' legal models.
- Considered loss events as failures in the duty of care to protect individuals and examined the compensatory mechanisms that may be available to them, including no fault liability and fault liability claims.

Purpose of Enforcement and Laws of Contract

The broad role of a health and safety enforcement agency is likely to be to protect people against risk to health and safety arising out of work activities.

The UK HSE's *Enforcement policy statement* (HSE41) describes the following principles in attempting to ensure firm but fair enforcement of health and safety law:

- Proportionality of enforcement.
- Consistency of approach.
- Transparency.
- Targeting.
- Accountability.

The law of contract has many implications in respect of occupational health and safety, particularly with regard to the relationship between an employer and worker, and between those who manufacture articles or substances and those who buy them.

Role and Limitations of the International Labour Organisation in a Global Health and Safety Setting

We have:

- Examined the role and status of ILO conventions, recommendations and codes of practice in relation to health and safety.
- Noted **Occupational Safety and Health Recommendation 1981 (R164)** which sets out the roles and responsibilities of governments, enterprises and workers.
- Noted how international conventions can be used as a basis for setting national systems of health and safety legislation.

Role of Non-Governmental Bodies and Health and Safety Standards

We have:

- Considered influential parties, such as employer bodies, trade associations, trade unions, professional groups, pressure groups and the public who have a role in regulating health and safety performance.
- Noted how the media can play an important role in communicating health and safety issues and can influence changes in attitudes to health and safety.
- Considered the benefits of schemes which promote co-operation on health and safety between different companies.

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Summary

- Explained the possible effects on business of stakeholder reaction to health or safety concerns.
- Noted an organisation's moral obligations to raise standards of health and safety within their supply chains.
- Examined the origins and meaning of 'self-regulation'.
- Described the role and function of corporate governance in a system of self-regulation.
- Considered how internal rules and procedures regulate health and safety performance.

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Exam Skills

We will now move on to look at a law question. Questions relating to the legal aspects of health and safety can be off-putting because it is a topic that health and safety practitioners are least familiar with.
However, if you plan your answer, you shouldn't find it difficult to get good marks.

QUESTION

Companies are subjected to many influences in health and safety.

(a) In contract law, **identify** what is meant by express terms. **(2)**

(b) **Outline** how influential parties can affect health and safety performance in a company. **(8)**

Approaching the Question

This is a short question and is reasonably well subdivided so it gives you a clear idea where the marks have been allocated. Part (a) asks you to simply identify what is meant by "express terms". Part (b) requires more detail and relates to section IA2.4 of the syllabus and the relevant influential parties that can affect health and safety performance.

If you are familiar with this material from your course notes and the syllabus then the answer to the question should be straightforward.

Suggested Answer Outline

For part (a) the examiner expects a concise summary such as:

Express terms are those specifically mentioned and agreed by all parties at the time the contract is made. They may take account of unusual circumstances but should not include unfair terms.

For part (b) the parties that should be considered include:

- Employer bodies – who may set performance standards for member organisations.
- Trade associations – who may also set performance standards for members and may require self-regulation and compliance with accredited management systems.
- Trade unions – whose representatives check workplace conditions and provide advice and guidance.
- Professional groups – such as IOSH, who set professional standards of performance and provide advice and guidance.
- Pressure groups – such as IOSH, ASSE or Board of Certified Safety Professionals, who set professional standards of performance and provide advice and guidance.
- The public – who, as customers, can influence the success of an organisation by boycotting goods and services.
- The ILO – who publish advice and guidance and enforce standards in conventions and recommendations.
- Insurance companies – who can stipulate specific performance standards for insurance cover and may remove statutory cover for non-compliance.
- The media – who may publicise incidents affecting the health and safety of workers and others.

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Example of How the Question Could be Answered

(a) Express terms in contract law refer to the specific details mentioned and agreed in the contract. They cover unusual circumstances, but shouldn't include unfair terms.

(b) Different groups can affect the H&S performance of a company; these can be by employers' bodies, who can set standards to follow for its members, trade unions who influence their members and provide H&S advice, insurance companies who impose conditions of operation, design and management on companies, ILO who publish advice and guidance and enforcement of standards as well as the media who will publish information of company ethics and conditions to the local or national community.

Reasons for Poor Marks Achieved by Candidates in Exam

- Failing to provide a comprehensive list of influential parties.
- Listing influential parties but not outlining how each of the parties is able to affect health and safety performance.

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Element IA3

Loss Causation and Incident Investigation

Learning Outcomes

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

1. Outline theories/models and use of loss causation techniques.
2. Explain the use of quantitative methods in analysing loss data.
3. Explain the significance and use of statutory and internal reporting for loss events.
4. Explain the reasons for loss and near miss investigations and the procedures to be followed.

Contents

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Theories/Models and Use of Loss Causation Techniques

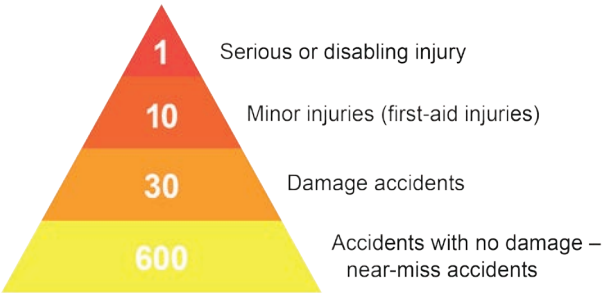
IN THIS SECTION...

- Incident studies have demonstrated that in any organisation there is a relationship between the number of major incidents and those with less serious outcomes.
- The single-cause domino theory suggests that in an accident there is a sequence of events or circumstances that precede the harm:
  - Ancestry (upbringing).
  - Fault.
  - Unsafe act.
  - Accident.
  - Injury.
- Multi-causal theories suggest that, preceding an incident, there is a combination of causal factors at each level that may combine to lead to the loss event.
- Reason's model of organisational accidents states that for a major accident to occur a series of defences must be defeated for the hazard to lead to a loss event. Unsafe acts may cause the failure of the defences. Unsafe acts are made more likely by local conditions in the workplace.

Accident/Incident Ratio Studies

There is no shortage of data on incidents such as accidents or near misses. Some researchers have studied the figures in detail and concluded that there appears to be a relationship between the numbers of different types of accident.

F. E. Bird used accident data to produce the following **accident triangle**:



Bird's accident ratio triangle

Other researchers have produced similar accident ratio triangles:

Labour Force Survey 1990

Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013 (RIDDOR) classifications

The actual figures vary between the different accident triangles but the important thing to note is that, for every major incident or fatality, there are many more less serious or near-miss incidents.

Heinrich's accident triangle

Analysis also shows that:

- It is invariably a matter of chance whether a given event results in injury, damage or a near miss, i.e. near misses could so easily become more serious incidents.
- Near-miss/less serious incident data can, therefore, be a useful predictor of accident potential.
- All events are due to failure to control – so we can learn from even minor incidents.

The data from these triangles has a number of limitations that you need to think about before trying to apply it:

- Not every near miss or minor incident involves risks which could actually have led to a serious incident or fatality.
- Be careful comparing:
  - Different triangles.
  - Different definitions (e.g. lost-time accidents).
  - Different industries (with different types of risk).
- Statistical significance – you need a certain amount of representative data for a meaningful comparison between your workplace and industry as a whole.

Domino and Multi-Causality Theories

One of the duties of the safety practitioner is to keep details of accidents and ill-health conditions and carry out investigations. The law requires certain accidents and occupational diseases to be reported. Often, the information that is recorded at the time of an accident is not adequate for the purpose of investigation into the cause, and so is certainly inadequate for the purpose of preventing the accident happening again.

For example, the report form may ask for the nature and cause of the injury. This could be written as:

- Nature of injury - cut finger.
- Cause of injury - caught on a sharp piece of metal.

The safety practitioner needs to know a lot more than this such as:

- Which finger?
- How serious was the cut?
- Was this part of the normal job?
- Should it have been sharp?
- Should it have been there?
- How should it have been handled?

A good starting point in investigations is to consider the two basic theories for accident causation.

Note that domino theory presents a simplified model, which considers only one cause of an accident. Also, in the Heinrich model, the focus is on immediate rather than root causes. Both models are highly reactive and cannot be used to predict the likelihood of accidents.

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Single Cause Domino Theory

According to **Heinrich**:

> *"A preventable accident is one of five factors in a sequence that results in an injury. The injury is invariably caused by an accident and the accident in turn is always the result of the factor that immediately precedes it."*

The five factors in Heinrich's accident sequence are summarised in the following table.

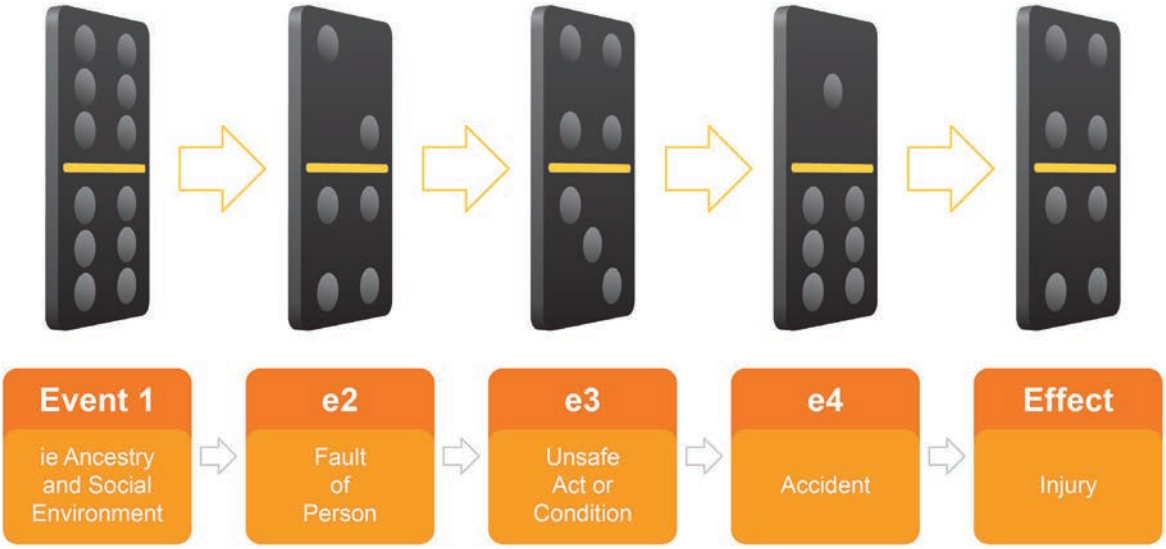
Heinrich's Accident Sequence

Accident Factors	Description
1. Ancestry and social environment	Recklessness, stubbornness, greed and other undesirable traits of character that may be passed along through inheritance. Environment may develop undesirable traits of character or may interfere with education. Both inheritance and environment may cause faults of person.
2. Fault of person	Inherited or acquired faults of person such as recklessness, violent temper, nervousness, excitability. These constitute reasons for committing unsafe acts or for the existence of mechanical or physical hazards.
3. Unsafe act and/ or mechanical or physical hazard	Unsafe performance of persons such as: standing under danger areas, careless starting of machines, removal of safeguards and horseplay; mechanical or physical hazards such as unguarded gears or points of operation, insufficient light, which result in accidents.
4. Accident	Events such as falls of persons, striking of persons by flying objects, etc. are typical accidents which cause injury.
5. Injury	Fractures, lacerations, etc. are injuries which result directly from accidents.

The major point that Heinrich makes is that a preventable injury is the natural culmination of a series of events or circumstances which occur in a fixed logical order. Here an analogy can be made with a row of dominoes placed on end, such that if one falls it will cause the next to fall and so on throughout the series (see figure that follows). If one of the dominoes is removed, the chain of events will be halted. In the same way, consider Heinrich's accident sequence:

1. Ancestry and social environment.
2. Fault of person.
3. Unsafe act and/or mechanical or physical hazard.
4. Accident.
5. Injury.

If this sequence is interrupted by the elimination of even one of these factors, the injury cannot occur and the accident has been prevented. In the case of the accident sequence, perhaps the easiest factor to eliminate is Number 3, the "unsafe act and/or mechanical or physical hazard".



Heinrich's domino sequence

Bird and Loftus extended Heinrich's theory to take into account the influence of management in the cause and effect of accidents, suggesting a modified sequence of events:

1. Lack of control by management.
2. This permits the existence of basic causes (i.e. personal and job factors).
3. In turn, this leads to immediate causes (such as substandard practices, conditions or errors).
4. These are subsequently the direct causes of the accident.
5. Finally, this results in loss (which may be categorised as negligible, minor, serious, or catastrophic).

This modified sequence can be applied to every accident and is of basic importance to loss-control management.

Multi-Causal Theories

There may be more than one cause of an accident, not only in sequence, but occurring at the same time. For example, a methane explosion requires:

- Methane in the explosive range of 5% to 15%.
- Oxygen, or air.
- Ignition source.

The ignition will only happen if these three events occur together. Each of the three events may, in themselves, be the end result of a number of different sequences of events. In accident investigation, all causes must be identified.

Usually simple accidents have a single cause, which is why such events so frequently occur; but the consequences tend to be of a minor nature. A major disaster normally has multiple causes, with chains of events, and combinations of events. Fortunately, they are rare occurrences.

The multi-causal model considers that there may be organisational, cultural, managerial, etc. causes that interact and result in an accident. The model is more complex than the single-cause domino theory and can be used not only for accident investigation, but also to prevent accidents if the outcomes of monitoring activities are analysed. The model can also be linked to more advanced analysis techniques, such as fault trees and event trees. The downside is that they are more complex and therefore take longer to carry out.

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Systems Theory

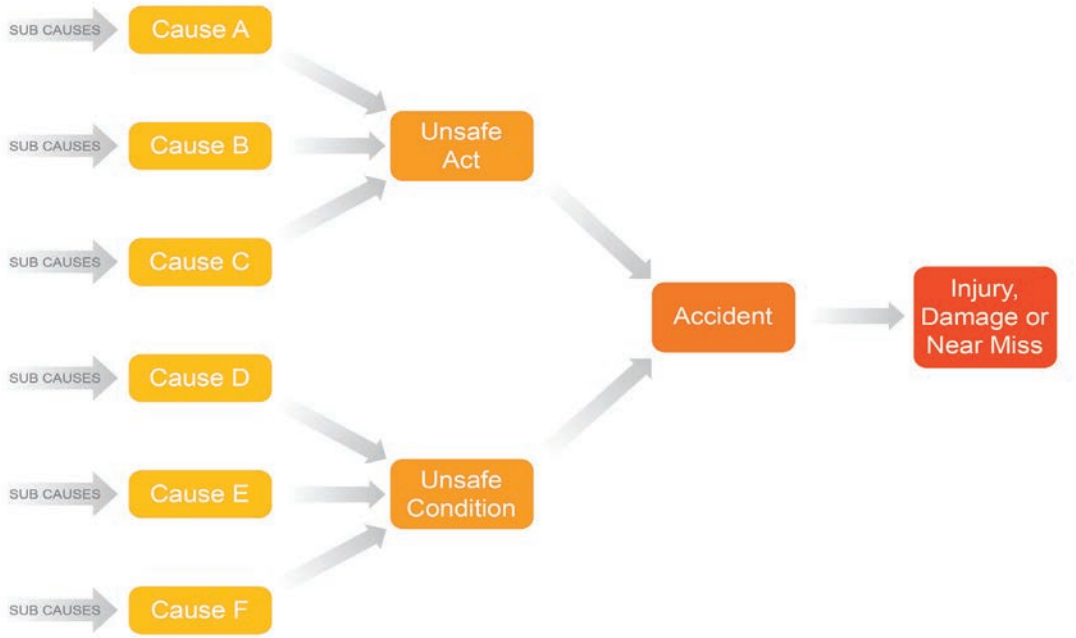
This is another way of looking at a multiple cause situation.

Factories and processes can be viewed as systems, i.e. an assembly of parts or components connected together in an organised way to perform a task, with inputs and outputs, and various kinds of control mechanisms.

A systems approach is often useful in simplifying complex operations. Part of the system can be taken as a 'black box', with only the inputs and outputs considered.

System failures are prevented or minimised by components which cannot fail, by backup systems, or by redundancy built into the system. Accidents happen in our system because it includes fallible components such as machines and human beings. The system is operating in the failure mode.

You can see the essential features of the multiple causation approach in the following figure.



Features of the multiple causation approach

Immediate, Underlying and Root Causes

There are various ways of classifying accident causes. Remember that the same term may be used by different people to mean different things – you can check this for yourself by doing an Internet search on the above terms.

When analysing accidents it is common to distinguish between immediate causes and underlying causes. The latter are also sometimes called root causes. The term used can vary, but the most important thing to remember is to look beyond the symptoms of the accident. You need to dig down beyond the obvious (immediate) causes to discover why it happened, or why it was allowed to happen. Usually, an accident occurs as a result of multiple chains of events; following these back will lead to underlying causes, tackling which can stop similar accidents happening again.

- **Immediate cause** refers to the direct cause of the accident, i.e. the actual agent of injury or damage, such as the sharp blade of the machine.
- **Underlying, or root causes** are the less obvious systemic, or organisational reasons for the incident.

We will now look at unsafe acts and conditions in more detail.

An **unsafe act** is human performance that is contrary to accepted safe practice and which may, of course, lead to an accident. **Unsafe conditions** are basically everything else that is unsafe after you take away unsafe acts. So, this is the physical condition of the workplace, work equipment, the working environment, etc. which might be considered unsafe and could therefore foreseeably lead to an accident if not dealt with.

Note that an unsafe act or unsafe condition alone could result in an accident. For example, "messing around" is an unsafe act which could take place in otherwise safe conditions, but could nevertheless result in an accident. Similarly, a person could be working in a perfectly safe manner, using safe equipment and materials, but suffer injuries as the result of the collapse of a floor affected by severe woodworm and dry rot. (You could argue, however, that collapse of the floor was due to an unsafe act, i.e. failure to inspect the floor and supporting joists and to calculate the floor loadings.)

According to the accident sequence we discussed earlier, unsafe acts and conditions are caused only by faults of persons, and these faults are created by the environment, or are acquired by inheritance.

The faults themselves generally arise because of inappropriate attitudes, lack of knowledge or skill, or physical unsuitability.

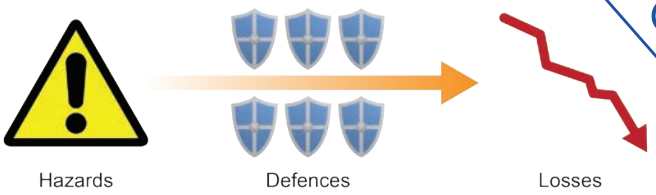
Reason's Model of Accident Causation

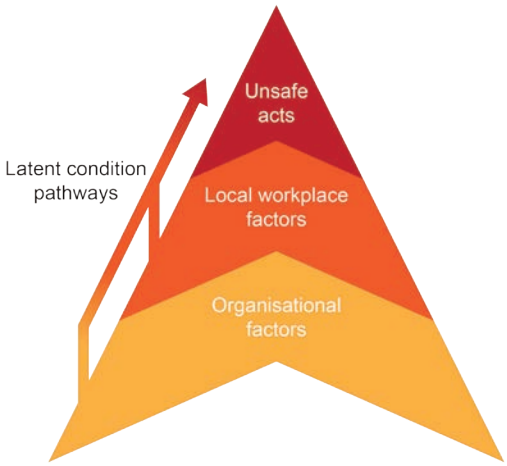
TOPIC FOCUS

Latent and Active Failures

Rather than using the words "immediate", "underlying" or "root" causes, the terms "latent" and "active" failures are also commonly used.

Following research into a series of disasters, **James Reason** (an occupational psychologist) has developed a model of accident causation for organisational accidents. An organisational accident is rare, but if it happens often has disastrous consequences (e.g. Piper Alpha, 1988). Reason's model shows that organisational accidents do not arise from a single cause but from a combination of active and latent failures.





Adapted version of Reason's model of accident causation

In the model there is a series of defence barriers between the hazard and a major incident. These not only prevent the incident (e.g. containment of the hazard, safe operating procedures, etc.) but also provide warning of danger (e.g. an alarm) and mitigate the consequences (e.g. means of escape). These multiple layers characterise complex technological systems, such as a chemical plant.

However, the barriers are not perfect and can be defeated.

(Continued)

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TOPIC FOCUS

Active failures are one cause for the barriers to be defeated.

Active failures are those unsafe acts which have immediate effects on the integrity of the system and are usually committed by those directly involved in the task. Such individuals often suffer directly as a result of the incident and may often be blamed as well. The cause of the failure will be due to an error (accidental) or a violation (deliberate). Such unsafe acts are made regularly but few will cause the defences to be penetrated, an example being the chemical plant operator who opens a valve allowing a hazardous substance to escape.

The model then shows that the local workplace factors influence the chance of an unsafe act occurring. In the case of the hazardous substance escape, this may be due to a lack of supervision or training, maintenance failure, unworkable procedures, etc.

According to the model, the local workplace factors are affected by decisions made at a strategic level by senior management, government, regulators, manufacturers, etc. In the case of senior management, this might be lack of recognition of the importance of occupational health and safety, which will be reflected in the culture of the organisation by the behaviour that is considered acceptable. The management may give safety a low priority with no commitment and minimal funding. These failures at the strategic levels, both in the organisation and the external environment, are described as **latent failures** because they remain dormant and possibly unrecognised until they interact with the local factors and the unsafe acts and work environments and increase the likelihood of an active failure.

When the gaps created by active failures align with those created by the latent conditions, the opportunity exists for a serious outcome.

Fault Tree Analysis (FTA)

In many cases there are multiple causes for an accident or other loss-making event - fault tree analysis is one analytical technique for tracing the events which could contribute. It can be used in accident investigation and in a detailed risk assessment.

The fault tree is a logic diagram based on the principle of multi-causality, which traces all branches of events which could contribute to an accident or failure.

A fault tree diagram is drawn from the top down (like an upside down tree). The starting point is the undesired event of interest (called the Top Event because it gets placed at the top of the diagram). You then have to logically work out (and draw) the immediate and necessary contributory fault conditions leading to that event. These may each in turn be caused by other faults and so on. Each branch of the tree is further developed until a primary failure (such as a root cause) is identified.

Event Tree Analysis (ETA)

Unlike identifying the root causes of an event under consideration, ETA is concerned with identifying and evaluating the consequences following the event. In FTA the main event is called the Top Event, whereas in ETA it is called the Initiating Event.

Event trees are used to investigate the consequences of loss-making events in order to find ways of mitigating, rather than preventing, losses. The stages involved in carrying out an event tree analysis are:

- Identify the Initiating Event of concern.
- Identify the controls that are assigned to deal with the Initiating Event such as automatic safety systems, and other factors that may influence the outcome such as wind direction or presence of an ignition source that would be important if there was an escape of a large amount of liquefied petroleum gas.

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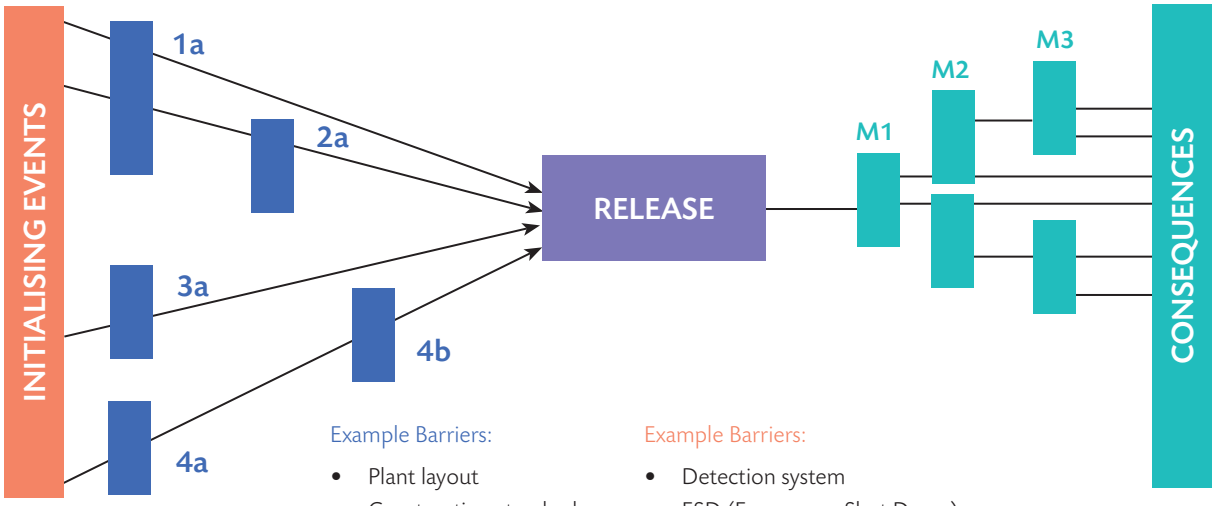
- Construct the event tree beginning with the Initiating Event and proceeding through the presence of conditions that may exacerbate or mitigate the outcome.
- Establish the resulting loss event sequences.
- Identify the critical failures that need to be dealt with.
- Quantify the tree if data is available to identify the likelihood or frequency of each possible outcome.

Bowtie Model

FTA is concerned with analysing faults which might lead to an event, whereas ETA considers the possible consequences once an undesired event has taken place. Both can be combined into a bowtie diagram (illustrated below), where faults (initiating events) lead to a critical event (a flammable gas release, for example). The critical event (release) then generates consequences which need to be mitigated through the use of barriers designed to prevent catastrophic fire and explosion.

The concept of risk control barrier models relies on placing barriers between the event and its results, or placing a barrier between the hazard and its realisation.

An example given by the UK HSE in the *Offshore Information Sheet No 3/2006* illustrates the concept of using barriers in a bowtie diagram, which represents all of the initiators of the scenario and the consequences. Between the initiators and the consequences, barriers are placed that should prevent, control, or mitigate the outcome of the event. In this case, such barriers are known as Lines of Defence (LOD) or Layers of Protection (LOP).



Based on Offshore Information Sheet No.3/2006, Guidance on Risk Assessment for Offshore Installations, HSE, 2006 (www.hse.gov.uk/offshore/sheet32006.pdf)

Reference numbers can be assigned to barriers which are common to several event initiators for a particular scenario (see barrier 1a in the diagram, which comes between two initiators and the release) as well as those common to several scenarios.

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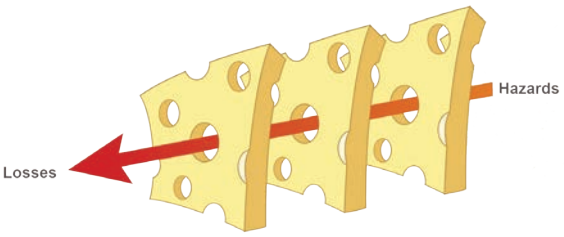
Swiss Cheese Model

In the Swiss Cheese model, an organisation's defences against hazards are modelled as a series of barriers, represented as slices of the cheese. The holes in the cheese slices represent weaknesses in individual parts of the system, and are continually varying in size and position in all slices. The system as a whole produces failures when holes in all of the slices momentarily align so that a hazard passes through holes in all of the defences, leading to an accident.



Swiss cheese barrier model

Behavioural Root Cause Analysis

Root cause analysis works back through the causal chain of an accident to identify the most basic preventable cause(s) that initiated the incident. If we use the simple concept that unsafe conditions and unsafe acts are the causes of accidents and that unsafe conditions are caused by acts or omissions of humans, then human failings become the predominant cause of accidents. The aim of behavioural root cause analysis is to identify the behaviours that led to the unsafe acts.

The models of accident causation we have already considered (linear and multi-causal) can be used to establish the causal chain. A simple method of asking 'why?' as the causal chain is investigated back to source will eventually come up with an unsafe act of behavioural origin. Tools such as fault tree analysis enable a multi-causal framework to be established with the human failings identified at the start of each branch of the causal chain.

Behavioural change programmes attempt to change individual worker behaviour by positively reinforcing desired behaviour and deterring undesired behaviour. The basic assumption is that in most cases unsafe acts are for rational reasons where persons are behaving in a way that will deliver potential rewards and usually ones that are soon, certain and perceived to be positive - in other words, 'temptations'. If the safe way is inconvenient, impractical or uncomfortable then making it as quick, comfortable and convenient as the unsafe way is an effective way of improving safety behaviour. We can call this "designing out temptation" and it generally proves far more effective than rule enforcement or disciplinary action.

Behavioural root cause analysis is an analytical tool designed to examine the unsafe acts and establish the underlying unsafe behaviours and the 'temptations' that triggered that behaviour. It aims to specifically examine the motivations for unsafe behaviour to identify the cues or triggers causing the behaviour and the consequences (or pay offs) that may result from the behaviour.

STUDY QUESTIONS

1. Outline the five factors in Heinrich's accident sequence.
2. How does Bird and Loftus' theory of accident causation differ from Heinrich's?
3. According to Reason, what in an organisation are "latent failures"?
4. What important principle of accident causation theory do accident ratio studies illustrate?

(Suggested Answers are at the end.)

Quantitative Analysis of Accident and Ill-Health Data

IN THIS SECTION...

- The amount of injury and ill health in a population may be described by calculating the accident/incident frequency rate, the accident incidence rate, the accident severity rate or the ill-health prevalence rate.
- Bar charts, pie charts and line diagrams can be used to represent incident data in a graphical format.
- Statistical variation within a population may be described using a normal distribution.

Calculating Loss Rates from Raw Data

In making comparisons between various industries, or between work areas in the same factory, it is useful to consider the commonly used injury ratios.

TOPIC FOCUS

Accident Frequency Rate

$$\frac{\text{Number of work-related injuries} \times 100{,}000}{\text{Total number of man-hours worked}}$$

It is a measure of the number of accidents per 100,000 hours worked.

Accident Incidence Rate

$$\frac{\text{Number of work-related injuries} \times 1{,}000}{\text{Average number of persons employed}}$$

It is a measure of the number of injuries per 1,000 employees measured over a defined period, e.g. a year.

Accident Severity Rate

$$\frac{\text{Total number of days lost} \times 1{,}000}{\text{Total number of man-hours worked}}$$

It is a measure of the average number of days lost per 1,000 hours worked and gives the average number of days lost per accident.

Ill-Health Prevalence Rate

$$\frac{\text{Total number of cases of ill health in the population} \times 100}{\text{Number of persons at risk}}$$

The calculation gives the percentage of the population with the disease.

DEFINITIONS

INCIDENCE

Reflects the number of new cases of a particular event in a population over a given time (e.g. a year) and is often used to describe accidents as each accident is a "new" event.

PREVALENCE

The total number of cases in a particular population as a proportion of the total population. It is often used to represent ill-health statistics and reflects not only new cases but also those who continue to suffer.

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Presenting and Interpreting Loss Event Data

Here we will look at some typical ways in which data can be presented.

Histograms

'Histogram' is the name given to a particular type of bar chart. It is the diagram used to illustrate a frequency distribution and it always has the following features:

- All the columns touch each other.
- Both axes have scales:
  - The horizontal axis carries the **variable** under consideration.
  - The vertical axis shows the **frequency** with which the values of the variable occur.
- The bars are all the same width but the values of the variable need not begin at zero, i.e. the first column of the histogram need not touch the frequency axis.

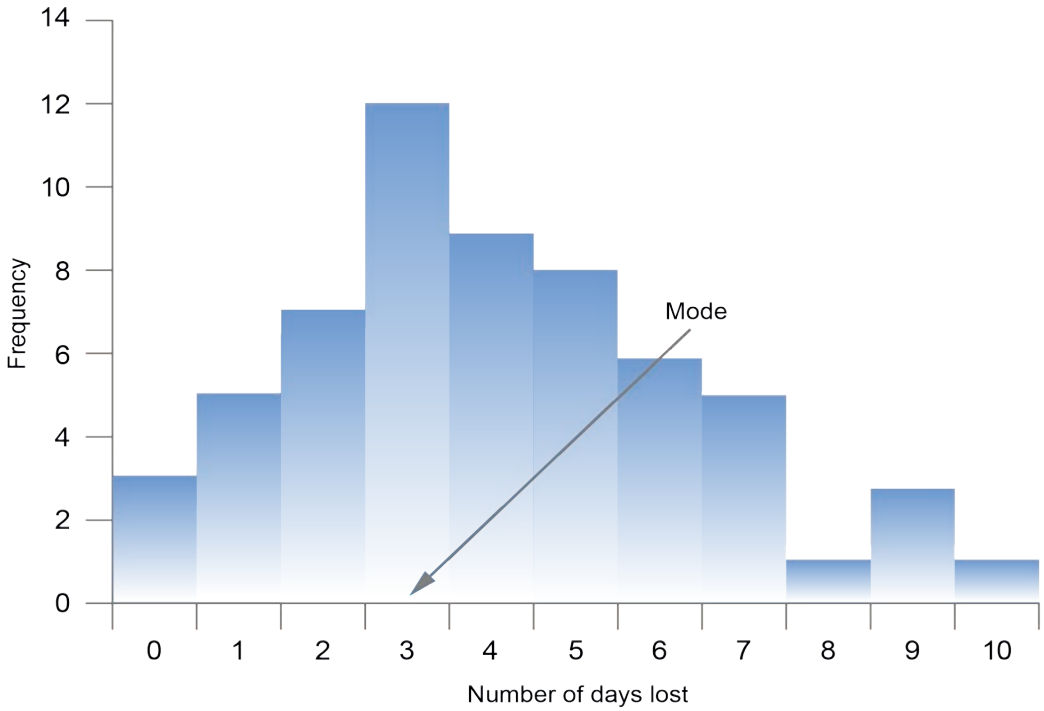
It can be useful to compare injury ratios

Example 1

The following table shows the **simple frequency distribution** of the number of days' absence caused by 60 lost-time accidents. (Columns 1 and 2 form the frequency distribution, columns 3 and 4 are calculated as shown from the frequency distribution.) The histogram (the next figure) is based on this table.

Days Lost per Accident

Days lost per Accident x	No. of Accidents Causing Lost-Time f	Man-Days Lost fx	Cumulative Frequency f_{cum}
0	3	0	3
1	5	5	8
2	7	14	15
3	12	36	27
4	9	36	36
5	8	40	44
6	6	36	50
7	5	35	55
8	1	8	56
9	3	27	59
10	1	10	60
Totals	60	247	-



Lost-time accidents causing specified no. of days' absence

(Note: The "mode" is the most popular frequency, i.e. 3 days.)

Example 2

When the variable can take a very large number of values, it is not practicable to construct either a frequency distribution or a histogram by the method given in Example 1; so we divide the values of x into a number of equal-sized groups and treat each group as a single unit. Such a distribution is known as a **grouped frequency distribution**. (If any calculations need to be carried out, the groups are represented by the value of x at the mid-point of each as a typical value.)

The following table shows the number of employees in the given age groups in an organisation that employs 300 people. The next figure is the histogram based on this table.

Number of Employees in Specified Age Groups

Age Groups	No. of Employees f	Cumulative Frequency f_{cum}	Mid-Points x
16-20	40	40	18
21-25	45	85	23
26-30	55	140	28
31-35	40	180	33
36-40	35	215	38
41-45	30	245	43
46-50	20	265	48
51-55	15	280	53
56-60	12	292	58
61-65	8	300	63
Totals	300	-	-

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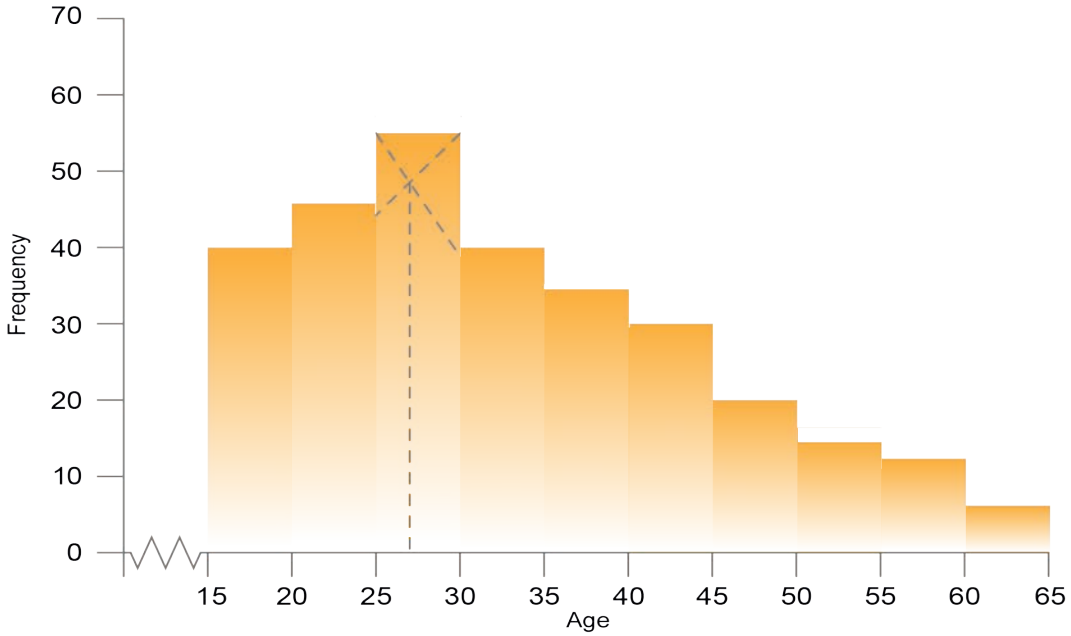
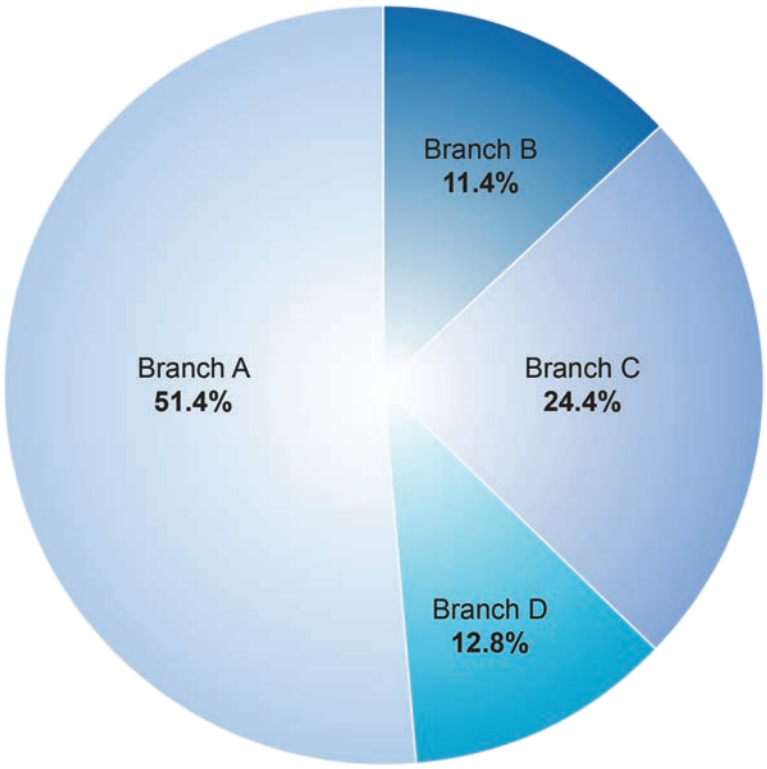


Number of employees in specified age groups

Pie Charts

These are circular diagrams, where the pie is divided into 'slices' representing the fractions into which the total of the variable is divided. To construct the diagram, the quantities must be converted into fractions of 360°. (The fraction is often expressed as a percentage.) The following figure is an example.

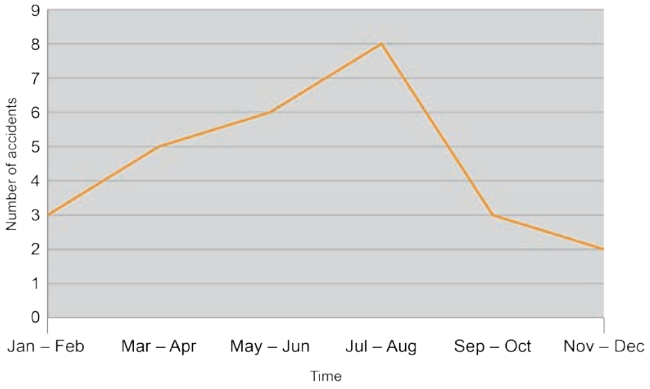


Proportion of lost-time accidents for each department

Line Graphs

Rather than using a bar chart or histogram the information can be displayed as a series of data points connected by straight lines.

The example below shows the number of accidents occurring in a year.



Number of accidents occurring in a year

Principles of Statistical Variability, Validity and the Use of Distributions

Statistical variability refers to the spread or distribution of a particular variable. Examples include:

- Height or weight of adults.
- Intelligence of people.
- Lifespan of a dog.
- Political views expressed before an election.
- Attitudes to safety in a workforce.

All of these display significant **variance**. For example, in a given population, relatively few people are extremely short or extremely tall, whereas many are "in between" these two extremes and are of "average" height.

What would we do if we wanted to answer the question: "*What is the height of an adult human being (from the UK)?*"

If we measured the height of one person chosen at random, then whoever we chose could not possibly give an indication of the variation in height displayed by adult human beings in a population of many millions. To get over this problem, we must collect a sample of sufficient size so that we can say that it is likely to be representative of the whole population. This means that the characteristics of the sample are more likely to reflect the characteristics of the whole population under study. In our example in which we are trying to determine the height of adult human beings, the sample should contain some short people, some tall people, approximately equal numbers of men and women, representatives of ethnic minorities, etc. If we make sure the sample is **representative** then there is a good chance it will provide an accurate indication of the average height of an adult human.

The **normal distribution** is actually a family of symmetrical distributions that have the same general shape (often described as bell shaped or Gaussian). This type of distribution tends to predominate in the 'natural' world, e.g. the heights, weights or intelligence of a sample of adults, the weights of a harvest of plums from a tree, the expected life of a batch of light bulbs, etc. You can see the shape of a typical normal distribution curve in the following figure.

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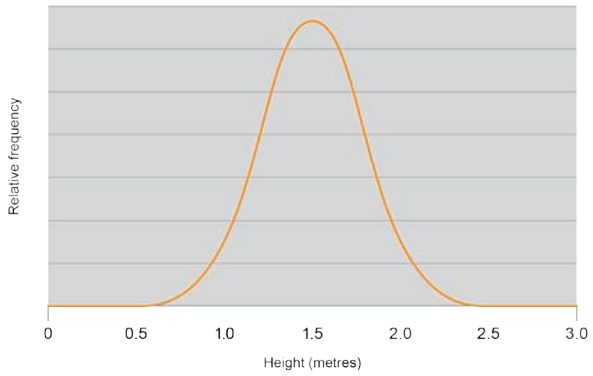

Example of normal 'bell-shaped' curve

The curve is symmetrical about the average value (or mean); the mean value coincides with the most common (or modal) value at the central hump and the distribution tails off either side of the hump.

This is the general shape you would expect to get if you plotted the numbers of people with a particular height (provided you had a large enough sample size). You would expect a symmetrical bell-shaped distribution about the average height of that sample of people.

The height of a normal distribution can be specified mathematically in terms of two parameters:

- The mean (μ) - where the curve is centred.
- The standard deviation (σ) - related to the spread/girth of the bell shape.

In general, a normal distribution (N) would usually be stated in the following shorthand format (the full equation is actually rather complicated):

$$N(\mu, \sigma^2)$$

σ^2, the square of the standard deviation, is known as the **variance**.

Normal distributions **all** share certain properties:

- Continuous data (i.e. data which can take any value not just integer (whole number) values).
- About 68% of the data values fall within 1σ of the mean (i.e. 1σ **each side** of the mean).
- About 95% of the data values fall within 2σ of the mean.
- About 99.7% of the values fall within 3σ of the mean.

So, if you have the mean and standard deviation for your data **and** your data can be modelled by a normal distribution, you can make predictions about it (using standardised normal tables). These predictions may concern the proportion of the population falling within a particular range of values or the probability of a randomly chosen item falling within a particular range. This is widely used in ergonomics (the science concerned with the 'fit' between people and their work), where much anthropometric data is assumed to approximate to a normal distribution – and data gaps are filled on this basis. An example of its use might be designing some protective equipment that might fit, say, 95% of the adult population. Use of this distribution would give you guidance on the range of fit that you would have to accommodate. This is provided, of course, the data approximates to a normal distribution.

You do, however, have to be cautious when interpreting statistical data. For example, before elections polling companies try to predict the outcome of the poll. It is not practical to ask everybody who is eligible to vote, so they have to identify a much smaller sample that is chosen at random, to ensure it is characteristic of the whole population eligible to vote. If the sample is suitably representative, then this should give a good indication as to the outcome of the election.

However, it is never possible to say with certainty whether or not the sample is perfectly representative of the population, so there is the opportunity for error. One cause of such error is the sample being too small and not accurately representing the range of features of the much larger population. The larger the sample, the better!

Two health and safety examples where the use of representative samples would be beneficial are:

- To design a chair ergonomically suitable for workers on a production line, we would need to have data relating to the physical features of workers, such as height, weight, length of leg, etc. so that the chair would be suitable for the majority of persons we might wish to employ and would not unfairly discriminate against those who do not have average characteristics.
- Organisations may wish to measure the safety climate, a feature which reflects the safety culture. If it was not possible to survey everybody then we could get a good indication by identifying and surveying a representative sample of the workforce.

STUDY QUESTION

5. In a factory with 20 employees, there were eight work-related injuries recorded over a period of a year. In a year, employees work for 38 hours a week for a total of 47 weeks. Calculate the accident frequency rate.

(Suggested Answer is at the end.)

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Reporting and Recording of Loss Events (Injuries, Ill Health, Dangerous Occurrences) and Near Misses

IN THIS SECTION...

- Requirements for reporting and recording certain loss events are set out in the ILO **Occupational Safety and Health Convention (C155)** and the accompanying **Protocol (P155)**. Employers should:
  - **Record** and **notify** occupational accidents, suspected cases of occupational disease, dangerous occurrences and commuting accidents.
  - **Inform** employees about the recording system and notifications.
  - **Maintain** records and **use** them to help prevent recurrence.
- Every organisation should maintain records of all significant incidents and have appropriate internal reporting procedures.

Reporting Requirements and Procedures

Article 11(c) of the **Occupational Safety and Health Convention (C155)** says:

> *"To give effect to the policy referred to in Article 4 of this Convention, the competent authority or authorities shall ensure that the following functions are progressively carried out:...*
>
> *(c) the establishment and application of procedures for the notification of occupational accidents and diseases, by employers and, when appropriate, insurance institutions and others directly concerned, and the production of annual statistics on occupational accidents and diseases;"*

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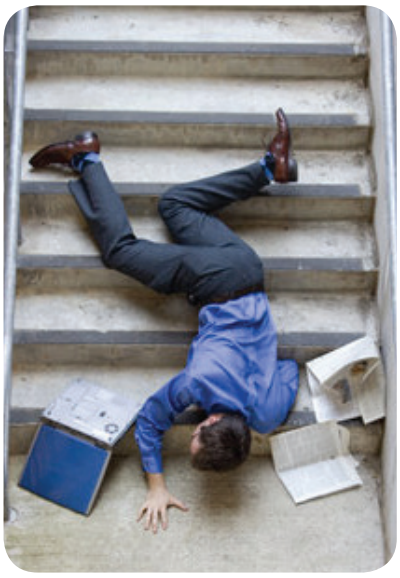

P155 deals with reporting requirements

The **Protocol (P155)** to the Convention (which must be ratified separately) is specifically aimed at reporting requirements. We will look at this and the accompanying ILO Code of Practice (**Recording and Notification of Occupational Accidents and Diseases 1996**) in what follows.

P155 defines a number of accident terms:

> *"(a) the term 'occupational accident' covers an occurrence arising out of, or in the course of, work which results in fatal or non-fatal injury;*
>
> *(b) the term 'occupational disease' covers any disease contracted as a result of an exposure to risk factors arising from work activity;*
>
> *(c) the term 'dangerous occurrence' covers a readily identifiable event as defined under national laws and regulations, with potential to cause an injury or disease to persons at work or to the public;*

(d) the term 'commuting accident' covers an accident resulting in death or personal injury occurring on the direct way between the place of work and:

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

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

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

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The basic requirements of P155 are that national governments should ensure that employers:

- **Record** and **notify** occupational accidents, suspected cases of occupational disease, dangerous occurrences and commuting accidents. The **minimum notification data** should comprise:
  - Enterprise, establishment, employer.
  - Person injured and nature of injury/disease.
  - Workplace, circumstances (accident/dangerous occurrence/disease).
- **Inform** employees about the recording system and notifications.
- **Maintain** records and **use** them to help prevent recurrence.

Notifiable diseases should at least include the prescribed diseases listed under ILO Convention C121. The schedule to C121 contains a list of diseases prescribed in relation to an activity, for which injury benefit should be payable. Examples include:

- Conditions due to physical agents and the physical demands of work, e.g. due to ionising radiation, vibration, noise.
- Infectious or parasitic diseases (in health, vet work, etc.).
- Conditions due to substances, e.g. silicosis, asbestosis; arsenic, chromium, lead poisoning; lung cancer and mesothelioma caused by asbestos.

The above examples are fairly typical of diseases which would be notifiable in many regions of the world.

Below are examples of some UK government notifiable occupational accidents and dangerous occurrences:

- Occupational accidents (fatal/non-fatal injuries), e.g. fatality, fracture of certain bones, amputation of certain joints, loss of sight.
- Dangerous occurrences, e.g. gas incidents (such as poisonings due to incomplete combustion), crane collapse, scaffolding collapse.

The ILO Code of Practice specifies a minimum recommended notification dataset:

- Enterprise/establishment/employer details:
  - Employer – name/address, telephone number.
  - Enterprise – name/address.
  - Establishment – name/address, economic activity, size (workers).
- Injured/diseased person:
  - Name, address, age, sex, employment status, occupation (also date of birth and length of service in cases of disease).
- Additional information:
  - For accidents:
    - Injury - fatal, non-fatal, nature (e.g. fracture), location (e.g. leg).
    - Accident and its sequence - location of place of accident, date and time; type, e.g. fall and related agent, e.g. ladder.

- For diseases:
  - Name and nature of disease and causative agent; work giving rise to exposure; duration of exposure (to agent/process); date of diagnosis.
  - For dangerous occurrences:
  - The same enterprise/establishment/employer details as before.
  - Dangerous occurrence details – date, time, location, type, circumstances.

UK arrangements for notifiable occupational accidents and dangerous occurrences require all work-related injuries and incidents to be reported by telephone or online reporting forms only.

An example of an official data collection form used in the UK for notifiable accidents can be found at:

https://extranet.hse.gov.uk/lfserver/external/F2508IE

Internal Reporting and Recording

Similar information as that kept for reportable incidents should be kept for minor injuries. The safety practitioner needs to design a suitable form to ensure that he gets the information that he needs for investigations. Reporting of near misses requires some careful thought. This could involve a report by the supervisor, or some sampling and interview technique.

Accident Investigation Records

Accident investigation forms are used to give management an objective tool for measuring and evaluating safety performance.

Format

The form is completed as a record of the investigation, but different work environments vary so much, that there is no such thing as a standard report form. Generally, the report form should include the following information:

- Name and personal details of the person who had the accident.
- Date, day and time of the accident.
- Where the accident happened, i.e. department and specific location.
- Occupation of the person involved.
- Job being done at the time.
- Nature of the injury or damage.
- What inflicted the injury or damage.
- Who had control of the cause of the injury or damage.
- What actually happened.
- What things caused the accident, i.e. physical conditions and acts of persons.
- Immediate remedial action.
- Recommendations to prevent the accident in future.

Use

Accident records are of no help if they are used only to count accidents. They should be used as a tool to help control the accidents that are causing the injuries and damage, and should provide the following useful information:

- The relative importance of the various injury and damage sources.
- The conditions, processes, machines and activities that cause the injuries/damage.
- The extent of repetition of each type of injury or accident in each operation.

- Accident repeaters, i.e. those workers who tend to be repeatedly injured, or are involved in more accidents.
- How to prevent similar accidents in the future.

Sample Forms

Here you can see four sample forms of the type you are likely to come across in your work:

- Supervisor's Report of Injury.
- Incident Investigation Report.
- Injury Report Form 1.
- Injury Report Form 2.

Supervisor's Report Form

Dept:_____ **Name:**_____

_____ **Date:**_____

Name of victim_____ Age_____ Sex_____

Date of injury_____ Time_____ Works No._____

Nature of injury_____

Where and how did accident occur?_____

Unsafe acts or conditions_____

Witnesses_____

Corrective/Remedial action_____

Recommendations_____

Supervisor's report of injury

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Incident Investigation Form

Employee (if involved)_____Works No._____

Department_____Section_____

Incident Date _____ Reported Date _____

DESCRIPTION OF INCIDENT (including location, witnesses, and circumstances surrounding incident)_____

_____

_____

_____

_____

Actual or possible causal factors_____

_____

_____

_____

Corrective/Remedial action_____

_____

_____

_____

_____

Signature_____Date_____

Supervisor's Name_____

Signature_____Date_____

Incident investigation report

Injury Report Forms

VICTIM: Name_____Works No._____Dept_____

Age_____Sex_____

Occupation when injured_____

Was this his/her regular occupation?_____If not, state regular occupation_____

How long employed?_____

ACCIDENT: Date_____Time_____Place_____

Description of how accident happened (include name, part, and plant number of machine or tool involved)

_____

_____

Was part of m/c causing accident properly guarded?_____

Type of feed_____Type of guard_____

Was employee following safety rules? _____

If not, why not?_____

Was injury result of lack of ordinary care?_____If so, how?_____

Did some other person cause the accident?_____If so, how?_____

How could recurrence be prevented?_____

INJURY: Describe injury and part of person injured

_____

Did victim resume work after medical attention?_____

If not, was he/she sent home or to hospital?_____

Home or hospital address_____

WITNESSES: Give name, number and department:

Name_____Works No._____Department_____

_____

_____

Name of foreman/chargehand _____

Name of immediate supervisor_____

ANY OTHER USEFUL INFORMATION:

Further description/cause of the accident together with sketch:

_____

_____

Completed by_____Position_____

Signature_____Date_____

Injury report form 1

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Name_____ Works No._____ Dept_____

Occupation_____ Date of injury_____ Time_____

Foreman/Chargehand_____

Nature of injury_____

Immediate cause of injury_____

Initial treatment_____

_____

Name of first aider_____

Signature_____ Date_____

Is further treatment required? **Yes/No** Victim sent **home/to hospital?**

Will injury cause loss of time? **Yes/No**

(Circle as appropriate)

Site of Injury	Head	Face	Eyes	Nose	Teeth	Chin	Ear	Neck	Throat	Arm	Elbow	Wrist	Hand
	Fingers	Thumb	Chest	Ribs	Back	Hip	Groin	Leg	Thigh	Knee	Shin	Ankle	Foot
	Instep	Toe	Shoulder		Abdomen								

Nature of Injury				
WOUNDS	Laceration	Contusion	Puncture	Foreign body
BURNS	Wet heat (scald)	Dry heat	Chemical	Friction

SKIN	Dermatitis
	Irritation
	Rash

FRACTURE
SPRAIN
STRAIN
PAIN
POISON
OTHER (detail):

Injury report form 2

Form Design

Accident forms should be designed to suit the work situation, and need to include information that is of use to the safety practitioner. Some ideas which are worth taking into account include:

- Requiring the reporter to state if the cause of the accident is:
  - Unsuitable working environment.
  - Physical unsuitability.
  - Lack of knowledge or skill.
  - Improper attitude.
- Requiring that six accident factors be stated:
  - The agency - the object or substance involved.
  - The agency part.
  - The unsafe mechanical or physical condition.
  - The accident type.
  - The unsafe act.
  - The unsafe personal factor.
- UK HSE booklets often identify causes found as a result of a detailed study. *Deadly Maintenance* was an investigation into maintenance accidents, and listed the causes as:

Absence of a safe system of work	46%
Defective or inadequate equipment	18%
Human factors or errors	13%
Poor design	4%
Unauthorised activity	5%
Management failure	6%
Not known	8%

Taking some of the above ideas, any accident or injury report form should at least require the person reporting an accident to say whether, in their opinion, the cause was:

- An unsuitable working environment.
- Lack of a safe system of work.
- Unsafe or inadequate equipment.
- Lack of effective instruction or supervision.
- Unsafe personal factors.

Computer Records

Use of personal computers has revolutionised the storage and manipulation of accident data.

Programs Available

The programs which are of most interest are:

- Database.
- Spreadsheet.

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A **database program** can be used to store accident data in a set format, then retrieve and analyse it. It can search through the whole of a year's company accident records and answer such questions as:

- How many employees had an accident on a Friday?
- How many accidents involved a broken arm?
- Who had accidents involving a power press?

A **spreadsheet program** is rather like a large sheet of graph paper, with many rows and columns, where a number or phrase can be put into each of the spaces. Columns or rows of numbers can be added, or calculations performed, using values in the table. The program can also produce graphs and other pictorial forms of information.

Computers have revolutionised storage issues and the manipulation of data

These programs can also be combined, with information and data being transferred from one to the other. A large company with a computer department would probably organise their own programs for accident statistics, but there are a number of commercial programs for the purpose in the UK which will accept accident records and produce the accident form F2508 for the HSE.

Preparing Data Input

It is only possible to retrieve and manipulate data which has been input first. Many programs will accept data directly from the keyboard. The person reporting the injury can be asked a series of questions, with the answers only involving choosing one item from a list.

There are advantages in having a special form completed for the purpose. Restricted access to the computer system maintains security of records. The written record can be retained as an additional safeguard.

The form must contain all the data required to prepare report forms for the regulator, and there would be certain items the employer would need, such as work area, job type, machinery used, work-in-progress, whether safety precautions were in place, whether personal protective equipment was being worn, etc. Care must be taken in the topics of "cause of injury" and "cause of accident" to avoid confusion and to get information which is useful later. A simple format requiring just a tick next to a statement is preferable.

STUDY QUESTIONS

6. According to Protocol P155, what should national governments ensure that employers do in relation to loss events?
7. Outline, with examples, the types of disease or ill-health conditions that should be reported.
8. What useful information can internal accident reporting and recording systems provide?

(Suggested Answers are at the end.)

Loss and Near-Miss Investigations

IN THIS SECTION...

- Useful guidance exists in the form of the UK HSE publication *Investigating Accidents and Incidents* (HSG245).
- Loss incidents should be investigated to identify the immediate and root causes, prevent recurrence, assist in any legal proceedings and identify any trends.
- An investigation includes examining the scene, evaluating relevant documentation and interviewing witnesses.

Implied Legal Requirements

Whether there are actual binding legal requirements for employers to investigate loss or near miss events will depend on the nature and content of the local legislation. However, there are other types of legal duty that employers may be subject to that can only be effectively discharged if some form of investigation takes place. These include duties associated with:

- **Risk assessment and review of health and safety arrangements**

  Investigating loss or near miss incidents provides information for the risk assessment and review process and is part of identifying hazards and assessing the adequacy of existing controls. The fact that a loss event or near miss has happened implies that controls could be inadequate and that improvements may be needed in the risk assessment process.

- **Statutory reporting of accidents**

  Where there is a legal duty to record and report accidents or other loss events, to provide the information required by a statutory reporting form will probably need some type of investigation, however basic.

- **Industrial injuries benefit or compensation**

  Where schemes exist to assist workers who have been injured in industrial accidents, any benefits or compensation awarded is likely to depend on the circumstances of the accident which can only be established through some process of investigation.

- **Common law duty of care**

  The employer has a moral duty of care for workers and this may well be embodied in the local regulatory framework as a legal duty. Accidents and loss events imply inadequacy in this duty of care which can only be explored and defended, if necessary, by accident investigation.

The UK HSE have produced a useful guide entitled *Investigating Accidents and Incidents* (HSG245) which we will draw on for guidance in this section. As well as identifying reasons and benefits for investigating accidents, it also outlines a four-step investigation process:

- Step 1: Gathering the information.
- Step 2: Analysing the information.
- Step 3: Identifying risk control measures.
- Step 4: The action plan and its implementation.

HSG 245: Investigating Accidents and Incidents

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Reasons for Carrying Out Investigations

Legal Reasons

As well as the implied legal requirements for employers to investigate loss events, there is the broad duty on employers and employees to take reasonable care of themselves and of others who may be affected by their acts or omissions. In health and safety, as in other sectors, everything is fine until something goes wrong, at which point someone usually has to be held accountable: "*If there's blame, there's a claim*". So accident investigation enables the employer to explore and defend, if necessary, the adequacy of their duty of care.

Accident investigation

Data Gathering

We can only act on the information we are given, irrespective of our position. As a safety practitioner, the way you gather your information will no doubt suit your requirements and your organisation. It is only after all the facts have been established that we can begin to interpret the results.

Many accidents may initially appear to be 'one-offs', but after looking at all the relevant information it may appear that there is a history of similar incidents, indicating a trend. It is important to look for existing or developing trends. For example, a spate of similar minor accidents could highlight a problem in an organisation that may be procedural, practical, or human in origin. If not treated, minor accidents could become major, so the ability to spot trends is an important skill.

Establishing Root, Underlying and Immediate Causes

The definition of "accident" includes much more than just those events that cause an injury. We wish to prevent all those events and occurrences that might have caused an injury or damage, as well as those which did. Within the wider concept of risk management, we are interested in the prevention of all losses. Here, we will mostly be concerned with injury accidents, but the wider concepts need also to be considered.

There will always be an **immediate cause** for an accident, but we are also interested in finding the **underlying and root causes**. This is why we need to consider the chain of events leading up to an accident; the domino effect of Heinrich's theory is a good example. Obviously, any remedy which starts at the earliest stages will not only prevent this accident but a lot of others that have the same underlying cause.

Accident reports tend to concentrate on "cause of injury", but the safety practitioner is more interested in "cause of accident". In the case of a multiple-cause accident, we need to consider at the very least if it involves an unsafe act, an unsafe condition and an unsafe person, and how these interact.

Since an incident could cause a fatality, a serious injury, a minor injury or just a near miss, all incidents should ideally be investigated. The purpose should be to find the cause, with the intention of preventing a recurrence, rather than to apportion blame. An injury usually involves some degree of blame falling on management, the supervisor, the victim and his/her workmates.

We can identify a number of purposes for conducting an accident investigation - the main ones follow.

The word 'cause' has an air of finality about it that discourages further investigation. If a pipe fails, for example, and the cause is said to be corrosion, we tend to think that we know why it failed. This may be true but it does not help us prevent further failures. We need to know the answers to many more questions:

- Was the material of construction specified correctly?
- Was the specified material actually used?

- Were operating conditions the same as those assumed by the designers?
- What corrosion monitoring did they ask for?
- Was it carried out?
- Were the results ignored?

And so on.

When analysing accidents it is common to distinguish between immediate causes and underlying causes. The latter are also sometimes called 'root causes' and there is some justification for a simple two-stage model. However, the HSE publication HSG245 *Investigating Accidents and Incidents* does make the following distinctions:

- **Immediate cause:** the most obvious reason why an adverse event happens, e.g. the guard is missing; the employee slips, etc. There may be several immediate causes identified in any one adverse event.
- **Underlying cause:** the less obvious 'system' or 'organisational' reason for an adverse event happening, e.g. pre-start-up machinery checks are not carried out by supervisors; the hazard has not been adequately considered via a suitable and sufficient risk assessment; production pressures are too great, etc.
- **Root cause:** an initiating event or failing from which all other causes or failings spring. Root causes are generally management, planning or organisational failings.

Consequently, you will find that the terminology used can vary but the most important thing to remember is to look beyond the immediate causes to the management-based failings that allowed the accident to happen.

Benefits of Carrying Out Investigations

Prevention of Recurrence

The purpose of the investigation and report is to establish whether a recurrence can be prevented by the introduction of safeguards, procedures, training and information, or any combination of these. Enforcement agencies look for evidence for blame. Claims specialists look for evidence of liability. Trainers look for enough material for a case study. Safety practitioners look to prevent accidents.

Improved Employee Morale

Employees will be more co-operative in implementing new safety precautions if they were involved in the decision and can see that problems are dealt with. Carrying out investigations provides a deeper understanding of the risks associated with work activities which is all to the benefit of the workforce. Blaming individuals is ineffective and serves to reinforce the concept that accidents and cases of ill health are unavoidable. Effective control measures, combined with adequate supervision, monitoring and management control will ensure that work activities are safe. Consequently health and safety investigations are an important tool in developing and refining the risk management system which protects the workforce. The process of carrying out an investigation is a demonstration of management commitment and is a sign of a caring employer.

Developing Managerial Skills

An effective investigation requires a methodical, structured approach to information gathering, collation and analysis. The findings of the investigation will form the basis of an action plan to prevent the incident from happening again and for improving your overall management of risk. This process is not exclusive to health and safety and can be applied to any unplanned event that poses a threat to the organisation. The managerial skills developed in investigating accidents and incidents are fully transferable and can be readily applied to other areas of the organisation.

Skills developed during an investigation can be applied to other areas of an organisation

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Investigation Procedures and Methodologies

Incident Report Forms

Incident report forms capture and store the data that you collect in an investigation and act as a systematic prompt for the investigation process. The amount of detail required from the investigation will depend on the:

- Severity of the outcome.
- Use to be made of the investigation and the report.

The report should be as short as possible, but as long as is necessary for its purpose(s).

The report is not expected to allocate blame, although some discussion of this is almost inevitable. Reports are usually 'discoverable' which means they can be used by the parties to an action for damages or criminal charges.

Whether the report is made on a standard form, or is specially written, it should contain the following information:

- A summary of what happened.
- An introductory summary of events before the incident in question.
- Root cause/immediate causes.
- Information obtained during any investigation.
- Details of witnesses.
- Information about injury, ill health or loss sustained.
- Conclusions.
- Recommendations.
- Costings.
- Support materials (photographs, diagrams to clarify).
- The signature of the person or persons carrying out the investigation.
- The date.

Standardised report forms should be kept at each workplace and used for each investigation. They should be returned to a central point for record-keeping and analysis.

It is important that supervisory staff at the workplace carry out preliminary investigations and complete a report, as they should be accountable for the work conditions and need to have personal involvement in failure (accident, damage or conditions causing ill health). This demonstrates their commitment and removes any temptation to leave 'safety' to others, who may be seen as more qualified.

The minimum requirement for accident recording will be established by your local/regional laws. We have already established the minimum data set recommended by the ILO, earlier in this element

Steps to Take Following an Adverse Event

The process of responding to an adverse event involves initial actions to deal with and assess the incident followed by a full investigation if this is considered necessary.

- **Emergency response**

  The first response to an incident is to take prompt emergency action, such as first aid and making the area safe.

- **Initial report**

  As a preliminary to any investigation the scene of the incident must be preserved as far as possible to safeguard any evidence and the names of the people, equipment involved and witnesses need to be recorded. The incident should be reported to a responsible person who will decide what further action is required.

- **Initial assessment and investigation response**

  For those accidents and dangerous occurrences that are reportable under your local/regional laws, this information must be notified to the enforcing authority.

  Details of the accident should be entered in an accident book and a decision should be taken on the scale of the investigation. If possible decide who will carry out the investigation, the resources required and brief the investigation team.

First-aid kit

- **Decision to investigate**

  The level of any investigation will be determined by the worst potential consequences of the adverse event and the likelihood of a recurrence. Note that the worst potential consequences of the adverse event is not the recorded outcome; a scaffold collapse may not have actually harmed anyone but would have the potential for fatalities or specified injuries if it happened again in the future.

  – **Minimal level investigation** - supervisor looks into the circumstances to learn any lessons which will prevent future occurrences.
  – **Low level investigation** - a short investigation by the line manager into the immediate, underlying and root causes to prevent a recurrence and to learn any general lessons.
  – **Medium level investigation** - a more detailed investigation by the relevant supervisor or line manager, the health and safety adviser and employee representatives which looks for the immediate, underlying and root causes.
  – **High level investigation** - a team-based investigation, involving supervisors or line managers, health and safety advisers and employee representatives. It will be carried out under the supervision of senior management or directors and will look for the immediate, underlying, and root causes.

The Investigation

If a full investigation is deemed necessary the following four steps set out a systematic and structured approach.

Step 1: Gathering of Relevant Information

Promptness

The best time to start an accident investigation is as soon as possible after the event. The less time between the accident and the investigation, the better and more reliable will be the information available. Facts will be easier to determine and more details will be remembered by those involved, while the conditions are more likely to be closest to those immediately before the accident.

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Equipment

Equipment required will depend on the circumstances:

- Photographic equipment – digital cameras allow rapid and easy storage and transfer of photographic evidence.
- Portable lights may be necessary if electricity is switched off or if the accident scene is in a poorly lit area in a confined space, such as a manhole.
- Sketchpad, pencils and measuring equipment.
- Record-keeping equipment including a notebook and possibly recording equipment.
- Sample collection equipment, such as jars or other containers which can be sealed to prevent loss, evaporation or contamination. Paper bags, plastic bags, envelopes and cartons may also be required.
- Tools for cleaning debris or spillages.
- Where explosive or flammable vapours and gases may be involved, portable gas/vapour detection equipment should be available. Similarly, where poisonous or radioactive materials may be involved, the appropriate detection equipment should be provided.

Inspection of the Scene

The first priority is to help injured people. You may also need to report the incident to your local regulator. For serious incidents, the site may need to be made safe but otherwise left undisturbed as a 'crime scene' pending an investigation by the police or a health and safety enforcement inspector.

Depending on the severity of any injuries or damage, the investigator should be present during clearing-up operations and reinstatement, or clues may be missed.

Failing this, the supervisor should take it upon him or herself to collect the necessary evidence but you cannot specify a routine because there are too many possible variations and circumstances. However, whatever situation the investigator has to deal with, there are certain things he or she will need, and there is a logical method of carrying out the investigation.

In the case of fire investigation, although not essential, it is helpful if the investigator can be present during the fire, or at least as soon as possible after it has occurred. The exact area where the fire started may be more obvious, although it may be obscured by smoke, and heat may prevent access to the building. The investigator may get useful information by watching the activities of the fire-fighters. He or she will also be able to photograph the course of the fire, which may subsequently prove useful.

An outline of a routine of investigation applicable in most cases, which can be modified to suit a particular situation, is as follows:

- Take a careful, detailed look at the scene of the accident from a distance, preferably from all sides, evaluating and noting:
  - The extent and severity of the damage.
  - Damage to surrounding property.
  - Environmental conditions, such as temperature, ventilation, humidity and illumination.
- Survey the accident site(s) to see if there are any obvious dangerous physical conditions that may have been responsible for the accident.
- In the case of spillages, splashes, or other escape of poisonous, explosive, flammable, or other dangerous material, it may be necessary to take samples for subsequent laboratory investigation.
- Where machinery or other equipment has been involved, it may be necessary to issue instructions prohibiting its use or repair until the investigation has been completed.

Interviewing Witnesses

Any investigation will involve people, and it is easy to upset them when asking questions about what has been done or what has not been done. However, casual remarks made during the site inspection may be revealing and the investigator should continue to talk to any personnel involved near the scene of the accident. This would be an ideal opportunity to explain that the object of the exercise is not to apportion blame or to criticise any individual, but to discover the causes so as to prevent a repetition.

The Inspector should talk to anyone near the accident

Types of Witness

There are three types of witness:

- The **primary witness** is the victim: only he/she will know exactly the events that led to the accident, and should be able to give a full account of his/her actions.
- The **secondary witness**, extremely rare in practice, is the eyewitness. The problem is that not many people really see the instant of an accident; their observations usually begin immediately after the accident has occurred.
- **Tertiary witnesses** are those who can offer a variety of corroborative statements regarding people's actions, or environmental information relevant to the circumstances surrounding the accident.

Putting the Witness at Ease

It is important to put the person being questioned at ease, and this can be done by explaining the purpose of the investigation (to discover the causes so as to prevent a repetition).

The witness will also relax if you encourage his or her participation and involvement in the exercise, by listening to any ideas he/she might have about possible preventive measures. An understanding and friendly manner is essential to obtain co-operation.

Remember that the witness must be reassured that the purpose of the interview is not to blame anyone, but to try to find out the cause and so reduce the possibility of a recurrence.

Interview Location

Where possible, interviews should be carried out at the scene of the accident, because it is generally easier for those involved to explain themselves clearly with the 'props' close at hand and be able to point out specific things and recall their actions related to specific locations.

Question Phrasing

It is a good idea to start all questions with **What, Where, When, How** or **Who**. Questions starting with Why will only put the witness on the defensive and possibly antagonise them.

Typical questions might be:

- **What** happened? **What** did you see? **What** time was it?
- **Where** were you at the time? **Where** was the victim?
- **When** did you realise something was wrong?
- **How** did it happen? **How** were you involved? **How** could it have been prevented?
- **Who** else was involved? **Who** else saw it? **Who** reported it?

What, where, when, how and who?

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Attitude

The question 'What happened?' often generates the best response and the investigator must listen, without interruption, to the witness's account of the accident. The investigator can always clarify any points at the end.

The investigator should be looking for the witness's version of the accident and should not disagree with any of the statements made or make any judgments on his/her evidence alone. After all, what a witness believes to have happened will depend to some extent on just how he/she perceived the situation, even though this might conflict with the actual facts of the matter.

Conclusion

When the witness has given their account of the accident, the investigator should repeat it to the witness to make sure that he understands it. This also allows the witness to add any details previously omitted or expand some points to make them clearer.

When the investigator and the witness are both satisfied that a true account has been given, the interview should end on a positive note by discussing any ideas the witness has regarding prevention of a similar occurrence. This will also help to reaffirm the purpose of the interview and ensure the witness's further co-operation, should it be needed.

Step 2: Analysis of Information

This involves examining all the facts, piecing them together to establish what actually happened and determining why it happened. This is often done to some extent while you are actually collecting data. As data comes in, you may start developing a theory of what you think may have happened. This theory may lead you to different areas of investigation (requiring more data). New data may result in a refinement of your theory until your theory is realistic enough to explain all the facts of the case. In general, you would achieve this by:

- Assembling all your data or evidence.
- Extracting the information that is relevant.
- Identifying any gaps – and following leads to fill those gaps.
- Discovering the immediate, underlying and root causes by systematically working through the event (there are systematic tools for this but simply asking 'Why' repeatedly is a good, simple method).

For systematic consideration of **all** possible causes and consequences in complex systems, you can use formal methods (e.g. fault tree and event tree analysis, 'cause and effect' (or 'fishbone') diagrams combined with 'brainstorming' methods).

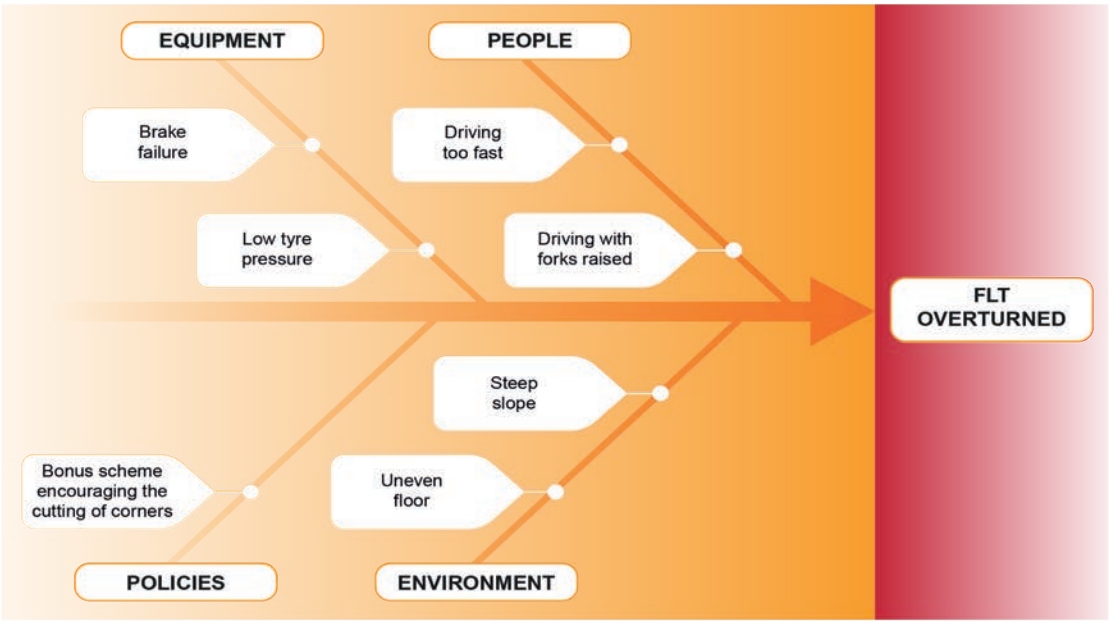
You may need a team-based approach.

Note on Cause-and-Effect Diagrams

A cause-and-effect diagram is an analysis tool, sometimes called a 'fishbone' diagram because of its basic structure. It is also known as an Ishikawa diagram, after the professor who developed the first one in the 1950s.

The purpose of a cause and effect diagram is to help people think through the causes of a problem thoroughly, considering all the possible causes rather than just the most obvious ones. It is often used in conjunction with a brainstorming session.

The following shows an example of a fishbone diagram applied to the problem of forklift trucks overturning.



Fishbone diagram: FLT overturn

Step 3: Identify Control Measures

Identify all possible control measures and then select the ones which are most suitable (taking account of reasonable practicability and the effectiveness of different control types). This may involve justifying selected controls using formal cost-benefit analysis.

Consider also the wider implications of an event. Is this an isolated event or is the same event waiting to happen on a similar piece of equipment in other parts of the plant or elsewhere? If so, do you need similar controls there, too, to prevent another occurrence?

Step 4: Plan and Implement

Plan what you have decided to do and do it. This will involve setting timescales (short-term versus long-term), allocating specific actions to individuals and checking that the proposed actions have actually been implemented.

Involvement in the Investigation Process

Who should carry out the investigation? Among those who may make an investigation are:

- The safety practitioner or one of his staff.
- A member of management.
- The supervisor, foreman or chargehand.

Managers

You will remember that many causes of accidents are due to management systems, or rather the lack of effective systems. The objective of any analysis or investigative report is to provide management with a means of deciding why their policies and procedures failed to prevent accidents, injuries and ill health. As it is management who ultimately make the decisions and allocate resources, it is vitally important that they are actively involved at every step of the procedures.

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Supervisors

Usually it is the immediate supervisor of the injured person, or the supervisor in whose department the damaged property belonged, who is better qualified to carry out the investigation than any other member of the management team, including the safety practitioner:

- He is likely to know most about the situation so is best suited to carry out the enquiries necessary for the investigation to reach a satisfactory conclusion.
- He should know his own workers better than anyone else does.
- He has a personal interest in establishing the causes of the accident because accidents affect the efficiency and morale of his department. He has to explain the consequences of work stoppage and personal injury to the members of his production team.

Employees' Representatives and Others

- Employees' Representatives

  Employees' representatives have the right to investigate both accident and ill-health incidents and this is usually carried out with approval of management.

- Safety Practitioner

  In the case of serious accidents, the immediate supervisor may not have the necessary authority to conduct the investigation, so the company safety practitioner should be in charge of the investigation, although he will find it helpful to have the assistance of the supervisory staff. It is essential that the investigator has the authority to go as far as is necessary to get to the cause of the problem.

Typical Investigation Procedure

Details about investigation procedure:

- Typically performed by the supervisor for the section; if it is serious, then he/she calls in specialists, such as the safety adviser or engineers.
- The supervisor or specialist should:
  - Discuss and write a report of events from the injured person.
  - Interview witnesses; check out any discrepancies.
  - Make sketches and drawings; take photographs.

Joint investigation by management and union safety representatives can be extremely useful. Often, an inspector will accept such a joint investigation as adequate, and attend later.

Communications Focusing on Remedial Actions and Lessons Learnt

Having investigated the loss event and identified the immediate and root causes and remedial action, it is important that the organisation learns from the event. Those involved in the same task or similar work associated with the loss event are likely to benefit most from the lessons learnt, and this might involve changes in the system of work, further training, etc. The method of communication will depend on the size of the organisation. Larger organisations may issue safety bulletins or newsletters or even have dedicated briefings on the incident.

MORE...

Investigating Accidents and Incidents - a workbook for employers, unions, safety representatives and safety professionals (HSG245) can be downloaded from the HSE website:

www.hse.gov.uk

STUDY QUESTIONS

9. What are the purposes of accident and ill-health investigation?
10. What equipment might be required in order to carry out an accident investigation?
11. What are the four principal stages of an accident investigation?

(Suggested Answers are at the end.)

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Summary

Theories/Models and Use of Loss Causation Techniques

In this element we have considered the various theories of accident causation, including:

- The **single cause domino theory**, in terms of which a number of factors need to be present in sequence for the injury to occur. If one factor is removed, the accident will not happen.
- **Multiple causation theory**, in terms of which there may be additional factors that must be present simultaneously for the accident to occur.
- **Reason's model of organisational accidents** which shows how latent (ongoing) failures increase the likelihood of active failures.

In accident ratio studies, the accident triangle shows that there appears to be a relationship between the numbers of different types of accident, e.g. fatal, major, near miss.

The underlying causes of accidents are unsafe acts and conditions:

- **Unsafe acts** are typically either deliberate violations or unintended errors.
- **Unsafe conditions** include those of mechanical and physical origin.

Quantitative Analysis of Accident and Ill-Health Data

It is useful to consider the commonly used accident and disease ratios, in order to compare injury and ill-health rates from different industries, or between work areas in the same workplace.

- Data gathered can be presented and interpreted in various ways, including: histograms, pie charts and line graphs.
- When working with statistical data, care must be taken to ensure that samples are representative of the relevant population of study.

Reporting and Recording of Injuries, Ill Health, Dangerous Occurrences and Near Misses

Requirements for reporting and recording certain loss events are set out in the **ILO Occupational Safety and Health Convention (C155)** and the accompanying **Protocol (P155)**. Employers should:

- Record and notify occupational accidents, suspected cases of occupational disease, dangerous occurrences and commuting accidents.
- Inform employees about the recording system and notifications.
- Maintain records and use them to help prevent recurrence.

Internal **reporting and recording** systems are also essential.

- Accident investigation forms are used to provide management with information for measuring and evaluating safety performance. Guidelines are given as to what information should generally be included.
- Accident records should be studied and analysed to gain information that can be used to help control accidents.

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Loss and Near Miss Investigations

Whether there are binding legal requirements for employers to investigate accidents will depend on the nature and content of local legislation.

We have considered various aspects of accident and ill-health investigations, including the purposes of investigation:

- Accident investigations are aimed at discovering the immediate, underlying and root causes of an accident.
- Safety practitioners are more concerned with the 'cause of accident' than 'cause of injury'.
- Discovery of underlying causes can help the introduction of practices that may prevent recurrence.
- Trends can be identified.

Exam Skills

Hopefully you coped really well with the practice question at the end of Element IA2. It's important to complete as many exam-style questions as possible so that you develop a really good exam technique.

Your question for Element IA3 is as follows:

QUESTION

Witness interviews are an important part of the information-gathering process of an accident investigation. **Describe** the requirements of an interview process that would help to obtain the best quality of information from witnesses.

Approaching the Question

As before, using good exam technique you should:

- Read the question.
- Consider the marks available. Again there are 10 marks available so you should spend around 15 minutes answering the question and provide around 12 different points of information.
- Next you need to highlight the key words; with this question the key words would include – describe, information-gathering, interview process, obtain, information, witnesses.
- An outline plan might include - issues around timing; environment; atmosphere; listening, etc.

Suggested Answer Outline

The following are important factors that the examiner might expect you to consider (note that these are examples only and there may well be other points you could cover):

- Planning the interview:
  - Timing of the interview - as soon as possible after the incident in order to preserve the evidence, and ensure an accurate recollection of events. However, the witness must be in a fit state to be interviewed (e.g. they may be traumatised or injured).
  - Location of the interview - calm and non-threatening (e.g. not the director's office, or in public view in the canteen), free from disruptions, distractions, e.g. noise, and with water available.
  - Introduce all the persons involved in the interview.
  - Interview witnesses one at a time to prevent accounts from becoming confused or influenced by the opinions of others.
  - If appropriate, offer the interviewee a witness or person to accompany them in order to put them at their ease, such as a union representative or friend.
- During the interview:
  - Make clear the purpose of the interview at the outset, so that the witness appreciates that the intention is to prevent recurrence, not to apportion blame.
  - Provide an overview of the process that will be followed so that the witness knows what to expect.
  - Develop a rapport with the witness by adopting a calm approach. Use questions which will help you understand the incident and not apportion blame.
  - Keep an open mind as to the causes of the incident and do not be hindered by hindsight.

  - Set the scene for the interview in order to find out what the witness actually saw/knows, not what they think they know from later discussions. For that reason it is often useful to start the interview with questions around the build up to the incident.
  - Take notes to record the interview and clarify/summarise throughout to check understanding. It may be possible to use recording devices such as video cameras, but these may make the witness uneasy.
  - Use open questions, such as "tell me about..." or "what happened...?" rather than leading or closed questions with yes/no answers.
  - When listening to an answer don't interrupt but allow the witness to talk. Use active listening techniques to demonstrate that attention is being paid, such as clarifying a point that has been made.
  - It may be beneficial to have photographs, plans, etc. for the area to hand to aid the discussion, together with resources such as flip charts for sketching/recording.
  - Use language that is easy to understand and not reliant upon technical terms or jargon.
- After the interview:
  - Summarise and agree the interview.
  - Tell the interviewee what will happen next, e.g. when the findings will be published.

This is a great question because it is not difficult to expand the bullet points, but remember that there are only 10 marks available and you have 15 minutes in which to complete your answer.

In a full answer you would need to ensure that you had **described** the meaning of the bullet points. Unfortunately many candidates lose marks by not taking account of the command word and providing too brief a response.

Example of How the Question Could be Answered

Following an accident you would need to investigate witnesses of the events to establish the facts; to do this you need to undertake an interview of the witnesses.

The process should take place in a non-confrontational manner, as soon as possible after the event, to keep the facts fresh and untainted by others' accounts/recollections.

The room itself should be somewhere that is non-threatening, i.e. not the manager's office, and should start in a relaxed manner with an introduction of why the interview is taking place and the need to establish facts to prevent re-occurrence of similar type of incidents in the future, and learn from what went wrong and why.

Questions should be open, to get responses which give information to the interviewer; the interviewer should allow witnesses time to answer questions and avoid interruptions and putting words into their mouth. The interviewer should have an open mind about the incident and make sure they listen sympathetically; sometimes they may need to highlight that they aren't the best person to interview the witness as they may be part of the causal factors of the incident.

Pen, paper, plans, documents, etc. should be available to talk about/discuss at interview, as well as for the interviewer to use to capture the facts. The interviewer should clarify what they think the witness has said or meant, because things often get mistaken in the process.

The language used should be appropriate to the incident; summarise the interview and let the interviewee know that they can always come back later with anything else they may remember about the incident.

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Element IA4

Measuring and Reviewing Health and Safety Performance

Learning Outcomes

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

1. Explain the purpose and use of performance measurement in relation to health and safety objectives and arrangements.
2. Explain the need for, and the objectives and limitations of, health and safety monitoring.
3. Describe the variety of health and safety monitoring and measurement techniques.
4. Explain the need for and process of reviewing health and safety performance.

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Purpose and Use of Health and Safety Performance

IN THIS SECTION...

Performance measurement serves several purposes:

- To establish whether health and safety objectives and arrangements have been effectively implemented, including the adequacy of control measures, by using key performance indicators.
- To provide information for the review process, which looks at the effectiveness of the entire health and safety management system and recommends changes that lead to improvement.
- To measure and reward success.
- To maintain and improve health and safety performance.

Meaning of Health and Safety Performance Measurement

In order to manage health and safety successfully there needs to be some measure of performance. Health and safety performance measurement is a critical part of the management system. Checking that risks are being managed in an organisation is a vital step and is essential to demonstrate that enough is being done to keep on top of health and safety and to identify how things could be improved in the future.

One response to the question: "*Why measure health and safety performance?*" is: "*How else will you know how well you are doing ?*" If you do not measure performance, you will have no idea of how far away you are from where you want to be, and whether your plans are actually working.

The purposes of performance measurement include to:

- Assess the effectiveness and appropriateness of health and safety objectives and arrangements in terms of:
  - Hardware (plant, premises, substances).
  - Software (people, procedures, systems).
- Measure and reward success (not to penalise failure).
- Use the results as a basis for making recommendations for a review of current management systems.
- Maintain and improve health and safety performance.

MORE...

www.

You will find the following two HSE guidance documents excellent background reading for this topic:

- *Managing for Health and Safety* (HSG65), available at:

  www.hse.gov.uk/pubns/books/hsg65.htm

- *Plan, Do, Check, Act – An introduction to managing for health and safety* (INDG275), available at:

  www.hse.gov.uk/pubns/indg275.pdf

Measuring health and safety performance provides information on the progress and current status of the strategies, processes and activities used by an organisation to control risks to health and safety. It sustains the operation and development of the health and safety management system, and the control of risk, by:

- Providing information on how the system operates in practice.
- Identifying areas where remedial action is required.
- Providing a basis for continual improvement.
- Providing feedback and motivation.

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Need for Active and Reactive Measures

Active means '**before it** happens', while **reactive** means '**after it** has happened'.

- Active monitoring provides information on compliance with predetermined standards and can be used as a predictor of future performance.
- Reactive monitoring relies on past data on loss-causing events and therefore only provides a historical picture of performance.

No single measure, by itself, will effectively measure the performance of the organisation. While we will be favouring the use of active monitoring, there is still a role for the reactive monitoring of accident and ill-health data.

What is important is to find some factor that can be measured which will relate directly to a specific objective in the safety policy, arrangements or control.

Meaning of Key Performance Indicators

Key Performance Indicators (KPIs) are quantifiable measures that an organisation can use to assess the degree to which strategic and operational goals have been met. They focus on aspects of performance that are the most critical for the current and future success of the organisation. To be effective they need to be measured frequently, should be easy to understand in terms of corrective action that needs to be taken, and of relevance to the senior management team.

The choice of KPIs depends on what is important to the organisation, but examples that might be used as a measure of health and safety performance include:

- Employee perception of management commitment.
- Number of safety inspections for the month.
- Number of non-conformances with legal or internal standards in safety inspections.
- Percentage of attendance at health and safety committee meetings.
- Percentage of health and safety committee recommendations implemented.
- Percentage of issues raised by health and safety representatives actioned.
- Percentage of staff with adequate occupational health and safety training.
- Total of hours in safety and health training in the month.
- Lost time due to accidents.

Attendance at a meeting can be used as a KPI

The important point is that the KPI should relate to a significant aspect of health and safety performance; those listed above provide measures of management commitment, and the effectiveness of the inspection system, health and safety committee and the training programme. Lost time due to accidents is also included as a reactive indicator but we will cover the limitations of accident data as a performance indicator later.

Types, Benefits and Limitations of Leading and Lagging Indicators

Leading Indicators

Leading indicators involve precursors that may lead to an accident, injury or disease. They focus on improving health and safety performance and reducing the probability of serious accidents. They can be used to monitor the effectiveness

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of the health and safety management system before accidents, incidents and failures happen. They can also be used to prevent or control their occurrence.

Leading indicators measure activities carried out to prevent and control injury. Examples include:

- Percentage of required process hazards analyses completed in a required time frame.
- Proportion of employees who have access to occupational health services.
- Percentage of tests of safety critical equipment completed within a required time frame.
- Number of field visits and communications carried out.
- Number of observations of behaviour and inspections conducted.
- Percentage of required risk assessments carried out.
- Percentage of required training completed.
- Percentage of incidents investigated with corrective actions applied.

Leading indicators are focused on future safety performance and continuous improvement. They are proactive in nature and report what is happening on a regular basis to prevent injuries. Consequently they should:

- Be predictive.
- Highlight even small improvements in performance.
- Measure positively **what is being done**, rather than negatively **what is failing to be done**.
- Generate frequent feedback.
- Make it clear what needs to be done to lead to improvement.

Lagging Indicators

Lagging indicators measure loss events that have already occurred. They quantify an organisation's safety performance in terms of past incident statistics such as numbers of incidents, reported accidents, incidences of disease or failures of systems. Most industries use these indicators as a measure of the outcomes of their management of health and safety. However, they provide insufficient information to ensure the success of the health and safety management process since they promote reactive rather than proactive management.

A reportable incident is a lagging indcator

Lagging indicators measure a company's incidents in the form of past accident statistics. Examples include:

- Injury frequency and severity.
- Reportable incidents.
- Lost workdays.
- Worker's compensation costs.

Lagging indicators are the traditional safety measure used to indicate progress toward compliance with safety rules. They evaluate the overall effectiveness of safety by crudely measuring how many people have been harmed or what things have gone wrong. The main limitation of only using lagging indicators of safety performance is that they tell you what has gone wrong, but not how well the organisation is doing at preventing the occurrence of incidents and accidents. The reactionary nature of lagging indicators makes them a poor measure of prevention. A low injury rate can generate complacency when there are still plenty of risk factors in the workplace to contribute to future injuries.

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Benefits and Limitations

Companies aiming at high standards of health and safety use leading indicators to drive continuous improvement. Lagging indicators measure failure; leading indicators measure performance, and that is what needs to be measured.

Leading indicators highlight the positive aspects of an organisation and help to confirm that correct procedures are in place. Conversely, lagging indicators highlight the number of negative issues that have occurred in an organisation, such as the number of accidents or fatalities. Another key difference is the fact that leading indicators tend to be very specific, focusing on particular aspects of a health and safety management system, whereas lagging indicators are non-specific since the number of accidents or fatalities that may be reported could be due to all sorts of causes which the indicator does not specify.

Assessment of the Health and Safety Objectives and Arrangements

Assessing effectiveness of health and safety performance implies that we must first have both something that can be measured, and some goal or standard against which to judge that measurement. As we mentioned in Element IA1, health and safety management system models all require a policy statement. This policy statement should be spelt out in clear objectives. At the very least it should commit the organisation to compliance with legislation (such as may be implemented in accordance with the ILO **Safety and Health Convention**). It should also commit to continual improvement.

We need to set objectives in terms of things that can be measured. A common statement is, "*If it cannot be measured, there is very little chance that it will be done*", so we need to state objectively what we mean.

Safe handling and use of substances

TOPIC FOCUS

A useful acronym to remember when setting objectives is **SMART**. Good objectives need to be:

- **S**pecific - as to what you want to achieve.
- **M**easurable - so you know if they have been met.
- **A**chievable - attainable.
- **R**ealistic - realistically achievable with the resources you have.
- **T**imely - set a reasonable timescale to achieve them.

In many regions of the world there are legal standards for chemical contaminants and dust levels, and for noise. The exposure to some chemicals must be kept as low as possible, and must not exceed a certain level. The safety objective could be set lower than this standard. We then have an objective to aim for. If we achieve this consistently, an even lower standard can be set. In this way, we comply with the requirement to reduce the level to as low as possible.

Similarly, equipment will need to be tested periodically. For each piece of equipment, the type of test, the frequency of testing, and the standard can be laid down.

It is possible to create standards with regard to training. Good practice dictates that certain jobs should only be performed by qualified or experienced workers. Refresher training and perhaps even re-testing can be used to make sure that practical skills are maintained. For example, first-aid qualifications must typically be renewed at specified maximum intervals, e.g. every three years or so.

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Measuring Performance Against Objectives

When setting objectives, we have to consider performance standards and indicators. It is easy to set and measure production standards and there are also standards that can be set for safety and health. Safety sampling and similar techniques can be used. The UK's HSE document **HSG65** suggests the use of two measuring systems with the main purpose of measuring and rewarding success, not penalising failure:

- **Active** systems, which monitor the achievement of objectives and the extent of compliance with standards. Examples would be monitoring the safety of plant and equipment; compliance with safe systems of work; safe behaviour by employees.
- **Reactive** systems, which monitor accidents, ill health, incidents and other evidence of deficient health and safety performance, such as hazard reports. Investigations into accidents should determine underlying causes; weaknesses; any need for training; and changes or replacement required in machinery, substances or working methods.

Arrangements for Actioning Objectives

Performance measurement involves an assessment of the effectiveness and appropriateness of these organisational matters. If they do not work, they need to be made to work.

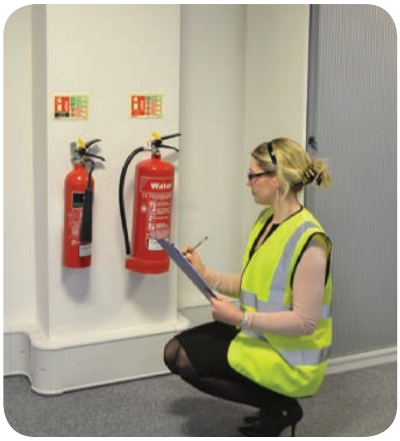
If each person in the safety organisation has a job specification and a list of tasks and duties, and there are expectations of achievement, then it is possible to measure how effectively these people have performed. What is needed is some form of '**measurement by objectives**'.

Periodically, there will be a review procedure and those who are filling a post but not performing a role may need to be replaced. The safety committee (if you have one), should consist of active members. If something needs to be done, then it should be made the clear responsibility of an individual. There is then a standard to measure performance, so the committee is more than just a 'talking shop'.

The term "arrangements" can also mean everything that is stated in this section of the employer's safety policy. The arrangements section usually includes such topics as:

- Accident reporting.
- Fire precautions.
- Training.
- Contractors and visitor arrangements.
- Dealing with any hazards in the operation (i.e. control measures).

Safe methods of work and permit-to-work schemes would also be detailed.



Checking fire safety equipment

Control Measures

An assessment of the effectiveness and the appropriateness of the control measures of a company is another important area of performance measurement, although this may not be so easy to measure accurately. Someone has to be in control of the organisation, but this control also has to be delegated. Since one person is usually not able to complete the whole task of achieving the safety objectives, it will have to be divided up and some degree of control exercised:

- The **formal control system** can be either authoritarian or consultative. To be effective, each person needs to know those areas where he must conform to a predetermined plan and those areas where he can exercise some discretion.
- There will also be an **informal control system**, where working groups establish and enforce the group norms. The ideal situation is where the individual and group targets coincide with the organisational targets.

Measurement of the degree of control is probably best achieved by systematic reviews:

- A supervisor would carry out some form of **daily assessment**.
- The sectional manager would need to hold a **monthly review**.
- A **quarterly review** might be appropriate for a department.
- An **annual review** would be appropriate for the whole organisation.

Control will involve a review of performance, and the setting of modified objectives for the next period of time. It is also the time to consider possible conflict situations and how these might be resolved, and any communication problems.

Review of Current Management Systems

The UK HSE publication, *Managing for Health and Safety* (HSG65), details the Plan, Do, Check, Act method of safety management that should be adopted.

We are concerned here with the elements of measuring (Check) and reviewing performance (Act), key elements in any system of management. To manage anything, including health and safety, we must have objectives or a policy which sets out what we hope to achieve. We then construct a suitable organisation and put the plan into effect.

After a suitable time interval we have to review performance; either we have achieved what we set out to do, or we have failed. This requires review against the performance measures already established. If we have achieved our objectives, we can congratulate ourselves and set more demanding objectives for next year. If we have failed, we must find out why:

- Were the objectives impracticable?
- Were resources not available?
- Was the safety practitioner incompetent?
- Should he or she be replaced?
- Should we increase the safety budget?

Every element of the management system can be audited or examined in detail. We require a system that is continually being improved.

A management system for health and safety should be in existence. The one suggested in HSG65 is based on the Plan, Do, Check, Act cycle so production managers should be used to operating along similar lines.

Management systems need periodic reviews

The safety practitioner needs to be in a position to recommend that safety matters, and risk management principles, are incorporated into the company management systems. The idea that good management involves accident prevention and loss prevention is a very sound one. This might involve adding safety and health objectives to a list of production objectives for each manager.

The integration of production and safety makes for a profitable and cost-effective organisation. You should be aware of the cost of accidents. If accident costs and other losses are deducted from any bonuses paid or credited to production managers, then the safety message is established and the safety culture of the organisation is assured.

STUDY QUESTION

1. List three purposes for performance measurement.

(Suggested Answer is at the end.)

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Health and Safety Monitoring

IN THIS SECTION...

- Monitoring requires a combination of both active and reactive measures to assess whether the health and safety objectives have been met.
- Active measures check that health and safety plans have been implemented and monitor the extent of compliance with defined systems, procedures, legislation and standards, e.g. routine inspections.
- Reactive measures analyse data relating to accidents, ill health and other loss causing events.
- Accident and ill-health data may not be wholly reliable:
  - Some incidents may not be reported.
  - Infrequent events may not reflect the effectiveness of current arrangements.
- Data may be qualitative (described by words), quantitative (described by objective numbers), subjective (based on personal opinion) or objective (unbiased and factual).

Objectives of Monitoring

TOPIC FOCUS

Objectives of Active Monitoring

The objective of active monitoring is to check that the health and safety plans have been implemented and to monitor the extent of compliance with:

- The organisation's systems and procedures (check that practice reflects the written procedures).
- Legislation and technical standards.

By identifying non-compliances, steps can be taken to ensure that any weaknesses are dealt with, so maintaining the adequacy of the health and safety plans, and helping to avoid any incidents.

Active monitoring checks that plans are implemented

Objectives of Reactive Monitoring

The objective is to analyse data relating to:

- Accidents.
- Ill-health situations.
- Other loss-causing events.
- Any other factors which degrade the system.

It is better to identify, and deal with, any potential problems by means of active monitoring, rather than waiting for an event to happen to highlight any shortcomings in the systems.

Limitations of Accident and Ill-Health Data as a Performance Measure

Accidents should be rare occurrences, and there are not all that many cases of illness and disease caused by the work environment. This means that there are not many cases to count, and the numbers may not be regarded as statistically significant.

Variations from year to year might be due to pure chance rather than any accident reduction measures that have been introduced. This is why we often resort to national statistics or even international data in order to find significant numbers to target safety programmes.

If we keep data for many years, it is possible to iron out these fluctuations by finding the moving average. As we get another year's, or month's, figures, we are able to enter this into the average and so identify a trend.

Accident statistics tend to reflect the results of actions which were taken some time ago, so there is not a rapid cause and effect situation. It is also unfair to blame a manager for accident situations when the present situation is, to some extent, dependent on actions taken a while ago, and the present actions will take some time to show. Cases of occupational disease are, by their very nature, long-term effects.

Using accident data as a performance measure

Accident data is relatively easy to collect. Serious injuries are quite difficult to hide. There is a number of standard calculations of accident rate which are fairly easy to understand. Management can easily link accidents with safety performance, so it should not be difficult to discuss accident reports, and get management to take action.

Accident recording therefore has some value, but it is of limited use in relation to assessing future risk. There are problems with under-reporting of minor accidents. Time off work does not correlate well with the severity of an injury, because some people will work with a broken arm, while others take a week off with a cut finger. Also, if the workers are made aware of safety matters, they tend to report more accidents. The picture may then look worse, when actually the safety culture is improving.

Distinctions Between, and Applicability of, Performance Measures

Active/Reactive

Active means 'before it happens', while **reactive** means 'after it has happened'. Measuring safety performance by looking for things before they happen can never be easy, but this is what the law requires. We carry out risk assessments to decide what might happen and then take action. We can certainly measure whether we have taken action in those areas where the risk assessment suggests that we do. If an accident occurs then we can no longer suggest that this is improbable; it needs to be included in the risk assessments.

Objective/Subjective

- **Objective** means that it is detached from personal judgment. For example, an audit question, such as: "*How many enforcement notices have been issued to your company in the last 12-month period?*" does not depend on the personal judgment of the auditor. However, a poorly phrased objective measure can distort your view by not taking account of the context and all the circumstances of the case. Objective measures are always desirable but are not always possible; some things, or facets, resist objective measurement.

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- **Subjective** means that it depends on someone's opinion, judgment, bias or discretion. As a result, the person carrying out the measurement will influence the measurement result. Questions like: "*Is housekeeping adequate?*", with no defined standard of adequacy, might get different results from different auditors.

An example of a relatively, though not totally, objective audit system relating to contractors was described a few years ago - the principles are still relevant. The system involved a statement, the contractor's response, the audit comment, and a score.

The form used was something like the one in the next table. The scores are:

1. Totally unsatisfactory.
2. Very little action - unsatisfactory.
3. Some reasonable action - but could be better.
4. As required.

Other scoring systems could be used.

Example of Objective Safety Scores

Item	Statement or Question	Contractor's Response	Audit Comment	Mark
12	Workforce to be trained in use of fire-fighting equipment	Agreed	Less than expected	2
13	Safety helmets to be worn at all times when on site	Agreed if provided by owner	Satisfactory	3
14	Contractors to wear distinctive clothing	Agreed	Not worn in hot weather	1
15	All waste to be cleared up daily	Agreed if skip provided	Usually satisfactory	2
16	All electrical equipment to be subject to routine inspection as laid down in owner's scheme	Agreed inspection schedule to be made	Not satisfactory, no list available	0
17	All dump-truck drivers to complete a course of training	Agreed owner and contractor to share cost	Satisfactory	3
18	All lighting equipment to be subject to owner's scheme of inspection and test	Agreed	Unspecified equipment found	1
19	Who decides when weather conditions are too bad for work to continue?	Owner's site foreman	Only one problem in 6 months	2

Scores on safety samples are also quite objective.

Qualitative/Quantitative

- **Qualitative** means that the data is not represented numerically, e.g. reports and commentaries, which although useful, are difficult to treat as an accurate measure.
- **Quantitative** means that the data describes numbers, e.g. the number of accidents reported. In such a case, we can see whether there has been an improvement or a reduction in standard.

Examples of quantitative measures of safety performance would be:

- Audits.
- Inspections.
- Safety tours.
- Safety sampling.
- Behavioural measures.
- Safety surveys.
- Benchmarking.

STUDY QUESTIONS

2. Give one example each of an active measure, reactive measure, objective measure and subjective measure of health and safety performance.

3. What are the limitations of accident and ill-health data as a performance measure?

(Suggested Answers are at the end.)

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Health and Safety Monitoring and Measuring Techniques

IN THIS SECTION...

- Monitoring can be active or reactive.
- Sickness absence and ill-health data can be used to identify patterns and high level causes of sickness absence, and work-related or other reasons for the absence.
- Measurement techniques include inspections, audits, safety tours, safety sampling, safety surveys, safety conversations and behavioural observations.
- The in-house health and safety practitioner has an important role to play in an external audit as facilitator and co-ordinator.
- Benchmarking enables an organisation's practice to be compared with other comparable organisations that display excellence.

Range of Measures Available to Evaluate an Organisation's Performance

Selecting the appropriate outcome indicator depends on the chosen objectives, but the following is a range of active and reactive outcome indicators relevant to a range of objectives.

Active Monitoring Data

There is a wide range of data that can be collated to assess health and safety performance, some of which are active – such as the uptake rate for toolbox talks, or the completion of risk assessments against the target.

These data cover the extent to which plans and objectives have been set and achieved, and include:

- Specialist staff.
- Safety policy.
- Training.
- Extent of compliance.
- Risk assessments.
- Health and safety committee meetings.
- Perceptions of management commitment.

Active monitoring measures if objectives have been achieved

Reactive Monitoring Data

Other data are reactive, and are typically based on accidents and incidents that have occurred. They include:

- Sickness absences.
- Fatalities.
- Near misses.
- Damage-only accidents.
- Lost-time accidents.
- Reportable dangerous occurrences.
- Reportable major injuries.
- Three-day, lost-time accidents.
- Health surveillance reports.
- Cases of occupational diseases.

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Active Monitoring Techniques

TOPIC FOCUS

Health and Safety Audits

The health and safety audit should be an in-depth, systematic, critical investigation into all aspects of safety. It needs to include management systems, policy, attitudes, training and practice.

Workplace Inspections

A workplace inspection involves someone walking round a part of the premises, looking for hazards or non-compliance with legislation, rules or safe practice, and taking notes. The task is made easier and more methodical if a checklist is used.

Safety Tours

A safety tour follows a predetermined route through the area or workshop and can be conducted by a range of personnel, from works managers to supervisors and safety reps. Such tours typically last only 15 minutes or so and may be carried out at weekly intervals to ensure that standards of housekeeping are acceptable, gangways and fire exits are unobstructed, and hazards are dealt with quickly.

Safety Sampling

This is an organised system of regular random sampling. Its purpose is to obtain a measure of safety attitudes and possible sources of accidents, by the systematic recording of hazard situations observed during inspections made along predetermined routes in a factory or on a site.

Safety Surveys

A safety survey is a detailed examination of a particular safety aspect. It could involve, for example, a detailed inspection of all aspects of fire-fighting equipment; examining all the safety devices on machines; or checking all the emergency exits.

Climate Surveys

Culture and climate surveys are covered in Element IA7, but it is worth noting that there are techniques to assess an organisation's attitude towards health and safety so that improvements can be made.

Behavioural Observations

Human factors and behavioural change programmes are covered in Element IA8, but monitoring the way workers behave (for example, the use of PPE or the correct driving techniques) is a valuable active monitoring technique, as it detects issues that can be addressed through behavioural change programmes before injuries occur.

Benchmarking

Benchmarking is the comparison of an organisation's performance to others within the sector or country as a whole. Benchmarking can also be carried out between sites within the same organisation to identify strengths and weaknesses and therefore develop improvement plans.

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Collection and Use of Sickness Absence and Ill-Health Data

Sickness absence is influenced by a variety of different personal, social and organisational factors. However, studies in the UK have suggested that between 2% and 16% of annual salary costs might be spent on absence by large UK employers. The variation in the costs of absence by different employers can be explained by the different methods of dealing with absence, such as informal internal cover or use of external agency staff. The number of part-time staff in an organisation also has an impact on cost, as does age profile. Young people are more prone to short-term absence, whereas long-term absence is more commonly associated with older workers.

A number of risk factors have been identified as being related to sickness absence, including overall health, job satisfaction and adverse social circumstances. However, any effective initiatives by an employer to significantly reduce preventable sickness absence will have cost benefits.

The collection and analysis of information relating to which employees are off sick and why will help to:

- Identify patterns and high-level causes of short/long-term sickness absence.
- Identify work-related/other causes of absence.
- Plan cover for absent employees.
- Benchmark the organisation's performance.

Recording sickness absence daily and summing it up on a weekly basis will help to keep the information accurate and act as a prompt to make contact with absent employees at suitable intervals.

In larger organisations, analysis of sickness absence records can reveal patterns of illness or injury that could be caused by, or made worse by, work:

- A number of cases of musculoskeletal problems amongst employees who carry out a particular task (poor ergonomics or manual handling techniques?).
- Frequent minor but vague illnesses in areas where deadlines are very tight, workloads are challenging or employees have little control over their work (work-related stress?).

Recording sickness absence keeps information accurate

Early action by the employer can significantly increase the chances of a quicker return to work by those off sick.

Information required to help manage absence and return to work includes:

- Name or identification of the employee concerned and contact details.
- Date of the first day of absence.
- Cause of absence.
- Whether the injury or illness is considered to be work related.

Once this is known:

- Working days absent (updated regularly).
- Date employee last contacted and the outcome.
- Expected length of absence, if known.
- Return to work date.

In the UK, the Institute of Occupational Medicine (IOM), in collaboration with HSE, have devised a standardised scheme for the classification and coding of sickness absence causes. This scheme is designed to allow employers to easily classify the reasons for sickness absence provided by employees from verbal reports, self-certificates or from a medical practitioner by means of a medical certificate.

There are two levels of coding within the scheme:

- At level 1, 23 categories specify the main body system affected by the illness or ailment such as:
  - 10 Anxiety/stress/depression/other psychiatric illnesses.
  - 11 Back problems.
  - 12 Other musculoskeletal problems (exclude back problems - include neck problems).
  - 13 Cold, cough, 'flu.
  - 14 Asthma.
  - 15 Chest and respiratory problems (exclude nose and throat problems, asthma, cold, cough, 'flu).
- For level 2, secondary coding can be used to specify more detailed cause classifications on the sickness absence, such as:
  - 10 Anxiety/stress/depression/other psychiatric illnesses:
    - 10001 Anxiety.
    - 10002 Behavioural disorder.
    - 10003 Bipolar disorder.
    - 10004 Delusion disorder.
    - 10005 Depression.
  - 11 Back problems:
    - 11001 Back ache/pain.
    - 11002 Disc problems.
    - 11003 Lumbago.
    - 11004 Sciatica.

The scheme has been designed to be broadly compatible with the internationally recognised ICD (International Classification of Disease) scheme at the top level, in order to allow the future comparison of rates, particularly with information collected at a local level then used to influence planning of health and related services.

Role, Purpose and Key Elements of Measurement Techniques

The primary purpose of measuring health and safety performance is to provide information on the systems used by an organisation to control risks to health and safety. Measurement information supports the maintenance of the health and safety management system by:

- Providing information on how the system operates in practice.
- Identifying areas where remedial action is required.
- Providing a basis for continual improvement.
- Providing feedback and motivation.

The following techniques examine different aspects of working practices at different levels in the health and safety management system in order to assess compliance with agreed practice. Non-compliance information is then used to improve systems and procedures.

Health and Safety Audits

Health and safety audits are ideally done by an external organisation, or a special unit from head office in the case of multi-site operations. The purpose is to assess the extent to which the elements of the system are still effective, and whether any action is necessary to avoid accidents and other losses. To be used as a measure, standards need to be set in the key areas. A scoring system can be introduced if the intention is to hold managers responsible for standards in their area of influence.

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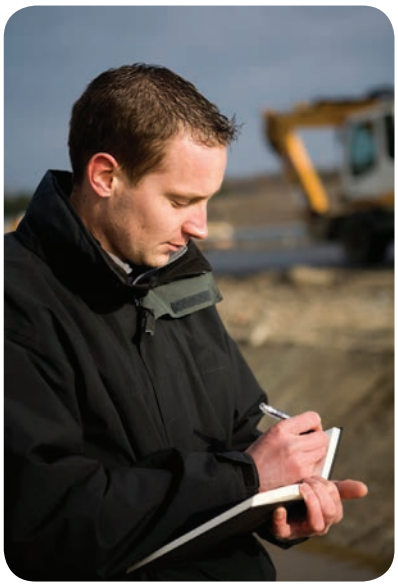
There are some points **against** the use of audits:

- They are time-consuming and costly.
- It is not feasible to carry out a full audit more than once a year.
- There is likely to be a lot of things to correct, and some of these may take time to complete.
- If there is a long time between the recommendation being made, and the solution being put into effect, the value of the audit is reduced.

A number of **proprietary audit systems** are available, sometimes referred to as the International Safety Rating System (ISRS). These are often computer-based and require answers to set questions. If there are to be comparisons between departments then there will need to be some uniformity. The scoring system should give weighting to significant safety performance. Human factors and attitudes need to be a major element of the audit, but these are not so easy to measure or score.

Workplace Inspections/Safety Tours/Safety Sampling

The advantage of **workplace inspections** is that the inspection can be far more frequent than an audit. To be an effective measure, the workforce as well as management need to be involved, as this gives them 'ownership' of the safety process. Management is able to demonstrate commitment to safety and it is possible to get a clear picture of problem areas and to take quick and effective action. A scoring system is required if comparisons over time, or with other sections, are to be made. Such an inspection usually goes under the name of **safety sampling** if it concentrates on a few specific points. A **safety tour** follows a set route.



Commitment to safety prompts effective action

Points to watch are that if the inspections or sampling are too frequent, then it is possible that an action point required by the previous inspection will not have been corrected when the next inspection takes place. Any scoring system used to compare sections must be shown to be fair and impartial. Be aware that some inspectors are lenient, and others are very strict; some inspectors just have to find something wrong. The training and experience of the inspectors is important. Often, inspections find minor matters that are not really likely to cause accidents and fail to find larger potential hazards.

Safety Surveys

Safety surveys make sure that aspects of safety are not overlooked in the general run of inspections. A safety survey generally results in a formal report and an action plan to deal with any findings.

Safety Conversations

Safety conversations provide the opportunity to respond to non-compliant behaviour in an effective but non-confrontational manner. The conversation is used to deliver feedback, describe a safer alternative, listen to the response and close the conversation in a productive manner. For conversations to be effective the instigator needs to listen attentively and emphasise any positive actions that have been observed. By drawing out responses from the other person and getting them to describe in their own words what they should be doing to keep safe it is more likely that the feedback will be taken positively. The focus needs to be on future ways of improving safety, with a verbal commitment to take on board those ideas.

Behavioural Observations

Behavioural observations are used in Behavioural Change Programmes with the aim of improving individual behaviour. The key principle is to positively reinforce the desired behaviour and deter or even punish the undesired behaviour. The first step is to identify the desired behaviour, which should be specific, observable and easily measured. Often, simply observing behaviour can in itself lead to a positive improvement in the behaviour, but this is usually only a temporary effect. Feedback needs to be provided very soon after the safe/unsafe act so that the safe behaviour is reinforced, not only to the individual but to all those affected, so that they appreciate the impact of the programme, e.g. collective results published weekly.

The In-house Health and Safety Practitioner's Role in Audits Carried Out by Third Parties

Auditing involves the sampling of a process by a competent person who is independent of the process. Auditors report on the effectiveness of the health and safety management system, focusing on inputs, outputs and testing internal controls. In the case of certification audits, the aim is to demonstrate commitment to prescribed health and safety standards such as those required by BS OHSAS 18001:2007. The auditors' independence gives credibility to the audit findings. Auditors should not have any personal accountability, or direct reporting relationships, in the group or area they are auditing, hence the value of external audit.

Audits cover three types of evidence:

- Documentation.
- Interviews.
- Observation.

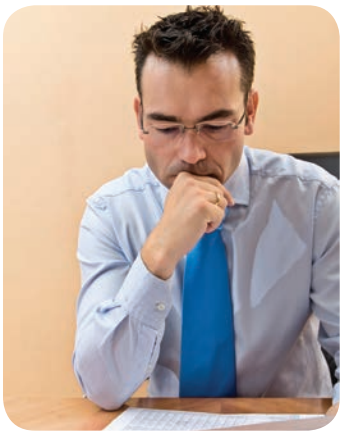
External auditors are often viewed negatively and do not know the organisation, so may ask for a lot of pre-audit documentation and take longer than internal auditors to complete their work. The in-house health and safety practitioner has an important role to play in an external audit as a facilitator and co-ordinator. The practitioner is familiar with the organisation's health and safety communication and information systems and is therefore well placed to ensure that suitable documentation is available for the external auditor. Similarly, the practitioner can organise interviews with appropriate responsible persons at all levels in the organisation and give briefings to key personnel if necessary. The in-house practitioner knows the workplace well and can advise on what observations are likely to be most productive in assessing control systems.

Comparisons of Performance Data

Previous Performance

It is always useful to compare present performance data with that obtained over the last few months or last year. The comparison of performance over time shows the overall trend and whether performance appears to be improving or deteriorating. However, you need to look at a reasonably long period of time as there may be seasonal fluctuations, for example, which could give a false view of performance. One way of overcoming fluctuations is to use the moving average, which shows the trend over time.

Other factors could affect the data, e.g. a reduction in staff numbers may lead to a reduction in absolute accident numbers which could be misread as an improvement in safety performance. To avoid such issues, it is possible to use accident rates which take into account the numbers of employees working and/or the number of man-hours worked, etc.



Comparing performance data to past years is useful

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Performance of Similar Organisations/Industry Sectors

It is sometimes useful to compare company data against other organisations or industry sectors that carry out similar functions or that deal with similar hazards. In this way, you can compare the performance of your company with others (benchmark) to determine the differences and similarities. Remember that you should check that the measurable parameters used are the same (it is easy to manipulate data by using different units of measurement or criteria). Once you have established that the data is comparable, it is worth trying to identify whether the trends are similar. Where there are marked differences, think about the reasons for these, e.g. geographical locations, different customer base, different shift patterns, etc. Some simple analysis may help you to understand your own data and may give you ideas as to how improvements can be made.

It can be reassuring to compare data with other companies or, on the other hand, it can be alarming; whatever the outcome, it is a worthwhile exercise.

National Performance Data

Some performance data is produced by national enforcement agencies and also by international organisations (such as the World Health Organisation). This data can be useful in gauging where you are as a company, i.e. are you maintaining standards in line with national figures or are there improvements to be made? It is easy to become complacent with respect to health and safety performance, particularly if your company appears to be continually improving. By comparing your company results to national figures, you may become motivated to further that improvement.

In Element IA3, we considered how to calculate injury rates, and to analyse and interpret raw data. It is worth revising that information at this point.

Use and Benefits of Benchmarking

Although the primary focus for performance measurement is to meet the internal needs of the organisation, there is an increasing need to demonstrate to external authorities that arrangements to control health and safety risks are in place and effective. Benchmarking is a tool that enables this by assessing the differences between your enterprise and best practice. It examines the processes and procedures of your organisation and compares them with the standards of the sector.

DEFINITION

BENCHMARKING

The process of comparing your own practices and performance measures with organisations that display excellence and whom you might wish to emulate.

The most useful form of benchmarking involves:

- Analysis of processes and procedures in your own organisation.
- Analysis of other enterprises.
- Adaptation of the findings to make improvements.

Benchmarking is a process that can be used to promote continuous improvement within your own enterprise.

STUDY QUESTIONS

4. List the main measurement techniques available for measuring health and safety performance in the workplace.
5. Explain the term "benchmarking".

(Suggested Answers are at the end.)

Reviewing Health and Safety Performance

IN THIS SECTION...

- The review process uses information from monitoring and audit data to make judgments regarding the effectiveness of the management system.
- This can lead to changes in the elements of the system and so continuous improvement.

Formal and Informal Reviews of Performance

Review is the process of making judgments regarding the effectiveness of the occupational health and safety management system and then making decisions to remedy any deficiencies that have been identified. It is a key element of any quality system.

Review should be a continuous process and should be both formal and informal at different levels in the organisation. A **formal review** will be carried out periodically, e.g. annually, and may cover the whole site or organisation, whereas an **informal review** might be instigated by, for example, a supervisor who has identified a failure by workers to adhere to required control measures (e.g. not wearing PPE).

Review Process

Review is combined with audit procedures. The audit looks at all aspects of the system - policy, organisation, planning, implementation and systems for measuring and control. Reviewing is the process that reacts to the findings of the performance measuring process. There should be an instant review in the event of an accident that causes an injury or loss. We have to learn from mistakes and be prepared to make changes. For any system of health and safety which is vital and dynamic, there will have to be periodic reviews. In many systems, it would probably involve:

- Monthly review of each section.
- Quarterly review of each department.
- Annual review of the organisation.

The review would probably cover:

- Assessment of degree of compliance with set standards.
- Identification of areas where improvements are required.
- Assessment of specific set objectives.
- Analysis of accident and incident trends.

Review should be combined with audits

The safety committee and safety representatives, supervisors and management, would all be involved in the review process.

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Inputs to a Review Process

A range of information is used as the basis of the review, including:

- Internal performance data, e.g. audit, accident, ill health and incident data, safety climate data.
- Achievement of specific objectives.
- Organisational arrangements, including any changes.
- External standards and legislation.
- Expectations of stakeholders.

Outputs from a Review Process

The review process leads to specific outputs which should lead to continuous improvement:

- Specific actions and improvement plans which meet the SMART criteria.
- New performance targets relating to both active and reactive measures (e.g. lost-time accidents).
- Reports to stakeholders, e.g. shareholders, employee groups, regulators.

STUDY QUESTION

6. Which two sources of information does the review process use?

(Suggested Answer is at the end.)

Summary

Purpose and Use of Health and Safety Performance Measurement

Performance measurement:

- Establishes whether the health and safety objectives and arrangements have been effectively implemented, including the adequacy of control measures.
- Provides information for the review process which looks at the effectiveness of the entire health and safety management system and leads to changes that lead to improvement.
- Enables success to be measured and rewarded.
- Maintains and improves health and safety performance.

When **setting objectives**, we have to consider performance standards and key performance indicators. Two measuring systems in use are:

- **Active** systems, which monitor the achievement of objectives and the extent of compliance with standards (e.g. monitoring the safety of plant and equipment; compliance with safe systems of work; safe behaviour by employees).
- **Reactive** systems, which monitor accidents, ill health, incidents and other evidence of deficient health and safety performance, such as hazard reports.

Health and Safety Monitoring

Objectives of **active monitoring** are to check that the health and safety plans have been implemented and to monitor the extent of compliance with:

- The organisation's systems and procedures.
- Legislation and technical standards.

Objectives of **reactive monitoring** are to analyse data relating to:

- Accidents.
- Ill-health situations.
- Other loss-causing events.
- Any other factors which degrade the system.

Accident recording has some value, but is of limited use in relation to assessing future risk. There are problems with under-reporting of minor accidents. Time off work does not correlate well with the severity of an injury, because some people will work with a broken arm, while others take a week off with a cut finger. Also, if staff are made aware of safety matters, they tend to report more accidents. The picture may then look worse, when actually the safety culture is improving.

Distinctions between, and applicability of, performance measures are:

- **Active** means 'before it happens', while **reactive** means 'after it has happened'.
- **Objective** means that it can be accurately measured, while **subjective** means that it depends on someone's opinion.
- **Qualitative** measures are those like reports and commentaries, which although useful are difficult to treat as an accurate measure, while some kind of score is **quantitative**.

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Health and Safety Monitoring and Measurement Techniques

Measurement techniques include:

- Health and safety audits.
- Workplace inspections.
- Safety tours.
- Safety sampling.
- Safety surveys.

Analysis of sickness absence records, particularly in larger organisations, can reveal patterns of illness or injury that could be caused by, or made worse by work.

It is always useful to compare an organisation's performance data:

- Over time.
- Against that of other organisations or industry sectors that carry out similar functions or experience similar hazards.
- Against national figures.

Reviewing Health and Safety Performance

Review is combined with audit procedures. The audit looks at all aspects of the system - policy, organisation, planning, implementation and systems for measuring and control. Reviewing is the process which reacts to the findings of the performance measuring process. In many systems, it would probably involve:

- Monthly review of each section.
- Quarterly review of each department.
- Annual review of the organisation.

The review would probably cover:

- Assessment of degree of compliance with set standards.
- Identification of areas where improvements are required.
- Assessment of specific set objectives.
- Analysis of accident and incident trends.

The safety committee and safety representatives, supervisors and management, would all be involved in the review process.

Exam Skills

This is another 10 mark question, but it is split into two sub-questions which have different mark allocations. This is a format which is quite common in Section A questions.

QUESTION

An advertising campaign was used to promote improvement in safety standards within a particular organisation. During the period of the campaign the rate of reported accidents significantly increased, and the campaign was deemed to be a failure.

(a) **Explain** why the rate of reported accidents may have been a poor measure of the campaign's effectiveness. **(2)**

(b) **Describe** four active measures which might have been used to measure the organisation's health and safety performance. **(8)**

Approaching the Question

Remember to:

- Read the question carefully.
- Consider the marks available. Here there are two parts to the question so you should allocate your time carefully – 2 to 3 minutes for part (a) and 10 to 12 minutes for part (b).
- Prepare an outline plan:
  - For part (a) it might include:
    - Why? Elaborate on these reasons.
  - For part (b) it might include:
    - List methods and choose **four** of them.
    - Describe how they would be "active". (Note that "active" is sometimes also known as "proactive".)

HINTS AND TIPS

Remember to present your answer in two parts, (a) and (b), and answer the specific questions asked in the two different sub-questions.

Suggested Answer Outline

In part (a) of your answer the examiner would expect you to give the reasons why the number of reported accidents went up.

Possible reasons might be:

- Pre-campaign under-reporting - the campaign made people aware of what they should be reporting; accidents/incidents may have been happening but were previously not reported.
- Increased awareness – workers now expecting more follow-up of issues raised, so will now actually report them.
- Previous under-reporting possibly due to worker reluctance because of:
  - Disciplining of those who reported such incidents on previous occasions.

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- Negative organisational health and safety culture which discouraged accident reporting.
- Lack of action by management when accidents were reported.

In part (b) you need to give four examples of active techniques which are available to measure an organisation's health and safety performance. These could include:

- Consultation – how frequent; its effectiveness; adherence to procedures.
- Procedures, safe systems of work, risk assessments, etc. – how many of them; whether they are up to date; awareness of them; adherence to them; whether or not in place.
- Training – hours done/delivered/attended; %age compliance with mandatory courses; refresher courses completed on time/those overdue; number of "no shows" on courses.
- Safety audits – number carried out compared to target number; findings completed compared to those overdue; issues raised by trends.
- Inspections – numbers completed compared to target numbers; findings completed compared to those overdue; issues raised by trends.
- Behavioural tours – numbers carried out compared to target numbers; findings completed compared to those overdue; issues raised by trends.
- Benchmarking – which department/other organisation compared with; results.

Example of How the Question Could be Answered

(a) Following the campaign, the number of accidents may have significantly increased because of a number of factors; these could include that previously very few people were actually aware that they needed to report accidents, so accidents happened, but weren't reported – resulting in under-reporting.

It may also have been that the campaign was very successful because it now raised people's awareness and expectations of what will be done now you have encouraged people to report accidents on site.

(b) Four active methods of measuring H&S performance of the organisation could entail:

- *Safety tours – these tours could take place on a regular basis and identify good and poor practice; these practices could then be logged to measure performance by scoring or tracking good and poor practice.*
- *Procedures, risk assessments, etc. – measuring the numbers that have been done against numbers required, checking whether they are in date and being reviewed in line with set frequencies, communicated to staff – by measuring awareness or understanding of them.*
- *Safety surveys – using a set survey and evaluating strengths and weakness and setting strategy for the future and implementing campaigns and then being able to measure through a survey the effectiveness of this campaign.*
- *Benchmarking – comparing your performance to previous years/months, other departments, sites or comparable companies (e.g. from national accident statistics published for your particular sector) to measure your performance in an active manner.*

Reasons for Poor Marks Achieved by Candidates in Exam

An exam candidate answering this question would achieve **poor marks** for:

- Lack of knowledge or understanding of reasons why accident reporting increased.
- Lack of in-depth knowledge or understanding of four examples of active health and safety performance measures.

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Element IA5

The Assessment and Evaluation of Risk

Learning Outcomes

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

1. Explain how to use internal and external information sources in identifying hazards and the assessing of risk.
2. Outline the use of a range of hazard identification techniques.
3. Explain how to assess and evaluate risk and to implement a risk assessment programme.
4. Explain the analysis, assessment and improvement of system failures and system reliability with the use of calculations.
5. Explain the principles and techniques of failure tracing methodologies with the use of calculations.

Contents

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Sources of Information Used in Identifying Hazards and Assessing Risk

IN THIS SECTION...

- Accident and ill-health data may be used to calculate incidence, frequency, severity and prevalence rates.
- External information sources include:
  - National governmental enforcement agencies such as the UK's Health and Safety Executive (HSE), the USA's Occupational Safety and Health Administration (OSHA) and Western Australia's WorkSafe.
  - International bodies such as the European Safety Agency, the International Labour Organisation (ILO) and the World Health Organisation (WHO).
  - Professional bodies such as the Institution of Occupational Safety and Health (IOSH) and the International Institute of Risk and Safety Management (IIRSM).
  - Trade unions.
  - Insurance companies.
  - Trade associations.
- Internal information sources include:
  - Injury data.
  - Ill-health data.
  - Property damage.
  - Near-miss information.
  - Maintenance records.
- Accident, ill-health and near-miss data are often under-reported.
- Trends cannot be established unless large amounts of data are collected over relatively long periods of time.

Accident/Incident and Ill-Health Data and Rates

Incident data can be used to support hazard identification, risk assessment and risk factors. Some of the accident data collected is used to generate the statistics required by legislation but other uses are to:

- Classify industries according to risk.
- Classify workplaces.
- Classify occupations.
- Consider accident trends.
- Consider parts of the body injured - use of protective clothing.
- Use 'cause of injury' to determine hazards in a workplace.
- Consider where the fault lies.
- Measure the effect of preventive/control measures.

It can sometimes be difficult to obtain and interpret such information.

Incident data can support hazard identification

Accident and Disease Ratios

In making comparisons between various industries, or between work areas in the same factory, it is useful to consider the commonly used accident and disease rates. You will remember these from Element IA3.

Incidence Rate

Incidence reflects the number of new cases in relation to the number at risk.

This is calculated from:

$$\frac{\text{Number of work-related injuries} \times 1{,}000}{\text{Average number of persons employed}}$$

It is a measure of the number of injuries per 1,000 employees and is usually calculated over a period of time, e.g. a year. It is often applied to discrete events, such as accidents.

Frequency Rate

This can be calculated from:

$$\frac{\text{Number of work-related injuries} \times 100{,}000}{\text{Total number of man-hours worked}}$$

It is a measure of the number of accidents per 100,000 hours worked.

Severity Rate

This is:

$$\frac{\text{Total number of days lost} \times 1{,}000}{\text{Total number of man-hours worked}}$$

It is a measure of the average number of days lost per 1,000 hours worked.

Prevalence Rate

Prevalence is a term often used to describe ill health in terms of the proportion of persons who have the prescribed ill-health condition at a particular time.

It can be calculated from:

$$\frac{\text{Total number of cases of ill health in the population} \times 100}{\text{Total number of persons at risk}}$$

This calculation will give the percentage of the population with the disease.

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External Information Sources

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External information sources include:

- National governmental enforcement agencies such as the UK's HSE (www.hse.gov.uk), the USA's OSHA (www.osha.gov), and Western Australia's WorkSafe (www.commerce.wa.gov.au/worksafe). These all produce legal and best practice guidance and statistics. Even if you are not under their regulatory control, their guidance can still be a valuable source of advice, especially where little or none exists in your region.
- International bodies such as the European Safety Agency (osha.europa.eu); the International Labour Organisation and their "safework" site (www.ilo.org); and the World Health Organisation (www.who.int).
- Professional bodies such as IOSH (www.iosh.co.uk) and IIRSM (www.iirsm.org).
- Trade unions, a number of whom produce information on safety and health matters. The trade union interest here may be in making members aware of possible compensation areas.
- Insurance companies, who set the levels of premiums and need data to calculate the probable risks of any venture. The average risks involved in most activities can be found in insurance tables. Since the risk manager is involved in managing risks, these tables will be extremely useful, although getting hold of them may not be so easy.
- Trade associations.

Internal Information Sources

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Internal information is the most relevant data for an organisation, but other sources will be needed for comparisons, unless the organisation is large enough to give statistical significance.

There should be a source of accident and ill-health data, as well as near-miss information, within the company.

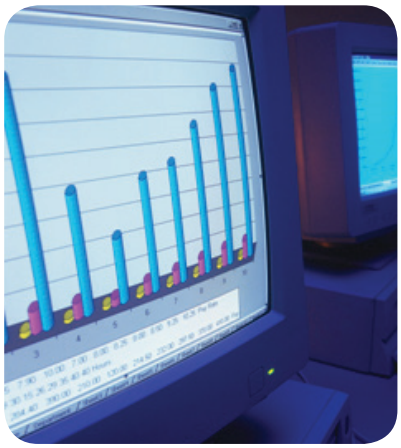
- **Accident reports** will be the most obvious source. It is important that the information recorded is adequate for risk assessments. We need to be able to investigate factors which contributed to the accident which means making a clear distinction between "**cause of accident**" and "**cause of injury**".
- **Absence records** may be another indication of problems. Health problems may not always be reported, so conditions which are made worse by the work situation, rather than being caused by it, are not so easy to spot.
- **Maintenance records** will usually show **damage incidents**.

Uses and Limitations of Information Sources

Internal information is obviously very relevant to risk assessments. However, the absence of accidents is not a very good indication that all is well. Can you think why this is so?

Accidents should be rare occurrences. Quite often there is a large element of chance involved in the severity of an accident. Near misses, which are usually a much larger figure, are a better indicator of risk.

Care must be taken when using **external sources** of information. The numbers are larger, and any statistics are based on a larger sample, so are statistically more relevant. However, the type of industry covered may be much wider than your own situation. In the case of a very specialised situation this may be the only indication of risk available. Different sources use a different multiplier when working out accident frequency rates, etc. so care needs to be taken when making comparisons.



Statistical information is available from a variety of sources

When comparing data between organisations it is important to make sure that they have the same terms of reference. For example, when comparing Lost-Time Accident (LTA) incidence rates between two organisations (based on numbers of employees), note the following:

- The two organisations may use different definitions for a LTA (many companies use "more than 1 day lost" for internal reporting of LTA, whereas some enforcement agencies use "more than 3 days lost" as their standard).
- There is no indication of injury severity.
- The figures may be for workers only and so may be misleading for an organisation that makes wide use of contractors.
- The figures may not take full account of overtime or part-time workers (they may not adjust the numbers of workers to 'full-time equivalents').
- Culture differences - one organisation may have a culture where they take time off even after a very minor injury; another organisation might have a very strong 'back to work' culture where an injured worker might be brought back to work on restricted, or 'light' duties, in order to avoid recording a lost-time accident.
- There may be different risk levels between organisations due, for example, to the nature of the work, premises, equipment, etc.
- There may be different risk management arrangements in place relating, for example, to standards of risk assessment, training requirements and standards of control.

STUDY QUESTIONS

1. What uses might we have for accident and ill-health data?
2. What internal information can organisations use to help in the assessment of risk?
3. Explain the difference between "incidence" and "prevalence" when referring to accident or ill-health statistics.

(Suggested Answers are at the end.)

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Hazard Identification Techniques

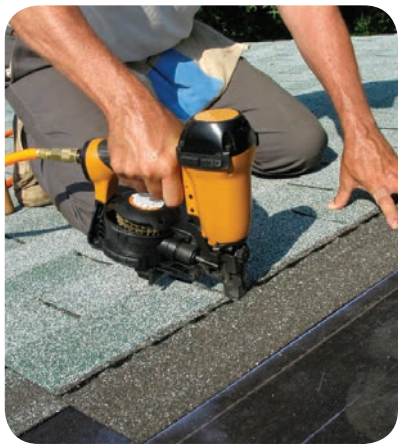
IN THIS SECTION...

Hazards may be identified using:

- Observation.
- Task analysis.
- Checklists.
- Incidents and near misses.
- Failure tracing techniques.

Hazard Detection Techniques

Before risk can effectively be managed, it is important to identify any hazards in the workplace; the following are some techniques that can be used.



Hazards in the workplace must be identified

Observation

Many hazard identification techniques rely on observation by the assessor(s) and are dependent on the experience and knowledge of the assessor.

The analyst should observe the work being done, including work being carried out by groups of operators, looking for:

- Actual and potential hazards - by observation and questioning.
- Less obvious 'invisible' hazards - such as health dangers from fumes, gases, noise, lighting and dangerous substances, etc.
- Behavioural aspects - rules and precautions for controlling any hazard or risk should be supplied by the operator, his/her supervisor or a specialist, but are they being followed?

Task Analysis

Task analysis is used to analyse all aspects of a task (including safety), often with the intention of improving efficiency. A job can also be analysed with the emphasis on safety or hazards.

The assessor divides the task into a number of steps, considering each step separately. The results of this analysis can be used to correct existing problems and to improve, among other things:

- Safe working methods, working instructions, worker protection, safety rules, emergency procedures, serviceability of machinery and plant.
- Reporting of hazards, provision of information.
- Layout of work areas.

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Checklists

To ensure a consistent and comprehensive approach to checking all the safety elements to be covered during an inspection, a checklist or inspection form is usually developed that covers the key issues. Checklists should also be structured to provide a coherent approach to the inspection process. This helps in the monitoring of the inspection process and analysis of the results, as well as simplifying the task of carrying out the inspection itself. Checklists do have some limitations in that although they prompt the assessor when looking for hazards, any hazard **not** identified in the list is less likely to be noticed.

One helpful method of structuring a checklist is by using the "4 Ps", as promoted by the UK Health and Safety Executive (HSE):

- **Premises**, including:
  - Access/escape.
  - Housekeeping.
  - Working environment.
- **Plant and substances**, including:
  - Machinery guarding.
  - Local exhaust ventilation.
  - Use/storage/separation of materials/chemicals.
- **Procedures**, including:
  - Permits-to-work.
  - Use of personal protective equipment.
  - Procedures followed.
- **People**, including:
  - Health surveillance.
  - People's behaviour.
  - Appropriate authorised person.

(Note that the examples given are purely for illustration and are not intended to be a definitive list.)

Checklists help in the monitoring and inspection process

While checklists are often included in safety procedures and manuals, do not feel that they cannot be changed and adapted. In particular, in terms of maintenance and safety inspections, the list should not act as a constraint on the inspector(s) identifying other potential problems or hazards. Checklists should be reviewed regularly to take account of recent or proposed developments in health and safety issues in the particular workplace.

Incident Reports

These represent reactive, but nonetheless useful, data. Reports can arise from external notification requirements under national legislation (discussed in Element IA3), or from internal reporting of all loss and near-miss events. Certain accidents and occupational ill-health incidents may be reported to, and analysed by, government regulators or enforcement agencies. In such cases, annual reports are usually published giving detailed figures of **reported** accidents 'analysed by cause'. These are useful when comparing differing sectors of industry.

Each company should maintain its own records, not just of 'notifiable' accidents and ill health, but of **all** accidents that have taken place. In this way, any trends, or particular areas that show significant changes, can be investigated at the earliest opportunity. The reports will also be a useful tool when carrying out risk assessments.

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Failure Tracing Techniques

The techniques we have described are usually more than adequate for most risk assessments. In more complex systems it may be necessary to use more structured methods to identify hazards. One powerful technique is called a Hazard and Operability Study (or HAZOP).

This breaks down a system, such as a chemical process, into different sections and then systematically asks what could go wrong in that section, what would be the consequences, and what measures could be introduced to reduce the likelihood of the failure occurring or, if it does fail, might mitigate the consequences. We will look at this and other techniques later in this element.

Importance of Worker Input

Rather than relying on one individual to undertake hazard identification, the team approach to risk assessment involves workers who have relevant experience and knowledge of the process or activity being considered, as they are likely to have the best understanding of the hazards.

Can you think of any other reasons why workers should be involved?

Involving workers also increases the "ownership" of the assessment as, having contributed to the exercise, an individual is more likely to appreciate the need for compliance with the control measures identified.

STUDY QUESTION

4. Giving two examples for each, identify the "4 Ps" recommended by the HSE when preparing a checklist for inspections.

(Suggested Answer is at the end.)

Assessment and Evaluation of Risk

IN THIS SECTION...

- The key steps in a risk assessment are:
  - Hazard identification.
  - Identification of who is at risk.
  - Estimation, evaluation of risk and identification of precautions.
  - Recording of significant findings and implementation.
  - Reviewing the assessment.
- Risk assessments may be generic, specific or dynamic.
- Risk assessments should take account of temporary and non-routine operations and consider long-term health hazards.
- Risk assessments may be qualitative, semi-quantitative or quantitative.
- The risk assessment process should be reflected in a policy, organising, planning and implementing, monitoring and review.

Key Steps in a Risk Assessment

According to the UK's HSE publication *Risk assessment – A brief guide to controlling risks in the workplace* (INDG163):

> *"a risk assessment is not about creating huge amounts of paperwork, but rather about identifying sensible measures to control the risks in your workplace."*

For the majority of work activities the five step approach is recommended:

- Step 1: Identify the hazards.
- Step 2: Decide who might be harmed and how.
- Step 3: Evaluate the risks and decide on precautions.
- Step 4: Record your findings and implement them.
- Step 5: Review your assessment and update if necessary.

Implicit within Step 3 of risk evaluation is the need to estimate the magnitude of the risk so here we will consider Step 3 as risk estimation, evaluation and deciding on precautions.

The UK's HSE's steps

Comprehensive Identification of Risks

If risk assessment is about identifying sensible measures to control the risks in the workplace, then the starting point has to be a comprehensive identification of risks. The range of risks in an organisation is a key factor in determining the approach that needs to be taken to manage health and safety, and the "riskier" the organisation the more effort needed to manage those risks. Each organisation has specific risks that arise from the nature of the business. In some businesses the risks will be tangible and arise from safety issues, whereas in other organisations the risks may be health-related and longer term.

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A broad examination of the nature and level of the threats faced by the organisation and the likelihood of these adverse effects occurring (i.e. severity and likelihood) will establish the likely level of disruption and cost associated with each type of risk. This enables significant risks to be identified and prioritised for action with minor risks simply noted to be kept under review.

Identify the Hazards

This is a crucial step in any risk assessment; we have already discussed the techniques that can be used.

Decide Who Might be Harmed and How

It is important to identify the different categories of persons who are exposed to each hazard, because this will influence the choice of control measures that could be adopted to reduce the risk. For example, control measures such as training could be used to protect workers, but would not be practicable for protecting others, such as members of the public.

The categories might include:

- Workers carrying out a task, e.g. operating a lathe.
- Other workers working nearby who might be affected.
- Visitors/members of the public.
- Maintenance staff.
- New/young workers.
- Persons with a disability.
- Persons who work for another employer in a shared workplace.

For each category you need to identify how they might be harmed. For example, for workers operating a lathe, loose clothing could become entangled in the rotating spindle, and other employees working nearby might be struck by swarf.

Risk Estimation, Evaluation and Precautions

Risk is the chance, high or low, that somebody could be harmed by these and other hazards, together with an indication of how serious the harm could be.

It is important that you understand the difference between **risk estimation** and **evaluation**.

Factors Affecting Probability and Severity of Risk

The magnitude of a risk associated with an incident is determined by two factors:

- The likelihood or probability of the event occurring, and
- The consequence or harm realised if the event takes place.

This is usually expressed as:

$$\text{Risk} = \text{Likelihood (or Probability)} \times \text{Consequence (or Harm)}$$

We now need to look at the factors that affect both the likelihood and the consequence.

DEFINITIONS

RISK ESTIMATION

Determining the magnitude of the size of the risk. This may range from being a relatively crude estimation, e.g. high, medium or low, to a more accurate estimation based on data. "Estimation" is used because risk deals with uncertainty and even the most detailed risk assessments have to make a number of assumptions.

EVALUATION

The decision-making process whereby we decide, on the basis of the risk we have estimated, as to whether it is acceptable or otherwise.

The **likelihood** of an adverse event occurring is affected by two factors:

- Degree of exposure to the hazard and, once exposed to the hazard,
- The likelihood that harm will occur.

Let's look at an example.

Consider a torn carpet in an office and the risks it creates. Before somebody could possibly trip on the carpet, they have to walk in the vicinity of the carpet, so the degree of exposure to the hazard is a key factor. If the carpet is situated in the centre of a main walkway then the likelihood of it causing an accident is much greater than if it is in a corner of a little-used store room. Similarly, the hazard from crossing a road will create a greater probability of harm if we cross the road several times a day, rather than if we cross it only several times a year.

The more you cross a road, the greater the probability of harm

Of course, merely encountering a hazard does not mean we will be harmed. Some people will see the hazard and avoid it deliberately and others will walk over it without being tripped up. In other words, a specific set of events must occur before a trip will occur, namely:

- Not noticing the hazard and taking avoiding action.
- Placing a foot into the tear such that the person can no longer maintain his or her balance.

The **consequence** is the outcome from the adverse incident occurrence. From most such incidents there is not just one possible outcome, but a whole range of them. For example, with our torn carpet, one individual might trip on the tear, recover their balance and suffer no harm at all. At the other extreme, someone else may trip, hit their head and die. In practice we have to use our judgment to decide the most likely outcome, probably in this case just a bruise. However, if the same incident occurred in a care home where most of the residents were elderly and frail, then the most likely consequence may well be a fracture.

Risk Evaluation

Having estimated the magnitude of the risk, we then have to decide if the existing control measures are adequate, or whether additional/different ones are necessary. According to the HSE publication *Risk assessment – A brief guide to controlling risks in the workplace* (INDG163), the easiest way of evaluating the risk is to compare your practices with recognised guidance. This is more than adequate for most assessments. However, as safety practitioners who may encounter non-routine or more complex risks, having made an informed estimation of the magnitude of the risk, we can use the information to help us decide what action, if any, is necessary.

Risk Control Standards

Having evaluated the risk and established whether or not it is acceptable, you have to ensure that the controls meet minimum standards. Such standards may be defined in legislation, codes of practice and relevant guidance.

Formulation and Prioritisation of Actions

When deciding on what action to take you should always follow the hierarchy of controls:

- **Elimination** - can I remove the hazard altogether? If not, how can I control the risks so that harm is unlikely?
- **Substitute the hazard** - try a less risky option (e.g. switch to using a less hazardous substance).
- **Contain the risk** - prevent access to the hazard (e.g. by guarding).
- **Reduce exposure to the hazard** - reduce the number of persons exposed to the hazard and/or reduce the duration of exposure.
- **Personal protective equipment** - provide protection for each individual at risk.

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- **Skill/supervision** - rely on the competence of the individual.
- **Welfare arrangements** - provide washing facilities to remove contamination and first aid facilities.

Invariably, combinations of control are applied, rather than relying on one alone. Just because a measure is near the bottom of the hierarchy does not mean it is not important (e.g. first aid) - it just means that an employer should not rely exclusively on it and must consider measures higher up the hierarchy.

If we have made an evaluation of the risk we should then be able to prioritise the necessary actions in terms of risks that need immediate attention, e.g. because of serious non-compliance, and those that may be dealt with in the short or even long term when resources become available. These actions may reflect going beyond the minimum legal standard and be best practice.

Requirements to Record Findings

Clearly, it is good practice to record the details of risk assessment.

The significant findings should include:

- A record of the preventive and protective measures in place to control the risks.
- What further action, if any, needs to be taken to reduce risk sufficiently.

In many cases, employers (and the self-employed) will also need to record sufficient detail of the assessment itself, so that they can demonstrate that they have carried out a comprehensive assessment. This record of the significant findings will also form a basis for a future revision of the assessment.

Use and Limitation of Generic, Specific and Dynamic Risk Assessments

- ### Generic Risk Assessments

  These risk assessments apply to commonly identified hazards and set out the associated control measures and precautions for that particular hazard. They give broad controls for general hazards but do not take into account the particular persons at risk or any special circumstances associated with the work activity. The UK's HSE guidance contains a wealth of information on hazards and controls required for a wide range of health and safety topics and can be used as the basis for generic risk assessments. In-house generic risks assessments can be used in workplaces where the particulars of the individuals at risk are not relevant and the activity is one that is standard and routine.

- ### Specific Risk Assessments

  These apply to a particular work activity and the persons associated with it. Specific activities, processes or substances used that could injure persons or harm their health are identified, along with exactly who might be harmed. Some workers have particular requirements such as new and young workers, migrant workers, new or expectant mothers, people with disabilities, temporary workers, contractors, home-workers and lone workers. The risk assessment needs to be specifically tailored to the individuals at risk as well as the specific nature of the work task.

Risk assessment need to be tailored for homeworkers

- ### Dynamic Risk Assessments (DRA)

  DRAs are needed when work activities involve changing environments and individual workers need to make quick mental assessments to manage risks. Police, fire-fighters, teachers and lone workers, for example, often have to make swift risk judgments and identify controls, sometimes on their own and in high-pressure, potentially stressful, environments.

To deal with these situations dynamic risk assessments are required. Dynamic risk assessment is "*the continuous assessment of risk in the rapidly changing circumstances of an operational incident, in order to implement the control measures necessary to ensure an acceptable level of safety*".

The UK's Home Office (a Government department) has produced a Dynamic Risk Assessment Model (1998), which sets out five stages:

- **Evaluate the situation**: consider issues such as what operational intelligence is available, what tasks need to be carried out, what are the hazards, where are the risks, who is likely to be affected, what resources are available?
- **Select systems of work**: consider the possible systems of work and choose the most appropriate. The starting point must be procedures that have been agreed in pre-planning and training. Ensure that personnel are competent to carry out the tasks they have been allocated.
- **Assess the chosen systems of work**: are the risks proportional to the benefits? If yes, proceed with the tasks after ensuring that goals, both individual and team, are understood; responsibilities have been clearly allocated; and safety measures and procedures are understood. If no, continue as below.
- **Introduce additional controls**: reduce residual risks to an acceptable level, if possible by introducing additional control measures, such as specialist equipment or personal protective equipment.
- **Re-assess systems of work and additional control measures**: if risks remain, do the benefits from carrying out the task outweigh the costs if the risks are realised? If the benefits outweigh the risks, proceed with the task. If the risks outweigh the benefits, do not proceed with the task, but consider safe, viable alternatives.

Limitations of Risk Assessment Processes

Risk assessment involves the evaluation of the likelihood of harm and its consequences for populations or individuals. Risk control requires the prioritisation of risks and the introduction of measures to prevent or reduce the harm from occurring. It is often assumed that an assessment of risks is scientific and objective whereas risk control is less straightforward because it combines the findings of risk assessment with other inputs, such as cost, risk perception, availability of technologies, etc. where there is more room for subjectivity. In practice, it is difficult to separate the two processes and assess risks without making assumptions. Consequently risk assessment becomes a mixture of science and policy and a tool for extrapolating from statistical and scientific data to obtain a value which people will accept as an estimate of the risk attached to a particular activity or event.

There is also the public's attitude to acceptance of risk to consider. Nuclear power is regarded by some people to be too dangerous no matter how low the risks are. Other people question the premise on which risk assessment is based, which is that it is acceptable for certain persons to be exposed to particular risks so that others may benefit. In addition, there is some scepticism about the meaningfulness of low probability estimations for high risk outcomes, with evidence quoted from major incidents such as Three Mile Island in America and Chernobyl in the USSR.

There are also issues regarding the general accuracy of risk estimations. One view is that risk assessment systematically overestimates risks by representing worst case scenarios and therefore causes unnecessary alarm and concern among the public. On the other hand, there is the belief that risk assessment may often underestimate the true magnitude of the problem, particularly in the case of health risks, by ignoring factors such as synergic exposures (the interaction of two agents producing a combined effect greater than the sum of their separate effects) or the variations in susceptibility among individuals.

It must therefore be accepted that assessing risks involves uncertainties, and that the science on which most risk assessment judgments are based is often inconclusive. Risk assessment relates to hypothetical rather than real persons and is inevitably based on value-laden assumptions. In view of these shortcomings risk assessment continues to be a valuable tool for informing decisions but has serious limitations if used to blindly dictate them.

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Temporary and Non-Routine Situations

For workplaces where the nature of the work may change frequently (such as contract maintenance work), or the workplace itself changes (such as a construction site), the risk assessment needs to be more dynamic in order to accommodate these changing situations. In these situations it may be necessary to concentrate more on a broad range of foreseeable risks and develop a range of appropriate control options for these rather than try to document rigid control measures for a temporary and changing workplace. For this approach to be effective in a temporary situation, detailed planning and worker training in dealing with the significant risks is essential.

Consideration of Long-Term Hazards to Health

Another important issue easily missed by a standard approach to risk assessment is that of exposure to long-term hazards to health. Health hazards such as radiation, harmful substances and noise may not be readily observed in the workplace and need special consideration in the risk assessment process. Accident and ill-health records are unlikely to assist in identifying these types of hazard since the latency period before health effects are realised may be many years. Observation of the workplace is also ineffective since many health hazards are invisible and need specialist equipment to detect them.

The starting point needs to be an accurate hazard profile of the workplace which will recognise and identify potential long-term hazards to health. Radiation, harmful substances and noise frequently have their own specific risk assessment methodologies, detailed in appropriate legislation, which need to be followed in these circumstances.

Types of Risk Assessment

Before we continue, let's remind ourselves of the definitions of the following two terms:

- **Quantitative** - a measurement of magnitude is involved, e.g. there were four fatalities due to falls from height over a 12-month period at Business X; the airborne concentration of formaldehyde in a workplace was measured as 13ppm.
- **Qualitative** - no actual measurement is used. It involves describing the qualities, e.g. the airborne concentration was high or serious; the injury sustained was minor.

There are conceptually two basic categories of risk assessment: qualitative and quantitative. In practice there is also a third category which uses numbers to indicate rank order, called semi-quantitative. Quantitative risk assessment uses more rigorous techniques in an attempt to quantify the magnitude of the risk. Even in the high hazard industries (such as nuclear and chemical) most of the assessments are not quantitative. However, they are often used to satisfy a regulator that very unlikely events which, if they occurred, would have serious consequences not only to the organisation but also to the public (such as loss of containment of radioactive material in a nuclear facility) have been assessed. All risk assessments involve at least some element of subjectivity or judgment.

Qualitative Assessments

Qualitative risk assessments are based entirely on judgment, opinion and experience including approved guidance, rather than on measurements. They use technology-based criteria to establish if you have done enough to control risks, i.e. *" If I use this standard control measure I'm pretty sure the risk will be adequately controlled "*. They allow you to easily prioritise risks for further action, but while they enable risks to be ranked against other risks, they do not objectively estimate risks and so do not allow direct comparisons with external estimates.

DEFINITION

QUALITATIVE RISK ASSESSMENT

" The comprehensive identification and description of hazards from a specified activity, to people or the environment. The range of possible events may be represented by broad categories, with classification of the likelihood and consequences, to facilitate their comparison and the identification of priorities."

A qualitative risk assessment is carried out by the risk assessor(s) making qualitative judgments with respect to the likelihood and consequence associated with a particular loss event. This judgment may be made through observation and discussion with workers, as well as looking at other information, e.g. accident records. There are various ways in which likelihood and consequence could be categorised; the following is a simple example.

Example

Consider our torn carpet example again. There are a number of possible outcomes **should** someone trip on it; the severity categories might be:

- Minor - minor injury or illness with no significant lost time, such as a slight cut or bruise.
- Lost time - more serious injury causing short-term incapacity from work or illness causing short-term ill health, e.g. broken limb.
- Major - fatality or injury/illness causing long-term disability.

We use our experience to qualitatively judge the **most likely outcome**. We need to be sensible here otherwise we will end up with the worst possible consequence always being death (or even multiple deaths) and the ability to prioritise remedial action is defeated as a result.

In this example, the likely outcome could be that someone would be badly bruised with no significant lost time, and therefore "Minor" would be chosen.

The likelihood of someone tripping over the carpet could be categorised by one of the following terms:

- Very likely.
- Likely.
- Unlikely.

In this example we might judge that the likelihood of exposure to the hazard (coming into contact with the torn carpet) and subsequently tripping might be "Likely".

Think of our earlier equation for risk magnitude:

$$\text{Risk} = \text{Likelihood (or Frequency)} \times \text{Consequence (or Harm or Severity)}$$

It follows then, that, although no numbers are being used, it is easy to see that the risk of someone injuring themselves on the torn carpet is moderate. For this reason, remedial action must be carried out to minimise the risk which in the short term might involve using carpet tape to join the two ends. Where there are a number of hazards that have been assessed in a similar way, it is possible to prioritise the remedial action so that the ones which pose the greatest risk are resolved first.

Clearly each organisation would need to come up with their own categories which reflect the types of injury that may occur along with their likelihood frequency.

If the descriptors "Minor", "Lost time", "Major" are replaced arbitrarily with '1', '2' and '3', respectively, this is still a qualitative risk assessment since there is still no quantitative basis for the choice - just a switch of numbers for words. So, don't think that the mere presence of numbers somehow converts it into a more thorough quantitative assessment.

Semi-Quantitative

In many risk assessments where the hazards are not few and simple, nor numerous and complex, it may be necessary to use some semi-quantitative assessments in addition to the simple qualitative assessments.

This may involve measuring the exposure of a worker to a hazardous substance or noise which can then be used to assess whether the risks to the workers are acceptable or not.

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Semi-quantitative risk assessments may also use a simple matrix to combine estimates of likelihood and consequence in order to place risks in rank order.

Here is a simple 3 × 3 matrix:

The likelihood and consequence are each characterised as low, medium or high and are assigned a number 1, 2 or 3 respectively. The risk is determined by calculating the product of the likelihood and the consequence, so risks range from 1 (low likelihood and low consequence) to 9 (high likelihood and high consequence).

The key point about such matrices is that they are used to rank risks, i.e. put them in order. They have no meaning in terms of their relative sizes so it cannot be assumed that a risk value of 9 is nine times the size of a risk rating of 1.

Matrix ranking risk in terms of likelihood and consequence

Likelihood				
	H = 3	3	6	9
	M = 2	2	4	6
	L = 1	1	2	3
		Low = 1	**Medium = 2**	**High = 3**
		Consequence		

Quantitative Risk Assessment

Quantitative risk assessments attempt to calculate probabilities or frequencies of specific event scenarios. This is sometimes mandated by legislation, so that the results can be compared with criteria on what is considered an acceptable or a tolerable risk. They may use advanced simulation or modelling techniques to investigate possible accidents and will utilise plant component reliability data.

They are sometimes referred to as QRA or Probabilistic Risk Analysis (PRA).

The degree of quantification used is variable. This type of risk assessment typically uses advanced tools such as fault tree analysis and event tree analysis (see later). It relies heavily on having suitable data to calculate the probability or frequency of a defined event.

QRAs are evidence-based (i.e. use 'hard' data) to be as objective as possible. It may not be possible to fully quantify risks - especially for infrequent events. Despite the name, QRAs invariably involve some subjectivity; this is because some broad assumptions may have to be made, e.g. in the application of human reliability assessment. This approach is used for safety cases to establish that the risks have been fully identified, and to justify that enough has been done to reduce the risk to the lowest level reasonably practicable.

QRA is used in high-hazard chemical and nuclear installations and in the offshore oil industry for specific risk scenarios. Such risk assessments are included as part of their safety report requirements. Quantitative methods are also used in setting Occupational Exposure Limits (OELs) for airborne contaminants.

DEFINITION

QUANTITATIVE RISK ASSESSMENT

"The application of methodology to produce a numerical representation of the frequency and extent of a specified level of exposure or harm, to specified people or the environment, from a specified activity. This will facilitate comparison of the results with specified criteria."


High-hazard installation

For major hazard sites, such as large chemical installations, numerical estimates of the probability or frequency of plant failure may be calculated. This is at its most valid when it involves use of component reliability data, simply because the data is available (or can be measured) and is often based on a large sample size and so is statistically valid. The results of particular failure scenarios would then be considered, in terms of the different possible consequences, perhaps using fault trees and event trees (which may use component, structural, system and/or human reliability data). Consequence itself is not usually quantified as such. Rather, many failure scenarios (perhaps several hundred), all with different consequences are modelled, and the probability or frequency of each scenario actually developing is calculated. An example would be the failure of a chlorine storage vessel in a particular way with dispersion modelling of several different release patterns for a toxic gas cloud. In such cases, the likelihood of harm resulting from all the different potential causes of failure, has to be rolled up into a single estimate of the risk from that installation. We will consider some of these points in more detail when we look at failure-tracing methods later in this element.

Organisational Arrangements for an Effective Risk Assessment Programme

As risk assessment is a fundamental component of a health and safety management system, it is important that the process of risk assessment is effectively managed. Earlier in the course we looked at what constitutes an effective health and safety management system; it is sensible to use the elements of a health and safety management system to manage risk assessment.

Plan

- Where you are now and where you need to be.
- What you want to achieve, who will be responsible for what, how you will achieve your aims, and how you will measure your success.
- Write down this policy and your plan to deliver it.
- Decide how you will measure performance, looking for leading as well as lagging indicators (active and reactive).
- Remember to plan for changes and identify any specific legal requirements that apply.

Do

- Identify your risk profile.
  - Assess the risks, identify what could cause harm in the workplace, who it could harm and how, and what you will do to manage the risk.
  - Decide what the priorities are and identify the biggest risks.
- Organise your activities to deliver your plan. In particular, aim to:
  - Involve workers and communicate, so that everyone is clear on what is needed and can discuss issues – develop positive attitudes and behaviours.
  - Provide adequate resources, including competent advice where needed.
- Implement your plan.
  - Decide on the preventive and protective measures needed and put them in place.
  - Provide the right tools and equipment to do the job and keep them maintained.
  - Train and instruct, to ensure everyone is competent to carry out their work.
  - Supervise to make sure that arrangements are followed.

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Check

- Measure your performance.
  - Make sure that your plan has been implemented.
  - Assess how well the risks are being controlled and if you are achieving your aims.
- Investigate the causes of accidents, incidents or near misses.

Act

- Review your performance.
  - Learn from accidents and incidents, ill-health data, errors and relevant experience, including from other organisations.
  - Revisit plans, policy documents and risk assessments to see if they need updating.
- Take action on lessons learned, including from audit and inspection reports.

(Based on original source HSG65 *Managing for Health and Safety, HSE, 2013* (www.hse.gov.uk/pubns/priced/hsg65.pdf))

Acceptability/Tolerability of Risk

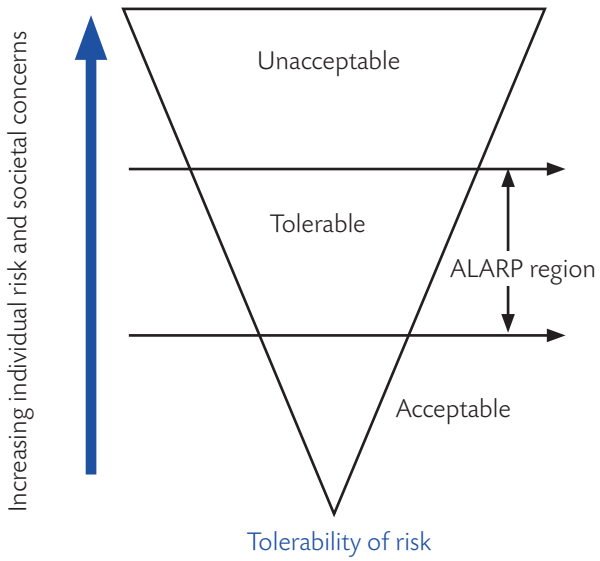
There are criteria by which a society decides which risks it is prepared to expect workers and members of the public to live with, and those it is not. In the UK the criteria are set out in the HSE document *Reducing Risks, Protecting People* (R2P2) in which, broadly speaking, the risks are classified into three categories:

- **Acceptable** - no further action required. These risks would be considered by most to be insignificant or trivial and adequately controlled. They are of inherently low risk or can be readily controlled to a low level.
- **Unacceptable** - certain risks that cannot be justified (except in extraordinary circumstances) despite any benefits they might bring. Here we have to distinguish between those activities that we expect those at work to endure, and those we permit individuals to engage in through their own free choice, e.g. certain dangerous sports/pastimes.
- **Tolerable** - risks that fall between the acceptable and unacceptable. Tolerability does not mean acceptable but means that society is prepared to endure such risks because of the benefits they give and because further risk reduction is grossly out of proportion in terms of time, cost, etc. In other words, to make any significant risk reduction would require such great cost that it would be out of all proportion to the benefit achieved.

  When we discuss **benefits** we mean:

  - Employment.
  - Lower costs of production.
  - Convenience to the public.
  - Maintenance of a social infrastructure, e.g. supply of food or production of electricity.

  These three terms are best illustrated by the following figure:



You can see that the risks that fall into the tolerable region are described as being "As Low As is Reasonably Practicable", often referred to as ALARP.

These are risks that society is prepared to endure on the following assumptions:

- They are properly assessed to determine adequate control measures.
- The residual risk (after the implementation of control measures) is not unduly high.
- The risks are periodically reviewed to ensure they remain ALARP.

How, then, are tolerability limits defined?

- **Boundary Between Acceptable and Tolerable**

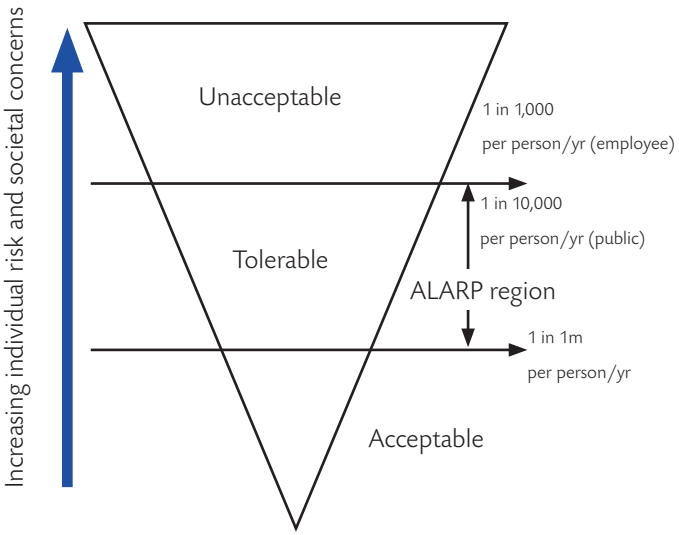
  The UK's HSE believes an individual risk of death of one in 1 million per year, or less for both workers and members of the public, is broadly acceptable. This risk is very low; indeed using gas or electricity, or travelling by air poses a much greater risk.

- **Boundary Between Tolerable and Unacceptable**

  Here there is a distinction between workers and the public.

  – For workers, an individual risk of death of one in 1000 per year represents the dividing line between what is tolerable for an individual for any large part of their working life and what is unacceptable (apart from exceptional groups).

  – For members of the public who have risks imposed on them who live, for example, next to a major accident hazard, the figure is an individual risk of death of one in 10,000 per year, i.e. ten times less risk. This figure equates approximately to the individual risk of death per year as a result of a road traffic accident.



Unacceptable/tolerable/acceptable boundary limits

STUDY QUESTIONS

5. Explain the difference between generic, specific and dynamic risk assessments.

(Suggested Answer is at the end.)

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Systems Failures and System Reliability

IN THIS SECTION...

- Systems comprise a collection of interrelated processes that all need to be managed as a whole.
- Systems can have very complicated interactions between processes and the failure of the system (or potential failure) may need detailed investigation to discover the (potential) causes by adopting both holistic and reductionist approaches.
- The overall reliability of equipment depends on both the reliability of all components and the way in which they are arranged. As well as the individual reliability of each element, the system reliability will be affected by the way those elements are connected together. They may be connected:
  - In series, i.e. one after the other, so that the failure of any one piece means the failure of the system.
  - In parallel, i.e. side by side.
  - As a combination of both.
- Methods for improving system reliability include:
  - Use of reliable components.
  - Quality assurance.
  - Parallel redundancy.
  - Standby systems.
  - Minimising failures to danger.
  - Planned preventive maintenance.
  - Minimising human error.

Meaning of the Term 'System'

A system is:

- A group of interacting, interrelated, or interdependent elements forming a complex whole.
- A set or arrangement of things so related or connected as to form a unity or organic whole.

Systems comprise a collection of interrelated processes that all need to be managed as a whole. In health and safety, we are often interested in the organisation as a system so that, when things go wrong, we need to be able to analyse the system to find out which parts have failed.

The organisation is a system

Principles of System Failure Analysis

Systems can have very complicated interactions between processes and the failure of the system (or potential failure) may need detailed investigation to discover the (potential) causes. There are two basic approaches: holistic and reductionist.

Holistic Approach

This requires looking at the behaviour of the total system rather than the isolated workings of individual components, e.g. the workings of a car or the use of a telephone.

Holistic means trying to understand all the interactions between the separate components as they work together as a whole - everything affects everything else.

Reductionist Approach

This approach divides the system into its components for individual analysis to identify system or subsystem failures, e.g. in a HAZOPS or FMEA study (see below).

Analytical Considerations of Systems and Subsystems Failures

Given the need for a systems approach to risk management and that a thorough investigation of an accident, incident or disaster requires a detailed analysis of the underlying causes, we need to understand how complex systems such as organisations, process plant, items of equipment or human/machine interfaces can be broken down into sub-elements for more detailed investigation.

Failure tracing methods are a good example of how to treat the fault, failure or events systemically:

- **Hazard and Operability Studies (HAZOPS)** is a powerful tool, developed primarily for use on chemical process plants but now with wide applicability. It employs a methodical approach using specialists guided by a formal system. The process critically examines sub-components of the process system (e.g. vessels, tanks, pipework) using guide words such as 'high, low, more, less' applied to key parameters such as pressure, temperature, flow, etc. The aim is to identify deviations from design intent that could have critical consequences and establish necessary safeguards at the design stage.
- **Failure Mode and Effects Analysis (FMEA)** is a simple but effective tool to improve reliability. The purpose of the analysis is to explore the effect of failures or malfunctions of individual components within a system. Consequently, the system needs to be broken down into sub-components, which can then be analysed for failure. So, for each sub-component, we examine the possible failure modes, the effect of this failure, and the consequences of the failure in terms of severity and likelihood of detection, which can be allocated a Risk Priority Code (RPC). This analytical approach allows us to focus on the critical failure modes where we need to improve reliability.

ITEM	COMPONENT	FAILURE MODE	EFFECT	RPC	ACTION REQUIRED

Failure mode and effects analysis table

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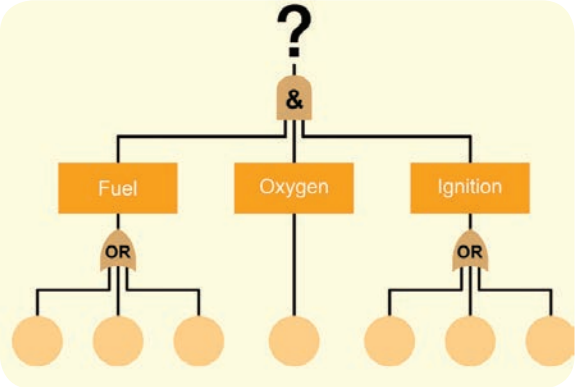
- **Fault Tree Analysis (FTA)** acknowledges the fact that most accidents are multi-causal, and employs analytical techniques to trace the events that could contribute. The fault tree is a logic diagram which traces all the branches of events that could contribute to an accident or failure. Consequently, we need to be able to identify the sub-elements that have a bearing on the final event; e.g. for an explosion, we need a flammable atmosphere, a source of ignition and enough oxygen. We then examine each of these sub-components to identify how they could arise. We can use quantified techniques, if necessary, to establish the critical events where reliability needs to be improved and introduce measures which will make the original accident or failure less likely.



Simple fault tree for an explosion

- **Event Tree Analysis (ETA)** starts with a primary event, then develops the resulting sequence of events that describe potential accidents, examining both the success and failure of safeguards as the accident sequence progresses. Event trees provide a methodical way of recording accident sequences and defining the relationships between initiating events and subsequent events within the system under study.

The selection of an appropriate tool for system and subsystem analysis will depend on the size and complexity of the system. It may be that a combination of tools is used, with HAZOPS or FMEA identifying critical failure modes, and ETA and/or FTA quantifying the consequences.

Using Calculations in the Assessment of System Reliability

Equipment Reliability

A question which is directly related to the maintenance and replacement of equipment concerns its reliability.

If equipment becomes unreliable and starts to break down, there will come a point when it is better to replace it than continue repairing and maintaining. It is, however, possible to increase the reliability of the process by having standby equipment in reserve, which is only used when there is a breakdown.

Some costs are increased (by having unused equipment), but these may be more than offset by the benefits from a more reliable process. This is the same principle as keeping a spare wheel in a car.

A reliability of 90% means there is a probability of 0.9 (out of 1) that the part will continue to operate normally for the period under investigation. To simplify things we will phrase the discussion in terms of equipment made up of components, but this is not meant to imply any limit on applications.

The overall reliability of equipment depends on both the reliability of all components and the way in which they are arranged. If a single component has a reliability of R, putting two identical components in parallel will increase the overall reliability. The assumption is that the second component will only start to operate when the first one fails or is out of commission, and that the system can work adequately with only one of the components operating. Adding more components in parallel increases reliability, as the equipment will only fail when all components fail.

In many cases, a system consists of several individual elements or subsystems. Each element will have a reliability value of its own which contributes to the overall system reliability. As well as the individual reliability of each element, the system reliability will be affected by the way those elements are connected together. They may be connected:

- In series, i.e. one after the other, so that the failure of any one piece means the failure of the system.
- In parallel, i.e. side by side.
- As a combination of both, which is quite common.

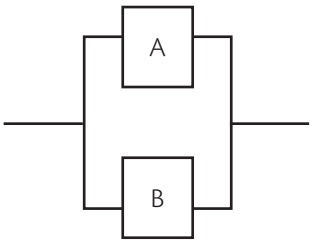
By 'reliability' we mean the probability of functioning when required. So a system which has a reliability of 0.95 will operate 95 times out of 100, in the long term. If there were five individual elements connected in series, with each element having a reliability of 0.99, the overall system reliability would be 0.99 to the power 5 = 0.95099 or 95.1%. If there were 10 such elements so connected, the overall reliability would be 0.99 to the power 10 = 0.90438 or 90.4%.

Consider a system of two identical components in parallel, with the reliability of each component *R*. The probability that a component continues normal operations is *R*, so the probability that it will stop operating during a specified period is 1 – *R*. The probability that both components fail is (1 – *R*) squared. The reliability of the system is the probability that at least one of the components is operating, which is 1 – (1 – *R*) squared. Similarly, the probability that *n* identical components in parallel will all fail is (1 – *R*) to the power *n*, and the reliability of the system is 1 - (1 – *R*) to the power *n*. It follows that **any system of parallel components is more reliable than the individual components**.

If components are added in series the reliability of the system is reduced. This is because a system with components in series only works if all separate components are working. Consider two components in series. If the reliability of each is *R*, the reliability of the two is the probability that both are working, which is R^2. If there are *n* components in series, their reliability is *R* to the power *n*. Thus, a system of components in series is less reliable than the individual components. These calculations are explained more fully in the following subsections.

Parallel Systems

In a parallel system, the failure of one component will not stop the system functioning.



Parallel system

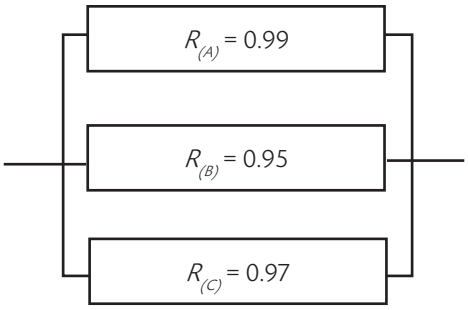
The reliability of the system is described mathematically as:

$$R_{(S)} = 1 - [(1 - R_{(A)})(1 - R_{(B)})]$$

(You are not required to know how the mathematics for this works, merely to remember the equation.)

The number of terms will increase with an increasing number of components in parallel.

Consider these three components in parallel:



Three components in parallel

The formula for this would be:

$$R_{(S)} = 1 - [(1 - R_{(A)})(1 - R_{(B)})(1 - R_{(C)})]$$

$$R_{(S)} = 1 - [(1 - 0.99)(1 - 0.95)(1 - 0.97)]$$

$$R_{(S)} = 1 - [(0.01)(0.05)(0.03)]$$

$$R_{(S)} = 1 - [0.000015]$$

$$R_{(S)} = \mathbf{0.999985 \text{ or } 99.9985\%}$$

Notice how much change has been introduced to the system. In series, the reliability is reduced to less than any of the individual components; in parallel, it is increased.

In an attempt to improve the reliability, the possibility of having components in parallel throughout the system may be considered. Unfortunately, there would be a financial cost to this. All the additional components that would have to be included would add to the cost of the finished product, with the result that it would be uneconomic to produce. There would also be a subsequent increase in size to accommodate the extra components.

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Series Systems

In series, components are joined to each other such that all must function for the system to operate. The following figure shows two components in series:

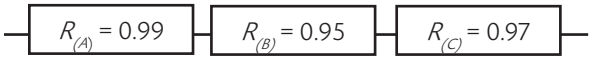
Series system

To calculate the reliability of the series system, the reliabilities are multiplied together:

$$R_{(s)} = R_{(A)} \times R_{(B)}$$

This applies no matter how many components are in the system.

For example, consider the next figure:



Three components in series

The reliability of the system *R(s)* is described mathematically as:

$$R_{(S)} = R_{(A)} \times R_{(B)} \times R_{(C)}$$

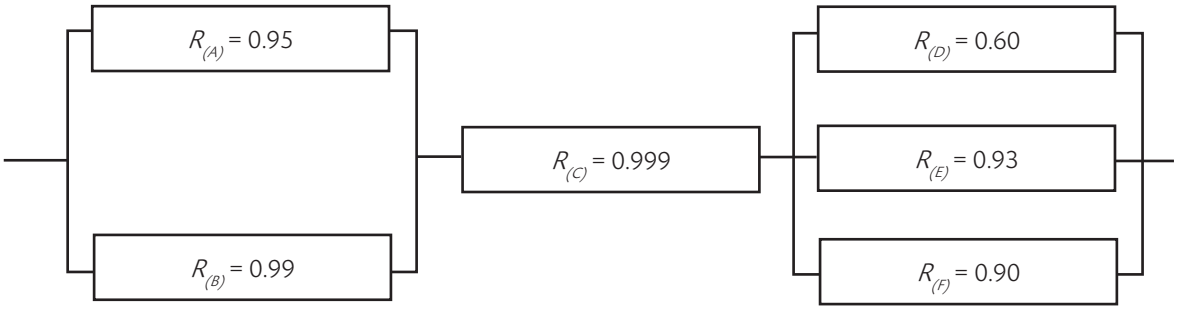
$$R_{(S)} = 0.99 \times 0.95 \times 0.97$$

$$R_{(S)} = \mathbf{0.91 \text{ or } 91\%}$$

Notice that the reliability figures are presented in the calculation as a figure, not a percentage. Also note how the individual effects quickly combine to reduce the reliability of a series system.

Mixed Systems

Unfortunately, systems are not composed solely of series systems or parallel ones but are generally mixed. To calculate the efficiency of a system, consider the example given in the following figure:



Mixed system

The basic principle is to break down the overall system into component series and parallel systems and treat each separately.

Looking at the parallel system involving $R_{(A)}$ and $R_{(B)}$:

$$R_{(1)} = 1 - [(1 - R(A))(1 - R(B))]$$

$$R_{(1)} = 1 - [(1 - 0.95)(1 - 0.99)]$$

$$R_{(1)} = 1 - [(0.05)(0.01)]$$

$$R_{(1)} = 1 - (0.0005)$$

$$R_{(1)} = \mathbf{0.9995}$$

Looking at $R_{(D)}$, $R_{(E)}$ and $R_{(F)}$:

$$R_{(2)} = 1 - [(1 - R_{(D)})(1 - R_{(E)})(1 - R_{(F)})]$$

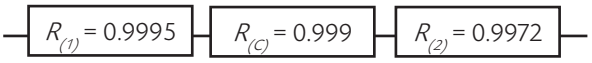
$$R_{(2)} = 1 - [(1 - 0.60)(1 - 0.93)(1 - 0.90)]$$

$$R_{(2)} = 1 - [(0.40)(0.07)(0.10)]$$

$$R_{(2)} = 1 - (0.0028)$$

$$R_{(2)} = \mathbf{0.9972}$$

The system can now be reproduced as a series system, shown in the following figure using the figures obtained for $R_{(1)}$ and $R_{(2)}$



Interim stage

$$R_{(S)} = R_{(1)} \times R_{(C)} \times R_{(2)}$$

$$R_{(S)} = 0.9995 \times 0.999 \times 0.9972$$

$$R_{(S)} = \mathbf{0.9957}$$

This example shows what is done in industry. The components that are less reliable are put in a parallel system to increase their reliability, while those with good reliability are left in series.

Unfortunately, not all systems are designed to break themselves down into neat parallel or series packages. Sometimes the system will have cross-connections.

To resolve the reliability of these systems, there are mathematical models that need to be used to analyse the system in each of the various operational modes and combine the findings. While these are important tools in the study of reliability, the mathematics and methods are beyond the scope of this course.

Common Mode Failures

Failure is defined as "*the termination of the ability of an item to perform a required function*". Common mode failure is where two or more components fail in the same way or mode due to a single event or cause, e.g. two or more pairs of braces attached to the **same** buttons will fail in the same way if the buttons fail. This will not happen if we have one pair of braces and a belt instead. Other examples might be:

- A machine where all the components are badly serviced by the same man with poorly calibrated equipment.
- Several components all connected to one other component - if that fails, they all fail in the same way due to that cause.

Principles of Human Reliability Analysis

Think about a person who is driving an unfamiliar car. The driver knows how to drive (a licence confirms that, i.e. training and certification). The driver will identify where all the controls are and what they do (familiarisation) and set off. A problem may occur if the windscreen wipers and the indicator stalks are reversed as compared to the normal arrangement. Initially, indicating during driving will be correct, but at some point the windscreen wipers will operate instead of the indicators. A human error will have occurred in a situation where the driver has already demonstrated an understanding of the working of the indicator controls.

Hardware design can only go so far for improved reliability; there still exists the human input into the operation. We have only mentioned human reliability as basically 'unreliable'. The question we have to ask of this human input is: "*How unreliable is it?*". We then have to establish the answer to this question.

Humans do not work in the same way as machines. They are not good at carrying out repetitive tasks to a consistent standard, nor do two humans perform in the same way. The reliability of a human being cannot, therefore, be determined to the same accuracy as a machine, but action can be taken to make reasonable assessments of the type and frequency of error so that positive action can be taken to minimise the effects.

HRA is a structured way of estimating the probability of human errors

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Human Reliability Analysis/Assessment (HRA) is a structured way of estimating the probability of human errors in specific tasks. It is used as part of certain risk assessment processes (e.g. QRA in the nuclear, offshore and chemical industries).

The methodology for HRA is similar in principle to task analysis:

- Determine the scope of the assessment (aim, tasks, etc.).
- Gather information (observation, etc.).
- Describe the tasks (goals, steps, interactions between person and system).
- Identify any potential human errors.
- Estimate overall human error probabilities for the task (if needed): measure, calculate, use of experts, use of some formal methods (e.g. THERP, SLIM, HEART*). This area is based on some judgment - it is not precise and involves estimates.
- Give the result to system analyst to incorporate into the overall risk assessment of the system and consider if human error has a significant impact on the system.
- Develop control measures (if there is significant risk).

* THERP is 'Technique for Human Error Rate Prediction', SLIM is 'Success Likelihood Index Method' and HEART is 'Human Error Assessment Reduction Technique'. HEART is a technique to arrive at the human error probabilities (HEPs) by matching the task being assessed to one of nine generic task descriptions from a given database and then to modify the HEPs according to the presence and strength of the identified error-producing conditions (EPCs).

Methods for Improving System Reliability

For any organisation, it is extremely important to have reliable systems in place to ensure that:

- Orders can be produced on time.
- Downtime is kept to a minimum.
- Where reliability affects safety, individuals are protected.

It is vital that reliability is designed in at every stage of the process.

The quality of components is important in maintaining system reliability

Use of Reliable Components

A system is only as reliable as the components that make it up. For this reason, it is vital that suitable, good quality, well-proven components from reputable suppliers are used. It is important that quality checks are carried out on the parts to ensure that they meet legal specifications, as well as any additional specified ones. Suppliers can be asked to provide details of their quality assurance procedures and testing regimes.

Quality Assurance

Materials will be delivered to the factory for processing into the finished product. As there are a number of opportunities for the product to fail to meet the required standard during the manufacturing process, there is a need to check at each stage. These checks should be recorded and a management process introduced that does this. This is **quality control**. The system will probably be one based on the **BS ISO 9000** series of documents detailing **quality assurance**.

These records are important in the event of a failure.

Parallel Redundancy

Additional components can be added in parallel so that, if one component fails, the other one will keep the system going. While this can be costly if components are expensive, it does mean that the system is less likely to fail as often and hence unplanned downtime is kept to a minimum.

Standby Systems

In order to prevent a system failure, a standby system can be installed so that, should part of the system or a component stop working, then an alternative system automatically steps in to continue operation. This type of system is invaluable where failure of the system could affect safety, e.g. lighting in an operating theatre.

Minimising Failures to Danger

When a system does fail, it is important that the failure does not end with the production of a hazardous situation. For this reason, it is vital that systems fail to safety. There is a number of ways of achieving this. One of the most important ways is through good design, e.g. ensuring that dangerous machinery has an automatic power cut-out as soon as a hazardous component fails.

Planned Preventive Maintenance

Planned preventive maintenance will improve safety and plant integrity as well as reliability. It is a means of detecting and dealing with problems before a breakdown occurs. For example, car manufacturers recommend that the oil is changed at specified intervals to prevent failure of the system and increase reliability.

Minimising Human Error

Human error does occur but can be minimised by ensuring that the:

- 'Right' person is doing the 'right' job.
- Individual has adequate training and instruction.
- Individual receives appropriate rest breaks.
- Man-machine interface is ergonomically suitable.
- Working environment is comfortable, e.g. noise, lighting, heating, etc.

STUDY QUESTIONS

6. (a) Define the term 'failure'.

   (b) Explain what is meant by 'common mode failure'.

7. Outline the methods available for improving human reliability.

8. (a) Draw a diagram of a system containing two components connected in series.
   (b) If the reliability of each component is 0.9, calculate the reliability of the complete system.

(Suggested Answers are at the end.)

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Failure Tracing Methodologies

IN THIS SECTION...

Failure tracing methods are structured techniques to assist in hazard identification and risk assessment. They include:

- Hazard and operability studies – identify hazards in a system and their effect on the system.
- Fault tree analysis – identifies the necessary events and how they combine to lead to a loss event called the Top Event.
- Event tree analysis – used to identify the possible consequences from an event and the influence of controls.

A Guide to Basic Probability

To understand the advanced risk assessment techniques that involve quantified risk assessment you need to understand the basic principles of probability.

Probability is the chance of an event occurring

Probability of a Single Event Occurring

Probability relates to the chance of an event occurring and in numerical terms can only have a value between 0 and 1:

- 0 means there is no chance of it happening, i.e. it is impossible.
- 1 means it is certain to happen.

Suppose we toss a coin.

There are only two possible outcomes, namely Heads or Tails.

- So, the probability of getting Heads, i.e. ½, or, 0.5.
- The probability of getting Tails is also ½, or, 0.5.

You will notice that given that there are only two possible outcomes, the sum of the two probabilities equals one, i.e.

Probability of Heads + Probability of Tails = 0.5 + 0.5 = 1.

Similarly, if we threw a six-sided dice, the probability it would land showing a six would be 1/6 = 0.167.

Probability of Multiple Events Occurring

Suppose we now toss a coin twice. What is the probability that on both occasions it will show Heads?

Here are all the possible outcomes:

- Heads and then Heads.
- Heads and then Tails.
- Tails and then Heads.
- Tails and then Tails.

There are four outcomes but only one matches "Heads and then Heads"; the probability is therefore ¼ = 0.25.

The probability is simply the product of each of the two events, i.e. ½ × ½ = ¼ =0.25.

So if we wanted to know what the probability is of obtaining three sixes if we threw three separate dice, it would be:

1/6 × 1/6 × 1/6 = 1/216 = 0.0047, which is not very likely!

So to calculate the probability of two or more independent events occurring, we **multiply** the probabilities.

Incidentally, the probability of winning the UK Lotto, i.e. selecting all six winning numbers, is 1 in 44,000,000, which is an extremely remote event! Yet, of course, as millions of people play every week there is often a winner.

Suppose we now wanted to know what the probability is of getting a 1 OR a 6 if we threw a dice.

The possible outcomes are, of course, 1, 2, 3, 4, 5 and 6. Of these six possibilities two meet our requirement of 1 or 6, i.e. 2 out of 6 = 2/6 (or 0.33).

- The probability of getting a 1 is 1/6.
- The probability of getting a 6 is also 1/6.

So the probability of getting a 1 OR a 6 is 1/6 + 1/6 = 1/3.

In other words, when we want to know the probability of one event or another, we ADD the probabilities of the two separate events.

Understanding these principles will be very useful to you when we look at Fault Tree Analysis.

The probability of rolling a six is 1/6

Probability and Frequency

In risk assessment we sometimes refer to the probability of an event and sometimes to the frequency of an event. What is the difference?

- **Probability** is the chance something will happen. So if the probability of tripping over a torn carpet happened to be 1 in a 1000, then this means that if 1000 people walked over the tear, on average, one would trip. How long this would take would depend how long it takes 1000 people to encounter the tear. If the tear was in a busy walkway, it might be only a matter of a few hours or less; if it was in a room that was hardly used, it might take many years. So exposure to the hazard is very important.
- **Frequency** takes account of the exposure. So if we say the event will happen on average once every 10 years, we say its frequency is 1/10 or $0.1y^{-1}$.

  We cannot combine frequencies, i.e. add or multiply them in the same way that we can probabilities, but we can multiply a frequency with a probability.

  Consider an event which has a probability of harm of 1 in 100, i.e. 0.01, and we know the event occurs 300 times a year; the frequency of the harm will be:

  0.01 (probability of harm) × 300 (frequency of occurrence per year) = 3 harmful events a year.

Principles and Techniques of Failure Tracing Methods in the Assessment of Risk

Failure tracing methods may be used in more detailed risk assessments. They are unnecessary in most cases, but provide a systematic methodology for identification of hazards and, in some cases, calculation of failure probabilities, for more complex cases; they are used extensively in, for example, quantified risk assessment. They can be used qualitatively and some quantitatively as well. Some can be used to model incidents and so can be used in accident investigation.

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Hazard and Operability Studies (HAZOPs)

The HAZOP method is designed for dealing with relatively complex systems, such as large chemical plants or a nuclear power station, where a deviation from what is expected in one component of the system may have serious consequences for other parts of the system The principles can be used in simpler situations, but a full HAZOP will not usually be cost-effective, except in a high risk situation. We will cover the principles and outline the technique.

HAZOPs are a form of structured "brainstorming".

The studies are carried out by a multidisciplinary team, usually made up of four to seven people. Members typically include:

- Study Leader - should not be closely involved with the project but should have good experience of HAZOP and can keep the team focused.
- Recorder - documents the proceedings.
- Designer - explains how the system should work.
- A user of the system, such as a production manager.

HAZOP studies are carried out by multi-disciplinary teams

Others who may contribute include:

- Maintenance engineer.
- Software specialist.
- Safety expert.
- Instrument engineer.

The team have a diagram that represents the system, showing each of the components of the system and how they are related. In the case of a chemical process plant this would be a pipeline and instrumentation diagram.

The steps involved in a HAZOP are:

- Divide the system into parts (sometimes called nodes). In the case of a chemical process plant this might be a pipeline between a storage vessel and a reactor.
- For each part define the design intention, i.e. what is meant to occur when it is operating normally.
- Apply a number of 'guide words' to the statement of intention, so that every possible deviation from the required intention is considered. The main guide words are:

NO or NOT	Negation of intention, e.g. no flow.
MORE	Quantitative increase, e.g. high pressure.
LESS	Quantitative decrease, e.g. low temperature.
AS WELL AS	Qualitative increase, e.g. impurity present.
PART OF	Qualitative decrease, e.g. only one of two components present.
REVERSE	Logical opposite of intention, e.g. backflow.
OTHER THAN	Complete substitution, e.g. flow of wrong material.

Let us consider a simple example.

In a batch process, two substances, A and B, are pumped from their respective storage vessels into a reaction vessel:

Parameter	Guide word	Deviation	Cause	Consequence	Actions
Flow of 'A'	No	No flow	Pump failure Pump off Line blockage Tank empty Reactor full	Incorrect product/reaction doesn't occur	Indicate pump working at control panel Maintain lines Level control on tank, etc.
	More	More flow	Pump at wrong rate	Incorrect product/reaction doesn't occur	Automatic control of pump rate

The design intention is for equal amounts of A and B to be pumped into the reactor vessel.

We can identify two parts to this system:

- Storage vessel A and the pipeline and pump to the reactor vessel.
- Storage vessel B and the pipeline and pump to the reactor vessel.

Let us apply the first guide word "NO" to the first part. In this case it would mean "no flow".

Think of some reasons why there might be no flow in the pipeline.

Here are some suggestions:

- Pump A has failed.
- Pump A not switched on.
- Storage vessel A is empty.
- Reactor vessel is full.
- Pipeline blocked.

Having established the possible causes of this deviation we then need to make an estimate of the risk for each cause. In other words:

- How likely is this deviation?
- How soon would we know that the deviation had occurred?
- What are the consequences?
- How serious are the consequences?

Having assessed the risk, we need to determine whether the existing control measures are adequate, or whether we need to add additional ones. In our example we might introduce a level gauge in the storage tank and reactor vessel, each linked to an alarm so that the operator of the plant would know when the levels were too high or too low. We might introduce a more reliable pump or even a second (redundant) pump that could take over should the first one fail.

Having considered this deviation we would then move on to the next guide word, which in this case would mean "more flow". Having examined flow we would move on to other parameters such as temperature and pressure, and apply the guide words again.

Clearly even a relatively simple system can result in a significant and lengthy analysis. For a major plant it can take considerable time and involve significant expenditure.

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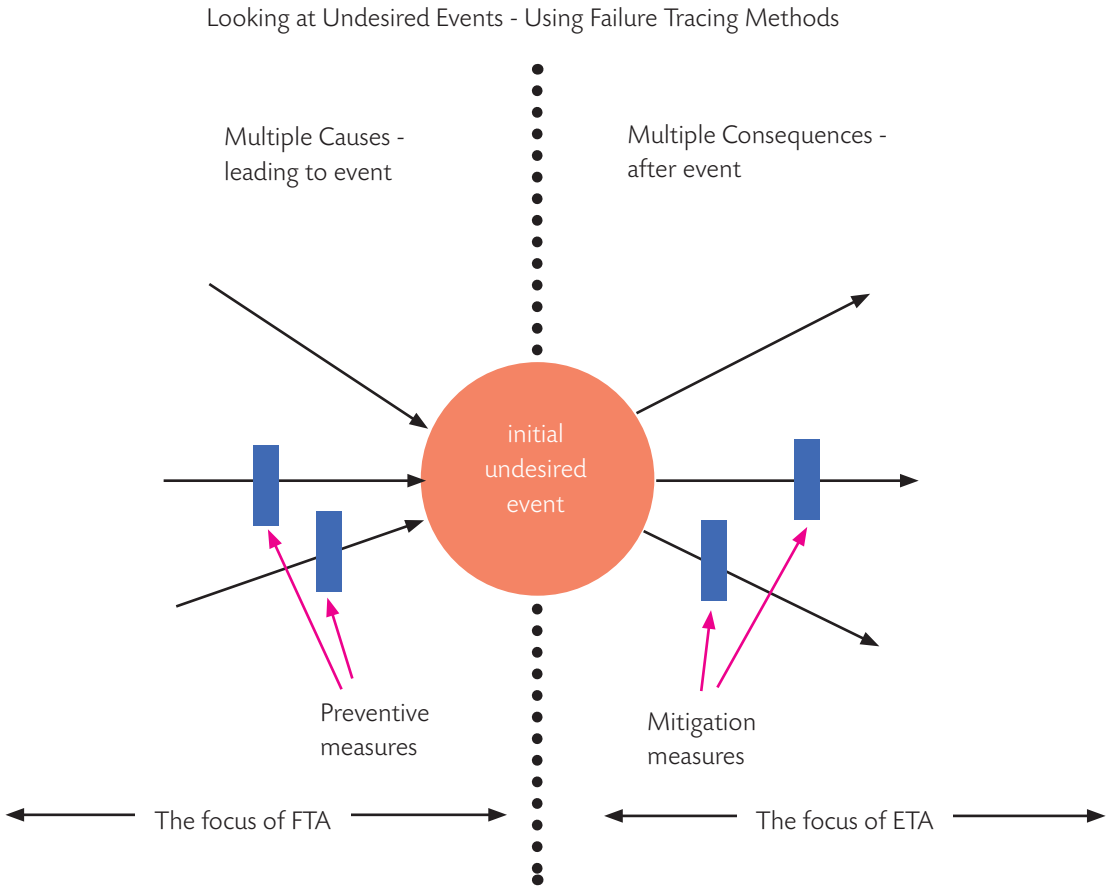
Fault Tree Analysis (FTA) and Event Tree Analysis (ETA)

Be careful not to get confused between these two techniques; they are, in fact, complementary (and are often used together) but focus on opposite sides of an undesired event. The following figure shows how they fit together:



Relationship between FTA and ETA ('Bowtie' model)

The figure only shows a single 'undesired event'; in reality, multiple causes can lead to many different events initially, each then escalating with multiple consequences. You can analyse each event with FTA and ETA. In summary, FTA is concerned with analysing faults which might lead to an event, whereas ETA considers the possible consequences once an undesired event has taken place. Both can be applied qualitatively or, if you have the data, quantitatively.

Fault Tree Analysis (FTA)

In many cases, there are multiple causes for an accident or other loss-making event. Fault tree analysis is one analytical technique for tracing the events which could contribute. It can be used in accident investigation and in a detailed risk assessment.

The fault tree is a logic diagram based on the principle of multi-causality, which traces all branches of events that could contribute to an accident or failure. It uses sets of symbols, labels and identifiers. For our purposes, you will only need a handful of these:

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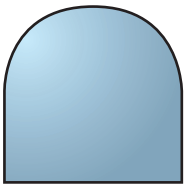
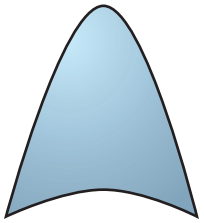
EVENT

Represents the Top event or sub events



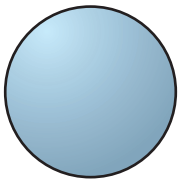
AND gate

Output only exists if ALL of the Inputs exist



OR gate

Output only exists if ANY one of the Inputs exist



Basic fault

Represents the root, or basic, cause

A fault tree diagram is drawn from the top down (like an upside down tree). The starting point is the undesired event of interest (called the Top Event because it gets placed at the top of the diagram). You then have to logically work out (and draw) the immediate and necessary contributory fault conditions leading to that event. These may each in turn be caused by other faults and so on. Each branch of the tree is further developed until a primary failure (such as a root cause) is identified. It could be endless (though, in fact, you will naturally have to stop when you get as far as primary failures). The most difficult part is actually getting the sequence of failure dependencies worked out in the first place. Let's look at a simple example of a fire to illustrate the point.

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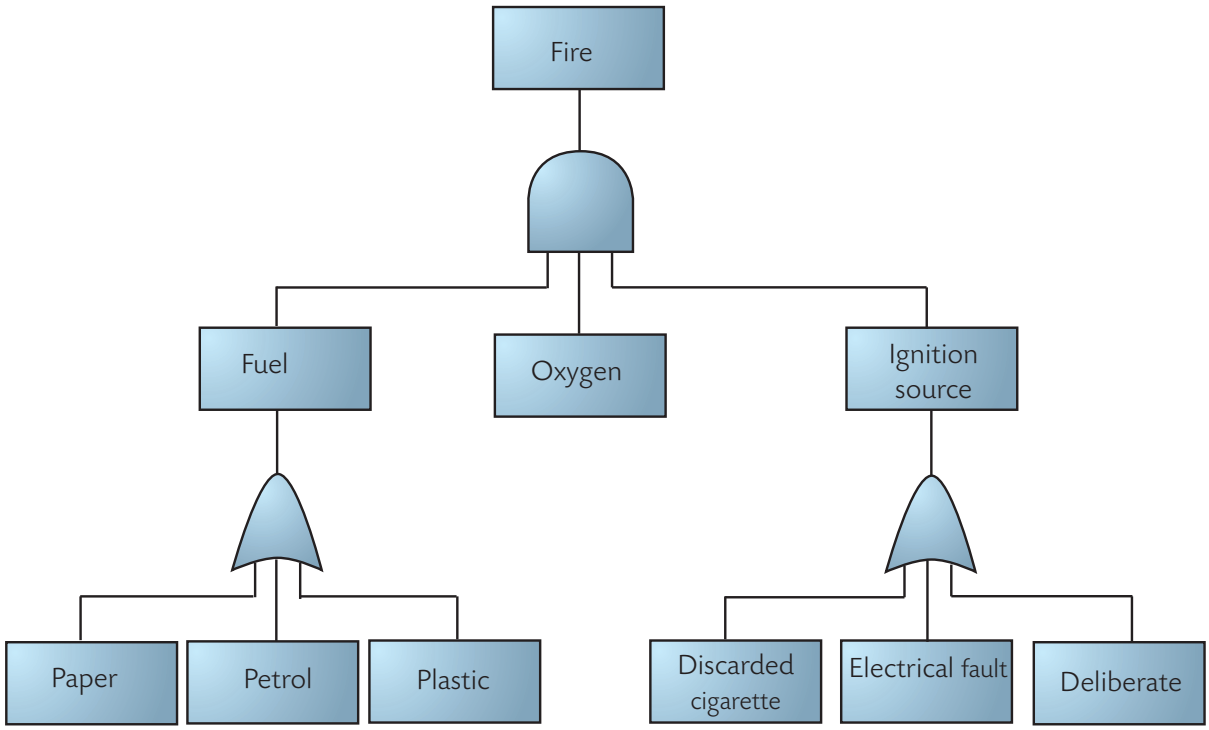


Fault tree analysis of a fire

The above figure shows a simple fault tree for a fire.

For the fire to occur there needs to be:

- Fuel.
- Oxygen.
- An ignition source.

Notice we use an AND gate to connect them here because all three need to be present **at the same time** to allow the Top Event. The example shows that, in this scenario, there happen to be three possible sources of fuel and three possible sources of ignition. An OR situation applies in each case, because it would only need one of these to be present. The example also shows a single source of oxygen (e.g. the atmosphere).

To prevent the loss taking place, we would first examine the diagram for AND gates. This is because the loss can be prevented if just one of the conditions is prevented.

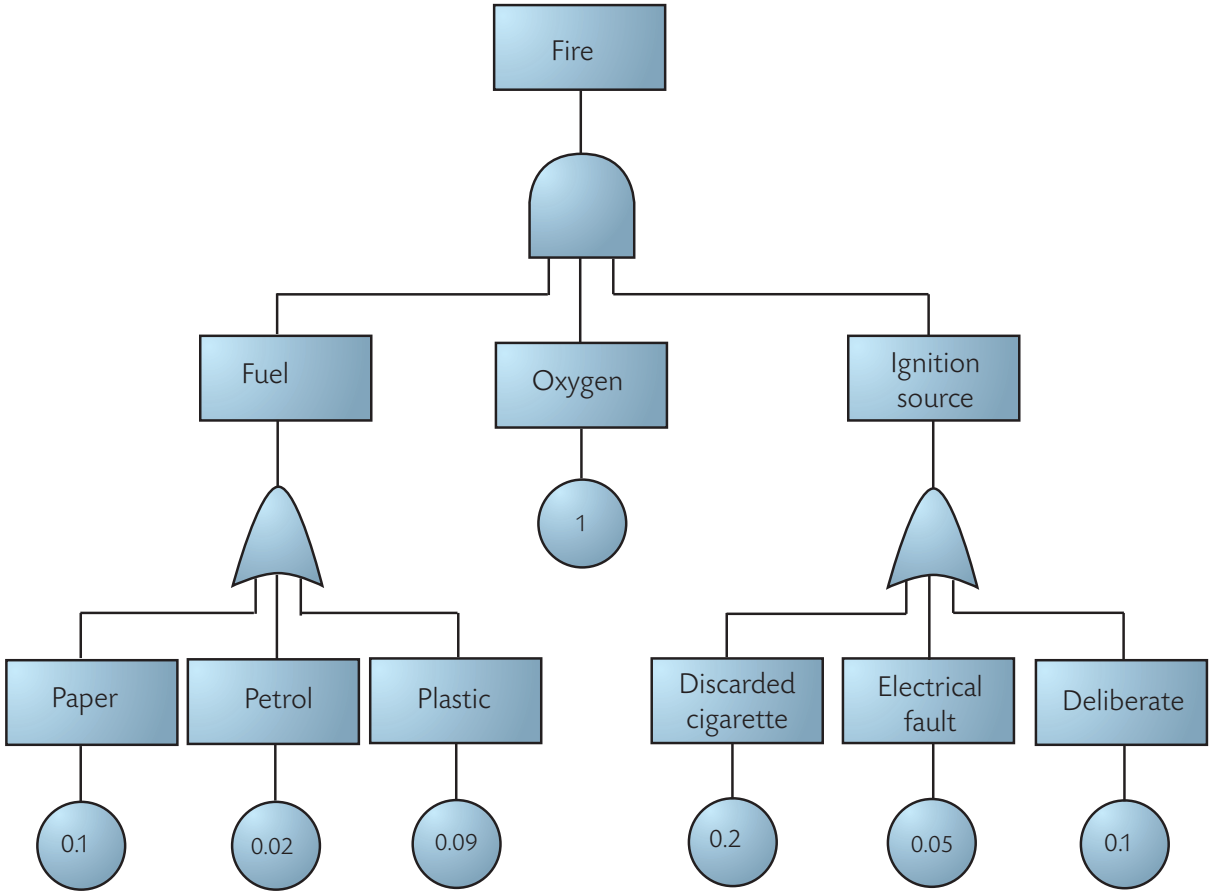
Fault trees can also be quantified, but need relevant data on the respective probabilities of each of the sub events.

HINTS AND TIPS

Don't worry about getting the symbols precisely right when you draw fault trees by hand; you can make your intentions quite clear by writing 'AND' or 'OR' in the appropriate logic gate as well. Also, as long as you describe the fault/failure in a box, don't worry too much about the (sometimes subtle) distinction between what should go in rectangles and circles.

Let's try this on the same example.

From previous experience, or as an estimate, a probability for each of the primary failures being present or occurring can be established, shown in the following figure (these are purely illustrative):



(We've assigned a probability of 1 for oxygen being present, as it is always in the surrounding atmosphere.)

We can then use two well-established rules of combination of these probabilities and progress up the diagram to get at the probability of the Top Event (fire) occurring. Essentially we:

- **Add** the probabilities which sit below an OR gate (this isn't strictly correct, but is a 'rare event' approximation).
- **Multiply** the probabilities which sit below an AND gate

So, in this example, combining probabilities upwards to the next level gives:

Probability of FUEL being present = 0.1 + 0.02 + 0.09 = 0.21.

Probability of OXYGEN being present = 1.

Probability of IGNITION being present = 0.2 + 0.05 + 0.1 = 0.35.

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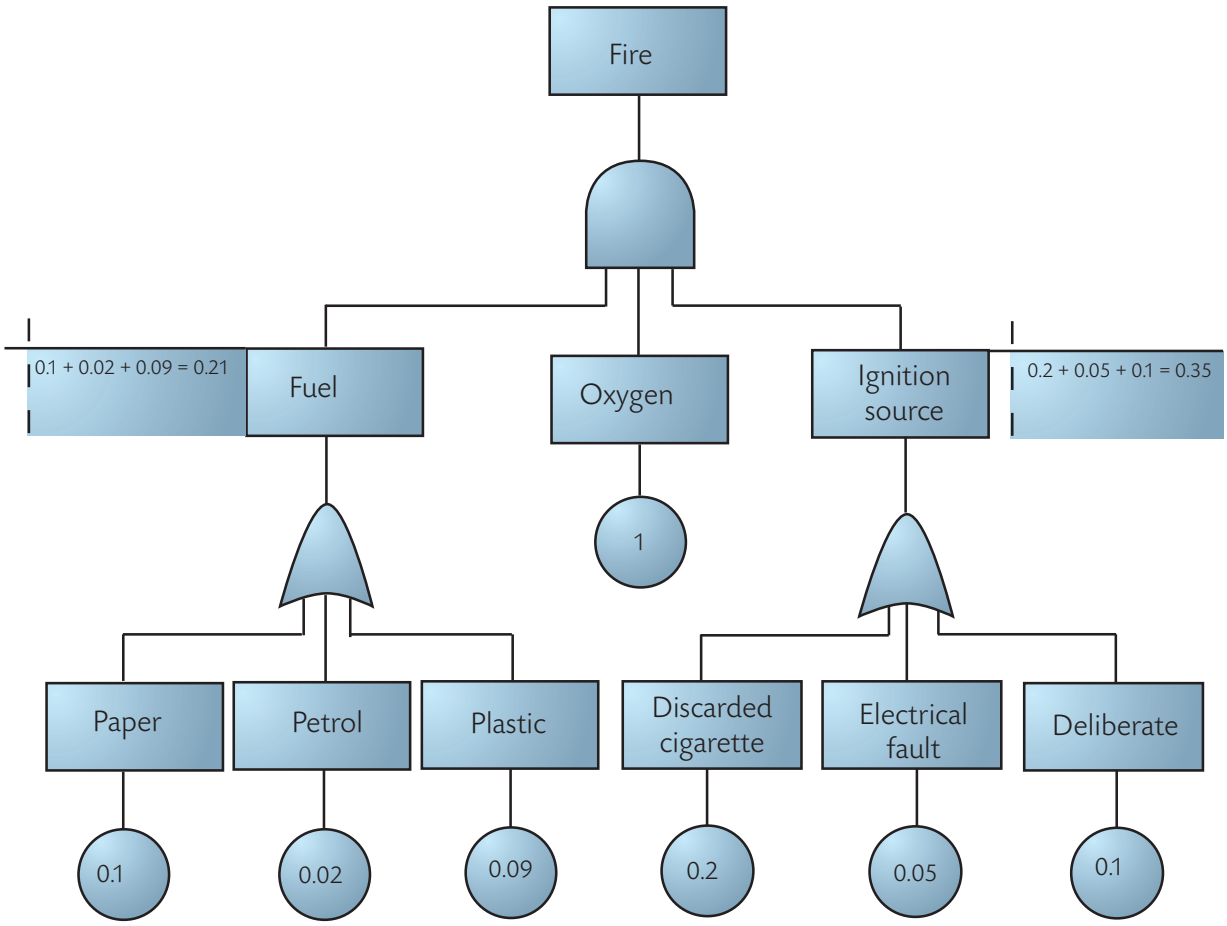
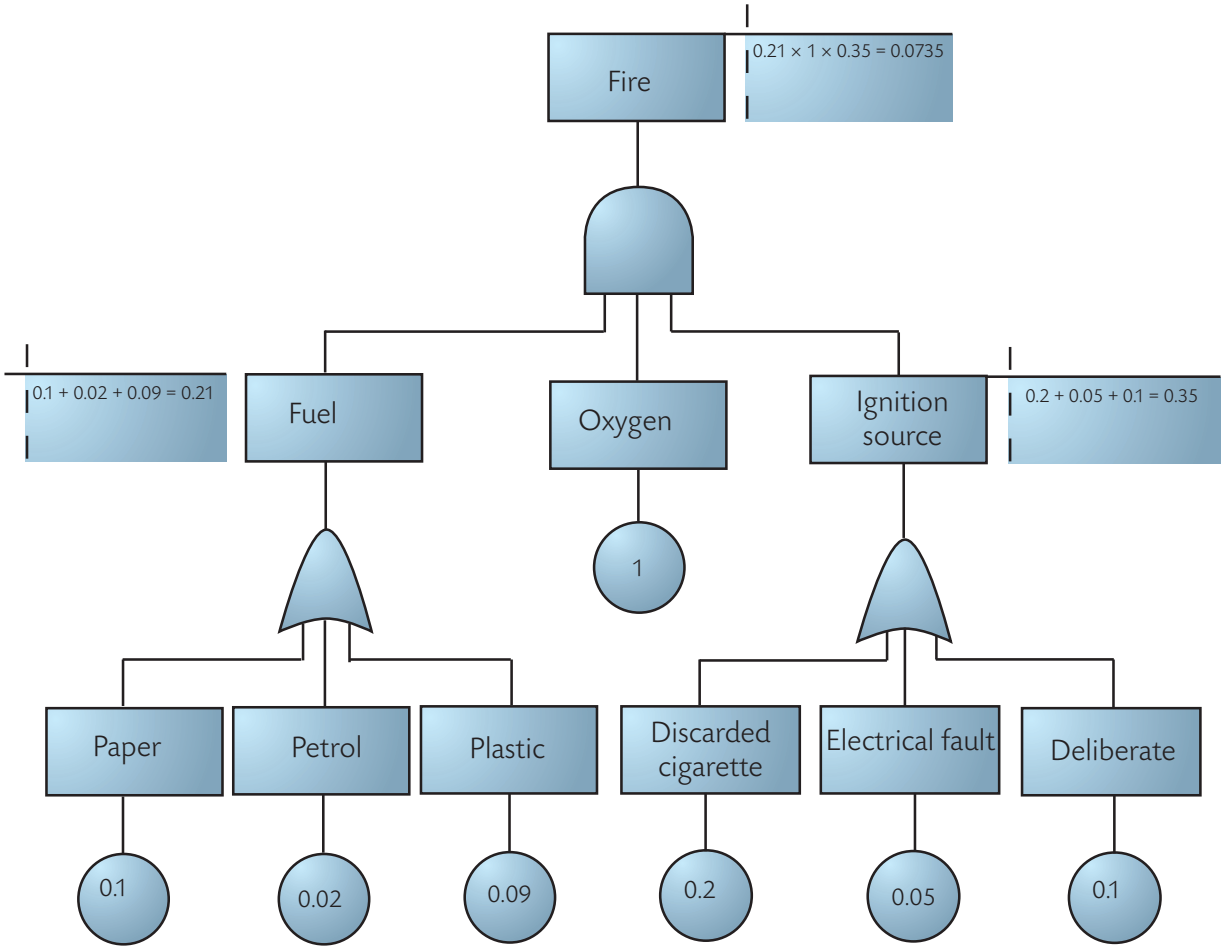
Updating the figure:



Moving up again, we can now calculate the probability of the Top Event. These faults are below an AND gate, so we multiply the probabilities, giving 0.21 × 1 × 0.35 = 0.0735. The fully quantified fault tree then looks like this:



So the probability of the Top Event is 0.0735.

You are probably wondering what this number means.

Well, if the probability was 0.1, this would mean there was a 1 in 10 chance of it occurring (i.e. 1/0.1 = 10).

If it was, say, 0.25 then this represents 1/0.25 = 4, i.e. a 1 in 4 chance, so 0.0735 means 1/0.0735 = 13.6, i.e. nearly a 1 in 14 chance of the fire occurring.

HINTS AND TIPS

To get maximum marks in the exam, make sure that you show all your workings when quantifying a fault tree.

Event Tree Analysis (ETA)

Unlike identifying the root causes of an event under consideration, ETA is concerned with identifying and evaluating the consequences **following** the event.

In FTA the main event is called the Top Event, whereas in ETA it is called the Initiating Event.

Event trees are used to investigate the consequences of loss-making events in order to find ways of mitigating, rather than preventing, losses.

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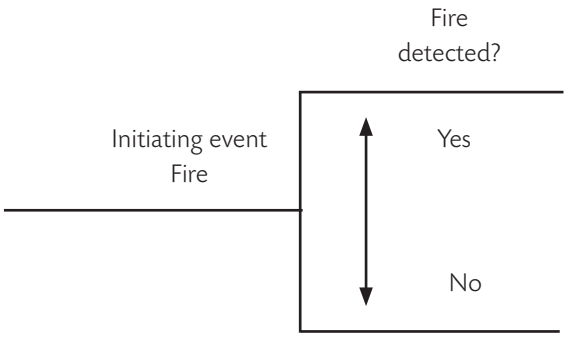
The stages involved in carrying out an event tree analysis are:

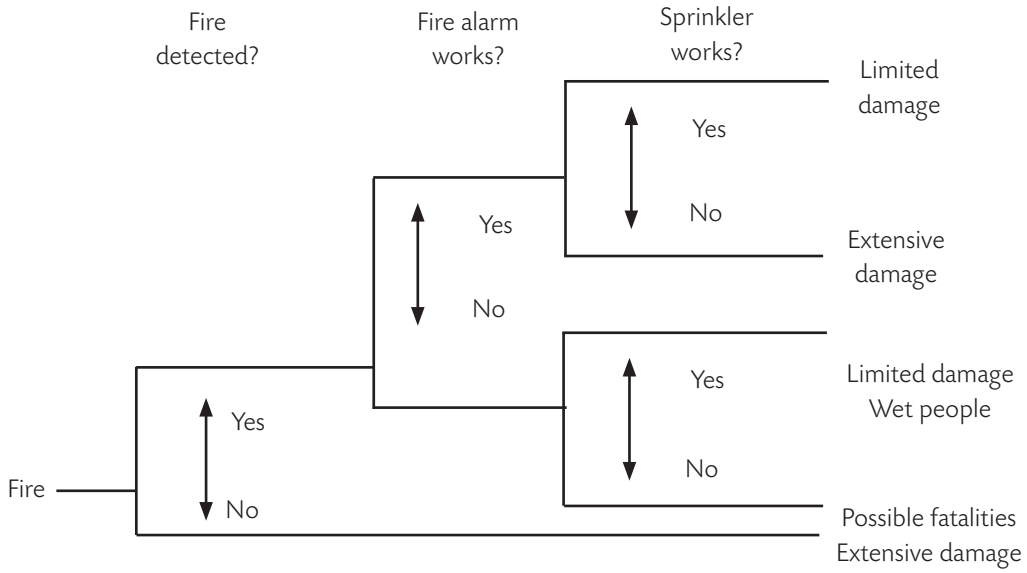
- Identify the Initiating Event of concern.
- Identify the controls that are assigned to deal with the Initiating Event, such as automatic safety systems, and other factors that may influence the outcome, such as wind direction or presence of an ignition source that would be important if there was an escape of a large amount of liquefied petroleum gas.
- Construct the event tree beginning with the Initiating Event and proceeding through the presence of conditions that may exacerbate or mitigate the outcome.
- Establish the resulting loss event sequences.
- Identify the critical failures that need to be dealt with.
- Quantify the tree if data is available to identify the likelihood or frequency of each possible outcome.

There is are a number of ways to construct an event tree. They typically use binary logic gates, i.e. a gate that has only two options, such as success/failure, yes/no, on/off. They tend to start on the left with the Initiating Event and progress to the right, branching progressively. Each branching point is called a node. Simple event trees tend to be presented at a system level, glossing over the detail.



Let us illustrate the process with a simple example where the Initiating Event is a fire:

The ETA diagram shows the Initiating Event on the left, leading to a mitigation measure: "*Is the fire detected?*" The answer to this question is a simple YES or NO, so the tree now branches to represent whether the answer to the question is YES or NO. Detection of the fire is, of course, the first step in minimising the consequence of the fire so now we need to consider those other factors that are necessary that will either minimise the outcome, or make the situation worse.



In this example, apart from detecting the fire we need to have an effective alarm system to alert persons in the building and an effective sprinkler system. The detection system switches on the alarm and then the sprinkler. Each factor is considered as to whether it occurs or does not occur, each leading to a further branch in the tree.

You will also note that in this example, should the fire **not** be detected, the alarm will not sound nor will the sprinkler operate, so if the fire is not detected there will be the worst outcome.

At the end of the branches on the right of the tree you can see the different outcomes identified, depending on the success or otherwise of the intervening factors.

To **quantify an event tree** we need to know the probability for each of the outcomes that follow from the Initiating Event - the probability that the:

- Fire is detected;
- Alarm works; and
- Sprinkler works.

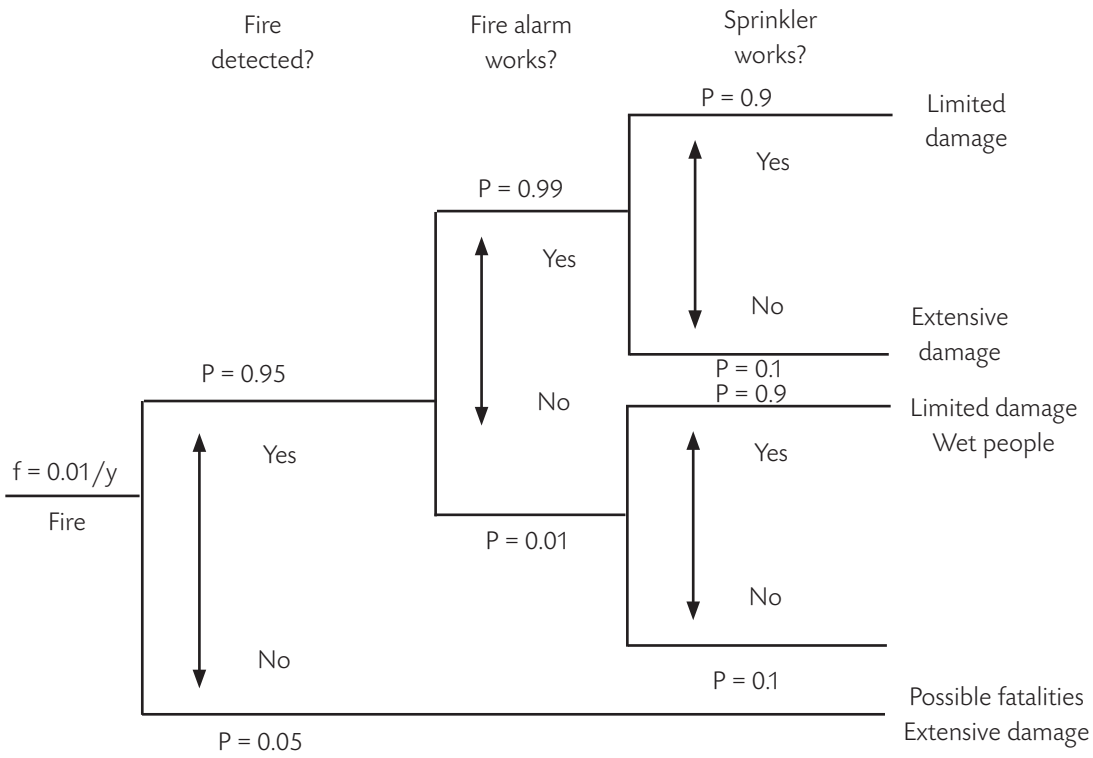
In binary logic, an event either happens, or does not. Let us suppose that the probability the fire is detected is 0.95; this means 95 out of every 100 times a fire takes place it will be detected. It follows that the probability it is **not** detected is 0.05, i.e. 5 out of every 100 times.

So the:

Probability of success + Probability of failure = 0.95 + 0.05 = 1.

In all binary events the sum of the two probabilities must always equal 1.

Here is the tree with the probabilities for the three events after the Initiating Event.



As we noted above, the sum of the probabilities for each event is always 1.

You will also notice that we have included the frequency of the Initiating Event, i.e. the fire, which is 0.01/y which means a fire will occur on average once every 1/0.01 years, i.e. once every 100 years.

We can now calculate the frequency of each of the possible sequences identified in the tree by multiplying the probabilities for each sequence and then multiplying this by the frequency of the Initiating Event.

So for the sequence leading to "Limited damage" we have:

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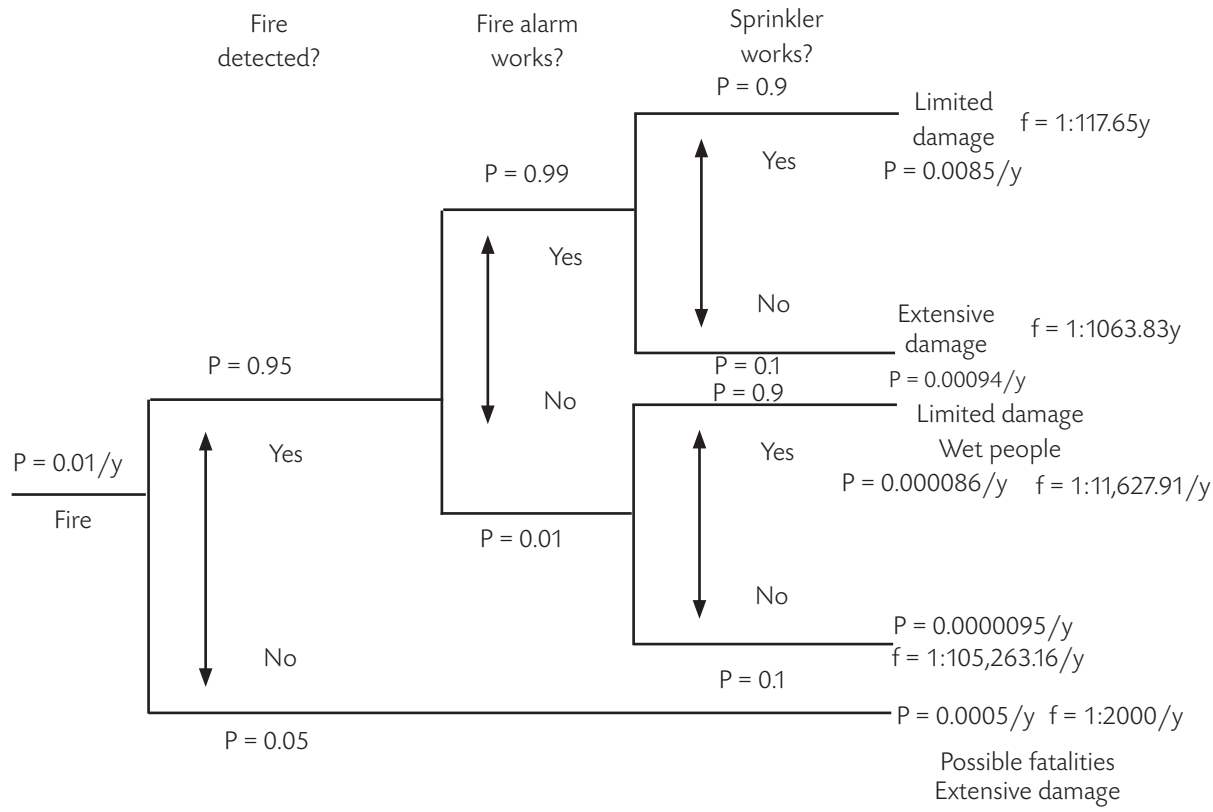
Frequency of fire (0.01/y) × Fire detected (0.95) × Fire alarm works (0.99) × Sprinkler works (0.9) = 0.0085.

This means this outcome will occur (on average) once every 1/0.0085 years = 118 years.

In contrast, the sequence in which the fire is **not** detected will occur with a frequency of 0.01 × 0.05 = 0.0005/y which is once every 1/0.0005 years = 2000 years.

Here is the tree with the expected frequencies for each of the outcomes:



What can we conclude from this?

Well, the most probable outcome, should a fire break out, is that all the controls will work and damage will be limited (probability = 0.0085). However the second most probable outcome is the fire not being detected and this leads to extensive damage and possible fatalities (probability = 0.0005).

What would we recommend?

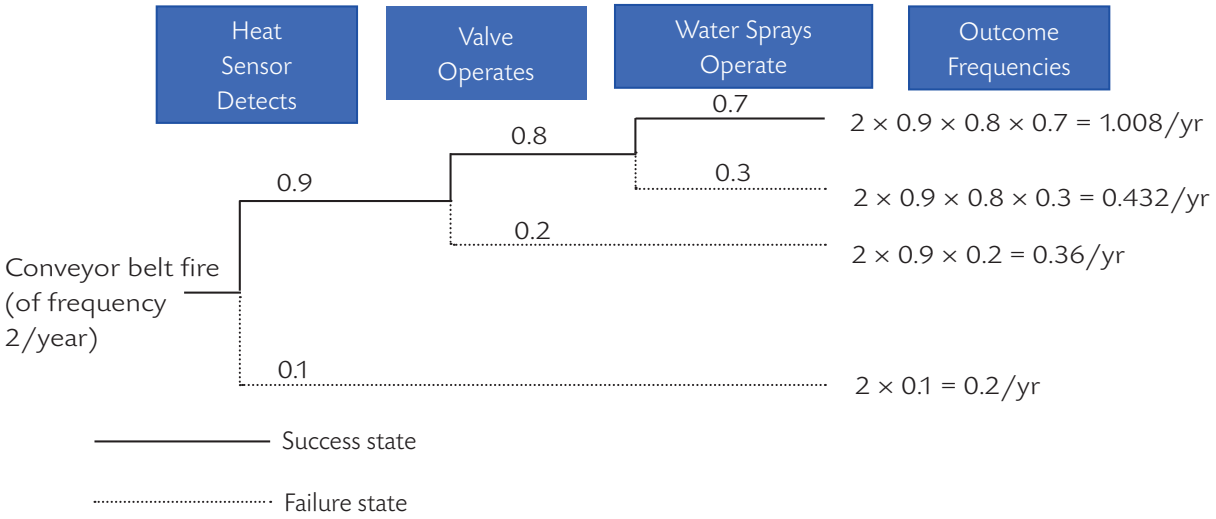
Well, the most probable outcome, should a fire break out, is that all the controls will work and damage will be limited (probability = 0.0085). However the second most probable outcome is the fire not being detected and this leads to extensive damage and possible fatalities (probability = 0.0005).

What would we recommend?

One solution would be to increase the reliability of the fire detection system. However, this is a crucial link in the sequence, since if it fails then the reliability of the alarm and sprinkler become irrelevant. A much better improvement would be to include a second detector, independent of the first. This would mean that BOTH detectors would have to fail, which is a much less likely event.

The following is a similar example. The figure shows a quantified event tree for the action following a fire on a conveyor system. Here the fire detector, i.e. the heat sensor, opens the valve leading to operation of the water sprays. As in the

previous example, should the sensor fail, the success of the valve or water spray is not relevant to the outcome; but here, should the valve fail, the success of the water spray becomes irrelevant.



The only outcome resulting in control of the event is where the sensor, valve and water spray operate (the example is a little contrived but serves to demonstrate the principles).

Notice how the frequencies of the outcomes are calculated. Notice also that the sum of all the outcome frequencies adds up to 2 in this case, i.e. the frequency of the Initiating Event (the conveyor belt fire).

The event tree could be used to check that there were adequate fire detection, warning and extinguishing systems.

STUDY QUESTIONS

9. The frequency of pipework failure in a large LPG storage facility is estimated at once every 100 years (f = 0.01/year). Immediate ignition of the released gas (probability, p=0.05) will result in a jet flame. Otherwise, prevailing winds will normally carry any vapour cloud off site across open countryside where it will disperse safely. However, under certain conditions (p=0.1), the cloud may drift to a nearby industrial estate where ignition (p = 0.5) will cause a vapour cloud explosion or flash fire.

    Using the data provided, construct an event tree to calculate the expected frequency of fire or explosion due to pipework failure BOTH on site AND on the industrial estate.

10. Outline the basic principles of a Hazard and Operability Study.

11. Briefly explain the difference between an "event tree" and a "fault tree".

(Suggested Answers are at the end.)

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Summary

Sources of Information Used in Identifying Hazards and Assessing Risk

We considered commonly used accident and disease ratios - incidence rate, frequency rate, severity rate and prevalence rate.

Information can be sourced both externally and internally:

- **External sources** include: national governmental enforcement agencies, international bodies, professional and trade bodies, and insurance companies.
- **Internal sources** include: accident reports, absence records and maintenance records.

Hazard Identification Techniques

Various techniques can be used to detect hazards including: task analysis, checklists, observations and incident reports.

A **checklist** which covers the key issues to be monitored is developed to ensure a consistent and comprehensive approach to checking all the safety elements to be covered during an inspection.

The analyst should make an **observation** of the work being done, including work undertaken by groups of operators.

Assessment and Evaluation of Risk

We looked at the key steps that characterise all risk assessments:

- Hazard identification.
- Identify who is at risk.
- Estimation, evaluation of risk and identifying precautions.
- Record significant findings and implement.
- Review the assessment.

Types of risk assessment include:

- Generic – apply to commonly identified hazards and set out the associated control measures and precautions.
- Specific – apply to a particular work activity and the persons associated with it.
- Dynamic – apply to work activities that involve changing environments and require quick mental assessments to manage risks.
- Qualitative - risks are represented by simple word descriptors.
  - **Risk** = Probability (or Frequency) × Consequence (or Harm or Severity).
  - **Probability** is the chance that a given event will take place.
  - **Severity** of risk is the outcome.
- Semi-quantitative - results represented by qualitative and quantitative descriptions. In some the risk is expressed as a number which indicates rank and not an absolute value.
- Quantitative - risks are represented by the frequency or probability of a specified level of harm, from a specified activity.

Organisational arrangements for risk assessment include:

- **Plan** - what you want to achieve, who will be responsible for what, how you will achieve your aims, and how you will measure your success.

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- **Do** - identify your risk profile, organise your activities to deliver your plan.
- **Check** - measure your performance, assess how well the risks are being controlled and investigate the causes of accidents, incidents or near misses.
- **Act** - review your performance and take action on lessons learned, including from audit and inspection reports.

Once hazards have been identified, the risk they pose needs to be assessed and prioritised.

Systems Failures and System Reliability

We have:

- Noted that systems can have very complicated interactions between processes and that failure of the system may need detailed investigation to discover the causes by adopting both holistic and reductionist approaches.
- Used calculations to assess the reliability of parallel, series and mixed systems.
- Considered common mode failure and the principles of human reliability analysis.
- Examined methods for improving system reliability by using reliable components, quality assurance, parallel redundancy, standby systems, minimising failures to danger, planned preventive maintenance and minimising human error.

Failure Tracing Methodologies

Principles and techniques of **failure tracing methods**:

- **HAZOPS** is:
  - A method designed for dealing with complicated systems where failures can affect other parts of the system.
  - Used, for example, at large chemical plants.
- **Fault tree analysis** starts with a **Top Event** and identifies the necessary preceding events and their combination that are necessary for the Top Event. It identifies causes.
- **Event trees** start with an **Initiating Event** and look at the consequences through the failure of control measures and the effect of other events.

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Exam Skills

This is an example of a 20 mark, Section B question for you to work on. It is split into three sub-questions and is based on a scenario.

You should allow 30 minutes to answer a Section B question in the exam.

QUESTION

An employer wishes to build a new gas compression installation to provide energy for its manufacturing processes. An explosion in the installation could affect the public and a nearby railway line. In view of this the employer has been told that a qualitative risk assessment for the new installation may not be adequate and that some aspects of the risk require a quantitative risk assessment.

(a) **Explain** the terms 'qualitative risk assessment' **AND** 'quantitative risk assessment'. **(5)**

(b) **Identify** the external sources of information and advice that the employer could refer to when deciding whether the risk from the new installation is acceptable. **(5)**

(c) A preliminary part of the risk assessment process is to be a hazard and operability study. **Describe** the principles and methodology of a hazard and operability (HAZOP) study. **(10)**

Approaching the Question

At first sight this might seem like a complicated question, but don't be put off by it as it isn't as bad as it looks.

I suggest that you re-read the appropriate sections of the element and think about the terms asked about in the question. This will help to get things clear in your mind. This question isn't about chemical process safety (which is examined in Unit IC of the International Diploma), but about risk assessment techniques.

Think about the marks available for the three parts of the question, and your timing.

Put together an answer plan for part (a) of the question around the terms "qualitative" and "quantitative" risk assessment. Remember that there are only 5 marks available for this part so the examiner is not looking for lots of information - just that you can show that you understand the terms and the differences between them.

Part (b) requires a list of sources of guidance, so reference to national governmental enforcement agencies and international bodies would be appropriate here. Remember that part (c) refers to a HAZOP so the examiner is looking for sources relating to how you conduct a HAZOP and decide on an acceptable level of risk.

Part (c) is worth 10 marks so you need an answer plan that covers 10/12 points that you know about how a HAZOP is conducted in order to get full marks. Use bullet points and expand each point to show that you understand what you are saying.

HINTS AND TIPS

As you write your answer, make sure that you refer back to the scenario described in the question to ensure that your answer has the correct emphasis.

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Suggested Answer Outline

This looks like a hard question, but remember that you can't expect to find every question easy to answer. You need to accumulate marks from your stronger questions and then work on getting 50% in the other questions to spread your mark risk.

You might get good marks for any or all of parts (a), (b) and (c) and they all count to your overall total so have a go.

In part (a) the examiner would have wanted you to explain the differences between the two terms, so make sure you get them the right way round or you lose all the marks here!

- Qualitative: informed subjective judgments; needs good hazard identification process and looks at likelihood of hazards occurring and severity of their consequences. Can be number or ranked (High, Med, Low, etc.).
- Quantitative: numerical, based on frequency/probability of events happening and their consequence; an objective approach which relies on specific data or comparison with specific criteria.

In part (b) the examiner was concerned with the issue of tolerability, so the UK HSE's publication "*Reducing Risks, Protecting People*" would be a great source to mention, as would be similar guidance which talks about tolerability.

Other sources could be experts, consultants, other organisations with similar installations or design companies, as well as insurance companies.

In part (c) you would need an understanding of how HAZOP studies operate, so you should mention identification of deviations from intended normal operation and that HAZOPs are best carried out at design stage of installation but can be used for modifications to processes/installations.

HAZOP studies have a team leader; there has to be awareness of the scope of the study which is to be conducted by the team. The installation/process is broken down into key parts/elements (known as "nodes"); you need objective data and information to support the study.

The study involves brainstorming and the use of guide words which are then applied methodically to each process parameter to form "deviations" from normal operating conditions. Examples of process parameters include flow, pressure, temperature and concentration, whereas guidewords include no, more, less and reverse. An example deviation would therefore be "less flow" or "more concentration". You would need to mention that the study looks at possible causes and consequences of each deviation and will identify possible corrective actions.

The study also needs to be documented and you can use a set format, which is then recorded and kept in the project file or H&S file.

HINTS AND TIPS

The examiner can set any questions based on the syllabus and related to the Learning Outcomes. Just because you don't use a certain type of process does not mean that there won't be a question on it.

Remember that you should be able to show that you can apply your knowledge and understanding to both familiar and unfamiliar situations.

Example of How the Question Could be Answered

(a) The terms qualitative and quantitative refer to the way the risk assessments are conducted.

Qualitative – as the word suggests this is a subjective approach to deciding on the level of risk; it looks at likelihood of incidents occurring and the severity of injury or damage to people or the environment from those incidents. It will be ranked and a typical approach is to rank them HIGH, MEDIUM or LOW risk.

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Quantitative – this is a numbers-based approach using data/frequencies of events happening and their consequence and is used more formally for higher risk applications, as it is an objective approach to assessing the risk.

(b) An employer could consult, externally, consultants who are experts in the installation/topic, industry guidance, manufacturers of the equipment to find out failure rates and types of incidents; insurance providers will also be able to put employers into contact with advice and guidance and support the employer with information. The HSE, the OSHA, the European Safety Agency, the ILO and the World Health Organisation are all good sources of information and their websites may have good guidance on reducing risks.

(c) A hazard and operability study (HAZOP) is a formal type of risk assessment which follows a set format, with a study leader gathering a team of people, who would consist of supervisors, operators, maintenance staff, designers, H&S professionals, etc. The team will follow a checklist which looks at the plant operating parameters, such as flow, temperature and pressure, together with agreed guide words, e.g. no, more, less, part of and reverse. Each parameter is combined with each guide word to identify possible deviations from the designed operating conditions. The possible causes of the deviations are then discussed, together with possible controls to prevent such deviations.

The process should take place at the design stage of new facility/plant or before modifications to existing take place.

This study should have an action plan which should be managed to ensure the plant is designed safely; anything that needs operational controls should be identified and this information acted upon by the operational department. The study should be kept as part of the H&S file for the installation.

Reasons for Poor Marks Achieved by Candidates in Exam

This was not a popular question when it appeared on an exam paper (possibly people were scared off by the term HAZOP), but an exam candidate who did answer this question would achieve **poor marks** for:

- Getting terms muddled up.
- Not linking the parts of the question back to the scenario (a complex high-risk installation which needed a good understanding of risk and tolerability).
- Not identifying relevant external sources of information for this complex installation.
- Showing no real understanding of the HAZOP process.

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Unit IA - Part 1

Suggested Answers

No Peeking!

Once you have worked your way through the revision 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.

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Element IA1: Principles of Health and Safety Management

Question 1

- Moral – as human beings, we should feel obliged to look after each other's safety.
- Legal – there are strict legal obligations imposed on employers and employees in respect of the safety of employees and others affected by the business.
- Economic – businesses that address health and safety risk are invariably more successful than those that do not.

Question 2

Any five from the following:

- Economic climate - wealthy countries can afford to give occupational health and safety a higher priority.
- Government policy - those who work tend to be healthier than those who are unemployed. Improving workers' health will help keep people at work, who can then contribute financially to society.
- Risk profile - higher-risk activities demand greater standards than those for lower-risk activities.
- Globalisation - businesses that operate across the world may adopt different standards, depending on the requirements of the host countries.
- Migrant workers - in recent years, immigration policies have increased the proportion of migrant workers.
- Sickness absence - in the UK sickness absence has reduced but is still substantial.
- Societal expectations of equality.

Question 3

Any four from:

- Better health and safety performance, which will reduce the costs from accidents and incidents.
- Greater awareness of legal requirements, which will reduce the chances of committing an offence.
- Improved relations and morale as employees see that their health and safety is being looked after.
- Improved image and positive public relations from a publicly responsible attitude towards employees.
- Greater business efficiency, which will reduce costs.
- Reduced insurance premiums, by demonstrating more effective risk control.
- Greater confidence from banks and investors from showing more effective risk management systems.

Question 4

(a) ILO-OSH-2001:

- Policy.
- Organising.
- Planning and implementation.
- Evaluation.
- Action for improvement.

(b) The elements of BS OHSAS 18001 are:

- Policy.
- Planning.
- Implementation and Operation.
- Checking and Corrective Action.
- Management Review.

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Question 5

The **advantages** of integrating management systems are (any two from):

- Likely to operate more cost-effectively than separate systems, and facilitate decision-making that best reflects the overall needs of the organisation.
- Offers the prospect of more rewarding career opportunities for specialists in each discipline.
- The objectives and processes of management systems are essentially the same.
- Integration should lead to the avoidance of duplication.
- Integration should reduce the possibility of resolving problems at the expense of creating new difficulties in other disciplines.
- An IMS should involve timely overall system reviews.
- A positive culture in one discipline may be carried over to others.

The **arguments against** integration are (any two from):

- Existing systems may work well already.
- Relevant specialists may continue to concentrate on the area of their core expertise and further specialist training may not be needed.
- Uncertainties regarding key terms.
- System requirements may vary across topics covered**.**
- Health, safety and environmental performance are underpinned by statute law, but quality management system requirements are largely determined by customer specification.
- Regulators and single-topic auditors may have difficulty evaluating their part of the IMS when it is **interwoven with other parts of no concern to the evaluator.**
- A powerful, integrated team may reduce the ownership of the topics by line management.
- A negative culture in one topic may unwittingly be carried over to others.

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Element IA2: Regulating Health and Safety

Question 1

There is little incentive to go beyond minimum legal requirements. The government has to employ enforcement officers and introduce sanctions which may be imposed by the courts.

Question 2

Prescriptive legislation has clearly defined requirements which are more easily understood by the duty holder and enforced by the regulator. It does not need a higher level of expertise to understand what action is required, and provides a uniform standard to be met by all duty holders.

However, it is inflexible and so depending on the circumstances may lead to an excessively high or low standard. In addition, it does not take account of the circumstances of the duty holder and may require frequent revision to allow for advances in knowledge and technology.

Goal-setting legislation allows more flexibility in compliance because it is related to the actual risk present in the individual workplace. It is less likely to need frequent revision and can apply to a much wider range of workplaces.

It is, however, much more difficult to enforce because what is "adequate" or "reasonably practicable" are much more subjective and so open to argument, possibly requiring the intervention of a court to provide a judicial interpretation. Duty holders will also need a higher level of competence in order to interpret such requirements.

Question 3

Employers' and government schemes. In **employer schemes**, employers pay premiums to insurance companies who pay compensation to the injured worker. In **government schemes** the government or a government agency provides the benefits.

Question 4

The two categories are special and general damages.

Special damages can be relatively easily quantified because they relate to known expenditure up until the trial. They include:

- Loss of earnings due to the accident or ill health before the trial.
- Legal costs.
- Medical costs to date.
- Building costs, if property has had to be adapted to meet the needs of the injured person.
- Necessary travel costs associated with the case.

General damages include future expenditure and issues which cannot be precisely quantified. They include:

- Loss of future earnings as a result of the incapacity.
- Future medical costs.
- Pain and suffering before and after the trial.
- Loss of quality of life, e.g. loss of mobility, inability to engage in sports which had been pursued before the loss.
- Loss of future opportunity, e.g. reduced likelihood of being able to secure suitable employment.

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Question 5

Punitive damages are awarded to punish and deter the defendant and other similar persons from such conduct that harmed the claimant. They are awarded by reference to the defendant's behaviour and aim to deter similar conduct in the future and to signify disapproval.

Question 6

Enforcement ensures that duty holders:

- Deal immediately with serious risks.
- Comply with the law.
- Are held to account if they fail in their responsibilities.

Question 7

Consistency is not a simple matter due to factors including:

- The degree of risk.
- The attitude and competence of management.
- History of incidents.
- Previous enforcement action.

Question 8

Its main aims are to promote rights at work, encourage decent employment opportunities including good health and safety standards, enhance social protection and strengthen dialogue in handling work-related issues.

Question 9

A **convention** is an agreement in international law which has to be ratified by member countries. A **recommendation**, as the name suggests, does not require ratification by member states.

Question 10

ILO **codes of practice** contain practical recommendations intended for all those with a responsibility for occupational safety and health in both the public and private sectors. Codes of practice are not legally binding instruments and are not intended to replace the provisions of national laws or regulations, or accepted standards.

Question 11

Roles and responsibilities of national governments:

"(a) issue or approve regulations, codes of practice..... on occupational safety and health and the working environment, account being taken of the links ... between safety and health, ... and hours of work and rest breaks ...;

(b) .... review legislative enactments concerning occupational safety and health and the working environment,... in the light of experience and advances in science and technology;

(c) undertake or promote studies and research to identify hazards and find means of overcoming them;

(d) provide information and advice, in an appropriate manner, to employers and workers and promote or facilitate co-operation between them and their organisations, with a view to eliminating hazards or reducing them as far as practicable; where appropriate, a special training programme for migrant workers in their mother tongue should be provided;

(e) provide specific measures to prevent catastrophes, and to co-ordinate and make coherent the actions to be taken at different levels, particularly in industrial zones where undertakings with high potential risks for workers and the surrounding population are situated;

(f) secure good liaison with the International Labour Occupational Safety and Health Hazard Alert System set up within the framework of the International Labour Organisation;

(g) provide appropriate measures for handicapped workers."

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Question 12

Roles and responsibilities of enterprises:

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

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

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

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

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

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

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

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

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Question 13

Roles and responsibilities of workers:

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

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

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

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

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

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Question 14

These bodies represent the interests of employers. In the UK the main body is the Confederation of British Industry (CBI). The CBI helps create and sustain the conditions in which businesses in the United Kingdom can compete and prosper for the benefit of all. The CBI is the main lobbying organisation for UK business on national and international issues, including health and safety practices and standards.

Question 15

A trades union is an organisation of workers who have formed together to achieve common goals in key areas such as wages, hours, and working conditions. The trade union negotiates with the employer on behalf of its members. This may include the negotiation of workplace safety and health issues and policies. In the UK, unions may appoint safety representatives from amongst the workers who may investigate accidents, conduct inspections and sit on a safety committee.

Question 16

The media can influence health and safety by:

- Making health and safety guidance easily accessible with minimal cost. Agencies such as OSHA (USA) and the HSE (UK) produce guidance for all categories of duty holders in all types of employment. This is available in hard copy and more commonly in electronic format that can be downloaded. This allows duty holders who have limited expertise to access relevant information and so comply with legal requirements.
- Publicising good and bad health and safety performance, e.g. TV and radio may publicise major accidents, prosecutions and public inquiries. Major disasters may be publicly discussed not only in the country in which they occurred but internationally. Incidents with lesser consequences may be publicised within the area in which they occurred. Such publicity increases the awareness of occupational health and safety issues and reminds duty holders of the possible consequences of failing to pay attention to these issues.
- Assisting in educating members of the professional body and promoting good health and safety standards by publishing professional journals (e.g. Institution of Occupational Safety and Health (UK)).
- Enabling anyone with an Internet connection access to a huge range of information (good and bad) which would otherwise be much less accessible.

Question 17

In the UK a number of **good neighbour schemes** have been established to encourage larger organisations to help smaller businesses and contractors with health and safety expertise. Small businesses do not have access to the same health and safety expertise, so if a large organisation can provide advice to a smaller one, then the smaller business will benefit and the larger organisation will be able to demonstrate its public responsibility.

Schemes have also been established between organisations of similar size. They might involve sharing expertise and equipment such as a noise meter. It is much less costly to share such resources and all members of the scheme will benefit.

Question 18

Self regulation is the process whereby an organisation monitors its own adherence to health and safety standards, rather than having an outside agency, such as a governmental body, monitoring and enforcing them. The benefit to the organisation is that it can set and maintain its own standards without external interference. Accordingly if problems arise, it can more easily keep its own internal affairs private. It also avoids the significant national expense of establishing an enforcement agency.

Self regulation of health and safety within a legal framework was one of the recommendations of the Robens Committee which was established in 1970 in the UK to "*review the provision made for the safety and health of persons in the course of their employment and to consider whether any changes are needed*".

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Question 19

The functions of the board of an organisation which ensure the effective governance of health and safety include:

- A demonstration of commitment to occupational health and safety and an appreciation that it is as important as other business objectives.
- Ensuring that health and safety is reviewed at board level.
- Those in the organisation at all levels have access to and receive competent advice.
- All staff including board members are trained and competent in their health and safety responsibilities.
- Ensuring that the workforce, and in particular health and safety representatives, are adequately consulted and that their concerns reach the right level within the organisation including, where necessary, the board.
- Systems are in place to ensure that health and safety risks are assessed and suitable control measures introduced and maintained.
- An awareness of what activities take place in the organisation, including those of contractors.
- Ensuring that regular information is received regarding matters such as accident reports and cases of work-related ill health.
- The setting of targets which allow the organisation to improve standards and to benchmark the organisation's performance against others within the same business sector.
- Ensuring that changes in working arrangements that have significant implications are brought to the attention of the board.

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Element IA3: Loss Causation and Incident Investigation

Question 1

The five factors of Heinrich's accident sequence are:

- Ancestry and social environment - character traits.
- Fault of person - inherited or acquired faults.
- Unsafe act and/or mechanical or physical hazard.
- Accident - event causing injury.
- Injury - effect of accident.

Question 2

Bird and Loftus extended Heinrich's theory to include the influence of management in the cause and effect of accidents. They suggested a modified sequence of events:

- lack of control by management;
- permitting basic causes (i.e. personal and job factors);
- leading to immediate causes (such as substandard practices, conditions or errors);
- which are the direct cause of the accident;
- which result in loss (which may be categorised as negligible, minor, serious or catastrophic).

Question 3

Latent failures are failures in the organisation or environment that remain dormant and are often either unrecognised or not appreciated until they lead to an active failure and a loss event. An example would be a lack of adequate training for a particular task. Only when a worker who undertakes the task commits an error due to the lack of training does the failing become appreciated.

Question 4

Accident triangles show there is a ratio between unsafe acts, minor incidents and more serious ones. If employers aim to reduce the frequency of unsafe acts, this will lead to a reduction in more serious outcomes.

Question 5

Accident frequency rate:

$$\frac{\text{Number of work-related injuries} \times 100{,}000}{\text{Total number of man-hours worked}}$$

Number of man-hours worked = 20 × 38 × 47h = 35720h.

$$\text{Accident frequency rate} = \frac{8 \times 100{,}000}{35720} = 22.4$$

Question 6

The basic requirements of P155 are that national governments should ensure that employers:

- Record and notify occupational accidents, suspected cases of occupational disease, dangerous occurrences and commuting accidents. The minimum notification data should comprise:
  - Enterprise, establishment, employer.
  - Person injured and nature of injury/disease.
  - Workplace, circumstances (accident/dangerous occurrence/disease).
- **Inform** employees about the recording system and notifications.
- **Maintain** records and use them to help prevent recurrence.

Question 7

Notifiable diseases to be reported should at least include the prescribed diseases listed under ILO Convention C121. The schedule to C121 contains a list of diseases prescribed in relation to an activity, for which injury benefit should be payable. Examples include:

- Conditions due to physical agents and the physical demands of work, e.g. due to ionising radiation, vibration, noise.
- Infectious or parasitic diseases (in health, vet work, etc.).
- Conditions due to substances, e.g. silicosis, asbestosis; arsenic, chromium, lead poisoning; lung cancer and mesothelioma caused by asbestos.

Question 8

Accident records should be used as a tool to help control the accidents that are causing the injuries and damage and should provide the following useful information:

- The relative importance of the various injury and damage sources.
- The conditions, processes, machines and activities that cause the injuries/damage.
- The extent of repetition of each type of injury or accident in each operation.
- Accident repeaters, i.e. those workers who tend to be repeatedly injured or are involved in more accidents.
- How to prevent similar accidents in the future.

Question 9

There will always be an immediate cause for an accident, but we are also interested in finding the underlying and root causes, which is why we need to consider the chain of events leading up to an accident. The domino effect of Heinrich's theory is a good example. Obviously, any remedy that starts at the earliest stages will not only prevent this accident, but a lot of others that have the same root cause. Often, accident reports tend to concentrate on 'cause of injury', when the safety practitioner is more interested in 'cause of accident'. In the case of a multiple-cause accident, we do, at the very least, need to consider if it involves an unsafe act, an unsafe condition and an unsafe person, and how these interact.

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Question 10

A number of items may be required for an investigation, including the following:

- Photographic equipment.
- Portable lights which may be necessary as electricity may be switched off or the accident scene may be in a poorly lit area in a confined space, such as a manhole.
- Sketchpad, pencils and measuring equipment.
- Record-keeping equipment, which should include a notebook and possibly recording equipment.
- Sample collection equipment, such as jars or other containers that can be sealed to prevent loss, evaporation or contamination. Paper bags, plastic bags, envelopes and cartons may also be required.
- Tools for cleaning debris or spillages.
- Where explosive or flammable vapours and gases are liable to be involved, some sort of portable gas/vapour detection equipment should be available. Similarly, where poisonous or radioactive materials may be involved, the appropriate detection equipment should be provided.

Question 11

Following the UK's HSG245, accident investigation can follow four complementary steps:

- Step 1: Gathering the information.
- Step 2: Analysing the information.
- Step 3: Identifying risk control measures.
- Step 4: The action plan and its implementation.

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Element IA4: Measuring and Reviewing Health and Safety Performance

Question 1

Any three from the following:

- To assess the effectiveness and appropriateness of health and safety objectives and arrangements in terms of:
  - Hardware (plant, premises, substances).
- Software (people, procedures, systems).
- To measure and reward success (not to penalise failure).
- To use the results as a basis for making recommendations for a review of current management systems.
- To maintain and improve health and safety performance.

Question 2

Active measures include inspection reports, safety tour reports, audit data.

Reactive measures include accident and ill-health data, complaints, near misses.

Objective measures include number of prosecutions over the last five years, number of risk assessments completed/reviewed during last year, number of individuals trained in a specific safety-related course.

Subjective measures include effectiveness of safety communication, presence of a good safety culture.

Question 3

Limitations of accident and ill-health data:

- Numbers tend to be small and so variations year to year may not be significant.
- Data, especially relating to ill health, may reflect working conditions from at least several years previously.
- Under-reporting - incidents to which the consequences may not be immediately obvious may not get reported, or reporting may be implicitly discouraged to demonstrate an apparent good performance.

Question 4

The main measurement techniques available for measuring health and safety performance in the workplace are: audits, inspections, safety tours, safety sampling and safety surveys.

Question 5

Benchmarking is the process of comparing your own practices and performance measures with organisations that display excellence and whom you might wish to emulate.

Question 6

The two sources of information that the review process uses are routine monitoring data and audit data.

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Element IA5: The Assessment and Evaluation of Risk

Question 1

Accident and ill-health data may be used to:

- Classify industries according to risk.
- Classify workplaces.
- Classify occupations.
- Consider accident trends.
- Consider parts of the body injured - use of protective clothing.
- Determine hazards in a workplace by using 'cause of injury'.
- Consider where the fault lies.
- Measure the effect of preventive/control measures.

Question 2

Useful internal information sources when assessing risk include:

- Accident and ill-health reports.
- Absence records.
- Maintenance records, which usually show damage incidents.

Question 3

Incidence indicates the number of new cases in a population in relation to the number at risk, whereas **prevalence** indicates the proportion of persons in a given population who have a defined (usually ill-health) condition.

Question 4

The "4 Ps" include:

- **Premises**, including:
  - Access/escape.
  - Housekeeping.
  - Working environment.
- **Plant and substances**, including:
  - Machinery guarding.
  - Local exhaust ventilation.
  - Use/storage/separation of materials/chemicals.
- **Procedures**, including:
  - Permits-to-work.
  - Use of personal protective equipment.
  - Procedures followed.
- **People**, including:
  - Health surveillance.
  - People's behaviour.
  - Appropriate authorised person.

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