

GC 2 - NEBOSH International General Certificate

Study notes

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Element 1 - Workplace hazards and risk control

Learning outcomes

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

1.1 Health, welfare and work environment requirements

1.1.1 Health and welfare provisions

Welfare

Welfare arrangements include the provision of sanitary conveniences and washing facilities, drinking water, accommodation for clothing, facilities for changing clothing and facilities for rest and eating meals.

Sanitary conveniences and washing facilities must be provided together and in a proportion to the size of the workforce. Guidance is available on the requisite number of water closets, wash stations and urinals for varying sizes of workforce (approximately one of each for every 25 employees). Special provision should be made for disabled workers and there should normally be separate facilities for men and women. A single convenience would only be acceptable if it were situated in a separate room whose door could be locked from the inside. There should be adequate protection from the weather and only as a last resort should public conveniences be used. A good supply of warm water, soap and towels must be provided as close to the sanitary facilities as possible. The facilities should be well lit and ventilated and their walls and floors easy to clean. It may be necessary to install a shower for certain types of work. Hand dryers are permitted but there are concerns about their effectiveness in drying hands completely and thus removing all bacteria. In the case of

temporary or remote worksites, sufficient chemical closets and sufficient washing water in containers must be provided.

All such facilities should be well ventilated and lit and cleaned regularly.

Drinking water must be readily accessible to the entire workforce. The supply of drinking water must be adequate and wholesome. Normally mains water is used and should be marked as 'drinking water' if water not fit for drinking is also available. On remote sites, potable water should be provided.

Accommodation for clothing and facilities for changing clothing must be provided which is clean, warm, dry, well ventilated and secure. Such accommodation is only necessary when the work activity requires employees to change into specialist clothing. Where workers are required to wear special or protective clothing, arrangements should be such that the workers' own clothing is not contaminated by any hazardous substances.

Facilities for rest and eating meals must be provided so that workers may sit down during break times in areas where they do not need to wear personal protective equipment. Facilities should also be provided for pregnant women and nursing mothers to rest. Arrangements must be in place to ensure that food is not contaminated by hazardous substances.

Workplace environment

The issues governing the workplace environment are ventilation, heating and temperature, lighting, workstations and seating.

Ventilation

Ventilation of the workplace should be effective and sufficient and free of any impurity and air inlets should be sited clear of any potential contaminant (e.g. a chimney flue). Care needs to be taken to ensure that workers are not subject to uncomfortable draughts. The ventilation plant should have an effective visual or audible warning device fitted to indicate any failure of the plant. The plant should be properly maintained and records kept. The supply of fresh air should not normally fall below 5-8 litres per second per occupant.

Heating and temperature

During working hours, the temperature in all workplaces inside buildings shall be reasonable (not uncomfortably high or low). 'Reasonable' is usually defined as at least 16°C, unless much of the work involves severe physical effort in which case the temperature should be at least 13°C. These temperatures refer to readings taken close to the workstation at working height and away from windows. These minimum temperatures cannot be

maintained where rooms open to the outside or where food or other products have to be kept cold. A heating or cooling method must not be used in the workplace which produces fumes, injurious or offensive to any person. Such equipment needs to be regularly maintained.

A sufficient number of thermometers should be provided and maintained to enable workers to determine the temperature in any workplace inside a building (but need not be provided in every workroom).

Where, despite the provision of local heating or cooling, the temperatures are still unreasonable, suitable protective clothing and rest facilities should be provided.

Lighting

Every workplace should have suitable and sufficient lighting and this should be natural lighting so far as is reasonably practicable. Suitable and sufficient emergency lighting should also be provided and maintained in any room where workers are particularly exposed to danger in the event of a failure of artificial lighting (normally due to a power cut and/or a fire). Windows and skylights should be kept clean and free from obstruction so far as is reasonably practicable unless it would prevent the shading of windows or skylights or prevent excessive heat or glare.

When deciding on the suitability of a lighting system, the general lighting requirements will be affected by the following factors:

- the availability of natural light;
- the specific areas and processes, in particular any colour rendition aspects or concerns over stroboscope effects (associated with fluorescent lights);
- the type of equipment to be used and the need for specific local lighting;
- the lighting characteristics required (type of lighting, its colour, intensity and local adjustability); the location of visual display units and any problems of glare;
- structural aspects of the workroom, such as the use of screens in open office layout and the reduction of shadows;
- the presence of atmospheric dust;
- the heating effects of the lighting; lamp and window cleaning and repair (and disposal issues);
- the need and required quantity of emergency lighting.

Light levels are measured in illuminance, having units of lux (lx), using a light meter.

Poor lighting levels will increase the risk of accidents such as slips, trips and falls. More information is available on lighting from *Lighting at Work*, HSG38, HSE Books.

Workstations and seating

Workstations should be arranged so that work may be done safely and comfortably. The worker should be at a suitable height relative to the work surface and there should be no need for undue bending and stretching. Workers must not be expected to stand for long periods of time, particularly on solid floors. A suitable seat should be provided when a substantial part of the task can or must be done sitting. The seat should, where possible, provide adequate support for the lower back and a footrest be provided for any worker whose feet cannot be placed flat on the floor. It should be made of materials suitable for the environment, be stable and, possibly, have arm rests.

It is also worth noting that sitting for prolonged periods can present health risks, such as blood circulation and pressure problems, and vertebral and muscular damage.

Seating at Work, HSG57, HSE Books, provides useful guidance on how to ensure that seating in the workplace is safe and suitable.

Typical workplace lighting levels	
Workplace or type of work	Illuminance (lx)
Warehouses and stores	150
General factories or workshops	300
Offices	500
Drawing offices (detailed work)	700
Fine working (ceramics or textiles)	1000
Very fine work (watch repairs or engraving)	1400

Other factors

The condition of floors, stairways and traffic routes should be suitable for the purpose and well maintained and undue space constraints anywhere in the workplace should be avoided. Translucent or transparent doors should be constructed with safety glass and properly marked to warn pedestrians of their presence. Windows and skylights should be designed so that, when they are opened, they do not present an obstruction to passing pedestrians. There must be adequate arrangements in place to ensure the safe cleaning of windows and skylights. Finally, there need to be adequate provisions for the needs of disabled workers.

1.1.2 The effects of exposure to extremes of temperature; preventive measures

The human body is very sensitive to relatively small changes in external temperatures. Food not only provides energy and the build-up of fat reserves, but also generates heat which needs to be dissipated to the surrounding environment. The body also receives heat from its surroundings. The temperature of the body is normally around 37°C and it will attempt to maintain this temperature irrespective of the temperature of the surroundings. Therefore, if the surroundings are hot, sweating will allow heat loss to take place by evaporation caused by air movement over the skin. On the other hand, if the surroundings are cold, shivering causes internal muscular activity, which generates body heat.

At high temperatures, the body has more and more difficulty in maintaining its natural temperature unless sweating can take place and therefore water must be replaced by drinking. If the surrounding air has high humidity, evaporation of the sweat cannot take place and the body begins to overheat. This leads to heart strain and, in extreme cases, heat stroke. It follows that when working is required at high temperatures, a good supply of drinking water should be available and, further, if the humidity is high, a good supply of ventilation air is also needed. Heat exhaustion is a particular hazard in confined spaces.

At low temperatures, the body will lose heat too rapidly and the extremities of the body will become very cold leading to frostbite and possibly the loss of limbs. Under these conditions, thick, warm (thermal) clothing, the provision of hot drinks and external heating will be required. For those who work in sub-zero temperatures, such as cold store workers, additional precautions will be needed. The store doors must be capable of being unlocked from the inside and an emergency alarm system should be installed. Appropriate equipment selection and a good preventative maintenance system is very important as well as a regular health surveillance programme for the workers, who should be provided with information and training on the hazards associated with working in very low temperatures. In summary, extremes of temperature require special measures, particularly if accompanied by extremes of humidity. Frequent rest periods will be necessary to allow the body to acclimatize to the conditions. An index called WBGT (Wet Bulb Globe Temperature) is normally used.

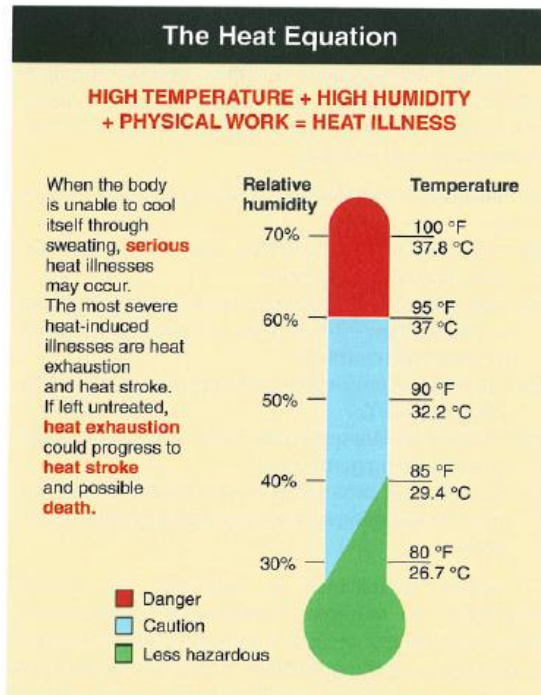


Figure – The heat equation

ILO recommendations for working in hot and cold environments

The ILO Code of Practice 'Ambient factors in the workplace' applies to any workplace where workers may be occupationally exposed to high or low temperatures and humidity. It applies to conditions in which:

- (a) temperatures and/or humidity are unusually high;
- (b) workers are exposed to high radiant heat;
- (c) high temperature and/or humidity occur in combination with protective clothing or high work rate;
- (d) temperatures are unusually low (e.g. in outdoor work during winter or in cold storage work);
- (e) high wind speeds (>5 m/s) prevail with unusually low temperatures;
- (f) work with bare hands is carried out for extended periods of time at temperatures below 15 °C.

Employers should assess the risks to the health and safety of workers from high and low temperatures, and determine the controls necessary to remove such hazards or to reduce risks to the lowest practicable level. The assessment should also examine the risks, arising from working with hazardous substances in hot or cold environments, caused by:

- (a) the use of protective clothing against hazardous substances that may increase the risk from heat stress; and
- (b) a hot environment that makes respiratory protection uncomfortable and less likely to

be used and necessitates restructuring of jobs in order to reduce the risks, for example by:

- (i) minimizing exposure to hazardous substances so that there is less need for protective clothing;
- (ii) changing the tasks so that work rates in hot conditions can be reduced

The risk assessment should include:

- (a) all stages of work cycles and the range of temperature and humidity under which the tasks are performed;
- (b) the range of clothing worn during the tasks;
- (c) major changes in physical activity level (metabolic heat production);
- (d) occasional tasks such as cleaning and maintenance of hot equipment and cold areas, and renewal of hot or cold insulation.

Where assessment shows that the workers may be at risk from heat stress, employers should, if practicable, eliminate the need for work in hot conditions or, if elimination is not practicable, take measures to reduce the thermal load from the environment. For workers who are at risk from exposure to radiant heat by working near hot surfaces, various methods are proposed in the code of practice including increasing the distance between the equipment and the exposed workers.

If it is not practicable to reduce the surface temperature, employers are recommended to consider:

- (a) the use of radiation barriers between the surface and the workplace (ensuring that they are maintained in a clean state);
- (b) water-cooling the hot surfaces, where practicable;
- (c) the use of portable reflective shielding;
- (d) the remote control of operations.

The code of practice requires employers to make water at low salt concentration or diluted flavoured drinks readily available to workers, and to encourage them to drink at least hourly, either by providing a close source or arranging for a regular delivery of drinks. Drinks at temperatures between 15 to 20 °C are preferable to iced drinks. Alcohol, caffeine, carbonated drinks or drinks with a high salt or sugar content are unsuitable. Drinking fountains are not recommended because they are too difficult to drink from in sufficient volume.

If a residual risk of heat stress remains even after all the control measures have been taken, workers should be adequately supervised so that they can be withdrawn from the hot

conditions if heat stress symptoms occur. First-aid facilities and trained first aiders should also be readily available.

If the assessment shows that the workers may be at risk from exposure to cold, the employers should, if practicable, eliminate the need for work in cold conditions (for example by rescheduling work to be performed in a warmer weather, or by moving the work from outdoors to indoors, or separating the cold parts of a process from the workers, as far as practicable). If elimination of such work is impracticable, employers should introduce other control measures to reduce risk from cold conditions.

If the work is done outdoors, or the temperature at the workplace depends on outdoor temperature, employers should take into account present and forecast weather conditions in scheduling work, and monitor conditions if the work is to last a long time.

The code recommends that if work is carried out at unusually low temperatures:

(a) employers should implement work-rest cycles with warm shelters for recovery when:

(i) work is likely to last for some time;

(ii) the temperature and wind speed are likely to vary;

(iii) workers are experiencing or showing symptoms of discomfort;

(b) work scheduling should allow for the extra time taken by tasks in the cold, and the need for adequate drink and food;

(c) where practicable, work rates should be designed to avoid heavy sweating, but if this does occur, employers should ensure that dry replacement clothing is available with warm changing facilities.

Under cold conditions, suitable protection should be given to the hands and fingers, particularly where dexterity is needed, as well as other exposed parts of the body. Employers should provide:

(a) facilities for warming the hands, for example by warm air;

(b) tools with insulated handles, especially in temperatures below freezing point;

(c) measures to ensure that the bare hand does not touch surfaces below -7 °C (e.g. by using workplace design or protective clothing);

(d) measures to ensure that bare skin does not touch liquids below 4 °C;

(e) appropriate measures to be taken in the event of insulating clothing getting wet;

(f) face and eye protection, as appropriate, for outdoor work and working in snow (e.g. safety goggles against glare).

Health surveillance is important for workers employed in extreme temperature environments. Where the control measures include work-rest systems or protective

clothing, workers should be examined by qualified occupational health personnel who should determine:

- their fitness for the conditions of work;
- any limitations that should be applied to their work;
- the programme of training and information of workers;
- the measures for providing such training and information;
- any pre-existing conditions which might affect their tolerance to heat or cold (such as heart disease, overweight or some skin diseases); and
- measures to minimize risks among vulnerable groups (such as older workers).

Workers exposed to heat or cold and their supervisors should be trained:

- to recognize symptoms which may lead to heat stress or hypothermia, in themselves or others, and the steps to be taken to prevent onset and/or emergencies;
- in the use of rescue and first-aid measures;
- about action to be taken in the event of increased risks of accidents because of high and low temperatures;
- to recognize the importance of drinking sufficient quantities of liquid and the dietary requirements providing intake of salt and potassium and other elements that are depleted due to sweating;
- and to be aware of the importance of physical fitness for work in hot or cold environments and the effects of drugs which can reduce their tolerance to thermal extremes.

Workers should be allowed sufficient time to acclimatize to an extremely hot or cold environment, particularly when they have recently moved from a country with a warmer or colder climate.

1.1.3 Prevention of falling materials through safe stacking and storage

Falling objects

Objects have the potential to fall onto or hit people at the workplace or adjoining areas if precautions are not taken. Adjoining areas could include a public footpath, road, square or

the yard of a dwelling or other building beside a workplace. Equipment, material, tools and debris that can fall or be released sideways or upwards are also considered falling objects.

Examples include:

- an object free falling from a structure, such as:
 - roof scaffolding, tools, rock, soil and bricks
 - fixtures including pictures, ceiling panels and white boards that have not been securely fixed, and
 - materials that fall from over stacked shelving.
- an object free falling from lifting machinery, a vehicle or other plant equipment, including loads being lifted that are not well secured or are unstable
- an object or material ejected while using machinery or hand tools
- the collapse of an unstable structure including shelves, benches and mezzanine floors not strong enough to bear the weight of the objects kept on them.

The role of PCBUs

PCBUs must manage the risks associated with an object falling on a person if it is reasonably likely to injure the person.

Adequate protection must be provided to minimise the risk and protect the person.

When managing risks, the risk must be eliminated, so far as is reasonably practicable. If elimination is not reasonably practicable, the risks must be minimised so far as is reasonably practicable.

This requires each relevant PCBU to provide and maintain a safe system of work including:

- fall prevention, so far as is reasonably practicable, and
- fall prevention, so far as is reasonably practicable, and
- if fall prevention is not reasonably practicable—a system to arrest falling objects, so far as is reasonably practicable.

Other control measures can include:

- use of 'isolation' or 'no go' zones where there is a risk of an object falling into an area
- providing appropriate training and supervision
- use of suitable Personal Protective Equipment (PPE).

Administrative controls (such as safe work methods or procedures) and PPE should only be used:

- when there are no other practical control measures available (as a last resort)
- as an interim measure until a more effective way of controlling the risk can be used, and

- to supplement higher level control measures (as a backup).

Selecting control measures—fall prevention

Fall prevention must be considered and, so far as is reasonably practicable, implemented before considering options for arresting the fall of objects. Control measures that can assist in protecting persons from falling objects are suggested below.

Securing a load

To prevent objects from falling freely from one level to another when they are being stored a secure physical barrier should be provided. Examples of additional control measures include:

- stacking items so they cannot slide, fall or collapse when they are stored above ground level
- using netting or restraining bars to keep items in place when they are stored above ground level so they cannot fall easily if they are disturbed
- following the safe load limit of the storage system when storing items
- ensuring shelving systems, barriers and other fittings are properly secured and well maintained
- inspecting pallets each time before use to make sure they are in a safe condition
- loading pallets correctly to ensure load stability—banding, shrink or stretch wrap can help with this.

Moving a load

When moving a load, a safe means of raising and lowering plant, materials and debris should be provided. Examples of additional control measures include:

- handling equipment such as a fork-lift truck that is suitable for the job is properly inspected, maintained and operated by competent and/or qualified persons as required
- following the safe working load limits and taking into account all relevant factors such as stability of ground conditions, use of outriggers or stabilisers, slewing rate and wind conditions (if applicable)
- making sure the load is balanced and secure when the load is lifted
- enclosing areas that loads are being lifted over, and
- establishing 'isolation' or 'no-go' zones with barriers and trained workers to restrict access.

Working at a height

Examples of controls for working at heights include:

- keeping large equipment at ground level
- good housekeeping, for example keeping the work area tidy and ensuring materials, debris, tools and equipment that are not being used are out of the way
- if placing an item on a scaffold or platform, providing a secure physical barrier at the edge of the elevated area, such as toe boards or infill panels that form part of a guardrail system
- tethering or otherwise securing tools and materials to prevent them falling on people below
- keeping tools or other materials away from edges and off of railings or sills
- using chutes when placing debris into a skip below a work area.

Demolition work

Principal contractors and other PCBUs involved in demolition work must provide adequate protection to ensure objects do not fall onto or hit construction workers or other people in adjoining areas such as a public footpath, road, and the yard of a dwelling or other building.

Selecting control measures—fall arrest

When considering control measures to contain or catch falling objects, identify the types of objects that could fall, as well as the fall gradient and distance, to ensure that any protective equipment or structures are strong enough to withstand the impact forces of the falling object.

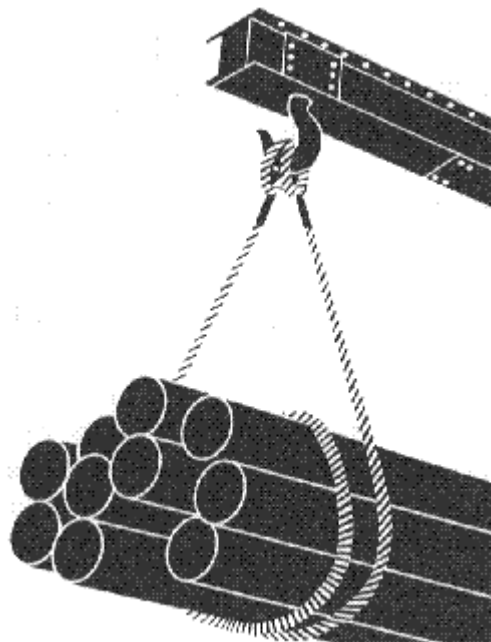
Examples of these control measures include:

- erecting a covered pedestrian walkway
- erecting a catch platform with vertical sheeting or perimeter screening, and
- providing overhead protection on mobile plant.

Maintaining control measures

Each relevant PCBU must ensure control measures are:

- suitable for the nature and duration of the work



- installed and used correctly, and
- maintained in good working order.

Reviewing control measures

Controlling health and safety risks in the workplace is an ongoing process that needs to take into account changes in the workplace. This is why procedures and risk control measures must be reviewed regularly to ensure they are still effective.

Potential hazards

Handling and storing materials involves diverse operations such as hoisting tons of steel with a crane, driving a truck loaded with concrete blocks, manually carrying bags and material, and stacking drums, barrels, kegs, lumber, or loose bricks.

The efficient handling and storing of materials is vital to industry. These operations provide a continuous flow of raw materials, parts, and assemblies through the workplace, and ensure that materials are available when needed. Yet, the improper handling and storing of materials can cause costly injuries.

Workers frequently cite the weight and bulkiness of objects being lifted as major contributing factors to their injuries. In 1990, back injuries resulted in 400,000 workplace accidents. The second factor frequently cited by workers as contributing to their injuries was body movement. Bending, followed by twisting and turning, were the more commonly cited movements that caused back injuries. Back injuries accounted for more than 20 percent of all occupational illnesses, according to data from the National Safety Council¹.

In addition, workers can be injured by falling objects, improperly stacked materials, or by various types of equipment. When manually moving materials, however, workers should be aware of potential injuries, including the following:

- Strains and sprains from improperly lifting loads, or from carrying loads that are either too large or too heavy.
- Fractures and bruises caused by being struck by materials, or by being caught in pinch points; and
- Cuts and bruises caused by falling materials that have been improperly stored, or by incorrectly cutting ties or other securing devices.

Since numerous injuries can result from improperly handling and storing materials, it is important to be aware of accidents that may occur from unsafe or improperly handled

equipment and improper work practices, and to recognize the methods for eliminating, or at least minimizing, the occurrence of those accidents. Consequently, employers and employees can and should examine their workplaces to detect any unsafe or unhealthful conditions, practices, or equipment and take the necessary steps to correct them.

MOVING, HANDLING, AND STORING MATERIALS

When manually moving materials, employees should seek help when a load is so bulky it cannot be properly grasped or lifted, when they cannot see around or over it, or when a load cannot be safely handled.

When an employee is placing blocks under raised loads, the employee should ensure that the load is not released until his or her hands are clearly removed from the load. Blocking materials and timbers should be large and strong enough to support the load safely. Materials with evidence of cracks, rounded corners, splintered pieces, or dry rot should not be used for blocking.

Handles and holders should be attached to loads to reduce the chances of getting fingers pinched or smashed. Workers also should use appropriate protective equipment. For loads with sharp or rough edges, wear gloves or other hand and forearm protection. To avoid injuries to the hands and eyes, use gloves and eye protection. When the loads are heavy or bulky, the mover should also wear steel-toed safety shoes or boots to prevent foot injuries if the worker slips or accidentally drops a load.

When mechanically moving materials, avoid overloading the equipment by letting the weight, size, and shape of the material being moved dictate the type of equipment used for transporting it. All materials handling equipment has rated capacities that determine the maximum weight the equipment can safely handle and the conditions under which it can handle those weights. The equipment-rated capacities must be displayed on each piece of equipment and must not be exceeded except for load testing. When picking up items with a powered industrial truck, the load must be centered on the forks and as close to the mast as possible to minimize the potential for the truck tipping or the load falling. A lift truck must never be overloaded because it would be hard to control and could easily tip over. Extra weight must not be placed on the rear of a counterbalanced forklift to offset an overload. The load must be at the lowest position for traveling, and the truck manufacturer's operational requirements must be followed. All stacked loads must be correctly piled and cross-tiered, where possible. Precautions also should be taken when stacking and storing material.

Stored materials must not create a hazard. Storage areas must be kept free from

accumulated materials that may cause tripping, fires, or explosions, or that may contribute to the harboring of rats and other pests. When stacking and piling materials, it is important to be aware of such factors as the materials' height and weight, how accessible the stored materials are to the user, and the condition of the containers where the materials are being stored.

All bound material should be stacked, placed on racks, blocked, interlocked, or otherwise secured to prevent it from sliding, falling, or collapsing. A load greater than that approved by a building official may not be placed on any floor of a building or other structure. Where applicable, load limits approved by the building inspector should be conspicuously posted in all storage areas.

When stacking materials, height limitations should be observed. For example, lumber must be stacked no more than 16 feet high if it is handled manually; 20 feet is the maximum stacking height if a forklift is used. For quick reference, walls or posts may be painted with stripes to indicate maximum stacking heights.

Used lumber must have all nails removed before stacking. Lumber must be stacked and leveled on solidly supported bracing. The stacks must be stable and self-supporting. Stacks of loose bricks should not be more than 7 feet in height. When these stacks reach a height of 4 feet, they should be tapered back 2 inches for every foot of height above the 4-foot level. When masonry blocks are stacked higher than 6 feet, the stacks should be tapered back one-half block for each tier above the 6-foot level.

Bags and bundles must be stacked in interlocking rows to remain secure. Bagged material must be stacked by stepping back the layers and cross-keying the bags at least every ten layers. To remove bags from the stack, start from the top row first. Baled paper and rags stored inside a building must not be closer than 18 inches to the walls, partitions, or sprinkler heads. Boxed materials must be banded or held in place using cross-ties or shrink plastic fiber.

Drums, barrels, and kegs must be stacked symmetrically. If stored on their sides, the bottom tiers must be blocked to keep them from rolling. When stacked on end, put planks, sheets of plywood dunnage, or pallets between each tier to make a firm, flat, stacking surface. When stacking materials two or more tiers high, the bottom tier must be chocked on each side to prevent shifting in either direction.

When stacking, consider the need for availability of the material. Material that cannot be stacked due to size, shape, or fragility can be safely stored on shelves or in bins. Structural steel, bar stock, poles, and other cylindrical materials, unless in racks, must be stacked and

blocked to prevent spreading or tilting. Pipes and bars should not be stored in racks that face main aisles; this could create a hazard to passers-by when supplies are being removed.

1.2 Violence at work

Violence at work, particularly from dissatisfied customers, clients, claimants or patients, causes a lot of stress and in some cases injury. This is not only physical violence as people may face verbal and mental abuse, discrimination, harassment and bullying. Fortunately, physical violence is still rare, but violence of all types has risen significantly in recent years. Violence at work is known to cause pain, suffering, anxiety and stress, leading to financial costs due to absenteeism and higher insurance premiums to cover increased civil claims. It can be very costly to ignore the problem. Violence from members of the public is a higher risk with several occupations - the health and social services, police and fire fighters, various types of enforcement officers, education, benefit services, various service industries and debt collection.

In 1999 the UK Home Office and the HSE published a comprehensive report entitled *Violence at Work: Findings from the British Crime Survey*. This was updated with a joint report *Violence at Work: New Findings from the 2000 British Crime Survey*, which was published in July 2001.

The report defines violence at work as:

All assaults or threats which occurred while the victim was working and were perpetrated by members of the public.

Physical assaults include the offences of common assault, wounding, robbery and snatch theft. Threats include both verbal threats, made to or against the victim and nonverbal intimidation. These are mainly threats to assault the victim and, in some cases, to damage property.

Excluded from the survey are violent incidents where there was a relationship between the victim and the offender and also where the offender was a work colleague. The latter category was excluded because of the different nature of such incidents.

The British Crime Survey shows that the number of incidents and victims rose rapidly between 1991 and 1995 but then declined in 1997. Unfortunately, since 1997 the decline seems to have reversed as the number of incidents has increased by 5 per cent.

Trend in physical assaults and threats at work, 1991-1999 (based on working adults of working age)					
Number of incidents (000s)	1991	1993	1995	1997	1999
All violence	947	1275	1507	1226	1288
Assaults	451	652	729	523	634
Threats	495	607	779	703	654
Number of victims (000s)					
All violence	472	530	570	649	604
Assaults	227	287	290	275	304
Threats	264	286	352	395	338

Source - British Crime Survey 1999.

It is interesting that almost half of the assaults and a third of the threats happened after 1800 hrs, which suggests that the risks are higher if people work at night or in the late evening. About 16 per cent of the assaults involved offenders under the age of 16 and were mainly against teachers or other education workers.

Violence at work is defined by the UK HSE as:

any incident in which an employee is abused, threatened or assaulted in circumstances relating to their work.

In recognition of this, the HSE has produced a useful guide to employers which includes a four-stage action plan and some advice on precautionary measures (*Violence at Work: a Guide for Employers*, INDG69 (rev)). The employer is just as responsible, under health and safety legislation, for protecting employees from violence as they are for any other aspects of their safety.

The HSE recommends the following four-point action plan:

1. find out if there is a problem;
2. decide on what action to take;
3. take the appropriate action;
4. check that the action is effective.

1.2.1 Risk factors relating to violence at work

Most people think of violence as a physical assault. However, workplace violence is a much broader problem. It is any act in which a person is abused, threatened, intimidated or assaulted in his or her employment. Workplace violence includes:

- **Threatening behaviour** - such as shaking fists, destroying property or throwing objects.
- **Verbal or written threats** - any expression of an intent to inflict harm.
- **Harassment** - any behaviour that demeans, embarrasses, humiliates, annoys, alarms or verbally abuses a person and that is known or would be expected to be unwelcome. This includes words, gestures, intimidation, bullying, or other inappropriate activities.
- **Verbal abuse** - swearing, insults or condescending language.
- **Physical attacks** - hitting, shoving, pushing or kicking.

Rumours, swearing, verbal abuse, pranks, arguments, property damage, vandalism, sabotage, pushing, theft, physical assaults, psychological trauma, anger-related incidents, rape, arson and murder are all examples of workplace violence.

Workplace violence is not limited to incidents that occur within a traditional workplace. Work-related violence can occur at off-site business-related functions (conferences, trade shows), at social events related to work, in clients' homes or away from work but resulting from work (a threatening telephone call to your home from a client).

Certain work factors, processes, and interactions can put people at increased risk from workplace violence. Examples include:

- Working with the public.
- Handling money, valuables or prescription drugs (e.g. cashiers, pharmacists).
- Carrying out inspection or enforcement duties (e.g. government employees).
- Providing service, care, advice or education (e.g. health care staff, teachers).
- Working with unstable or volatile persons (e.g. social services, or criminal justice system employees).
- Working in premises where alcohol is served (e.g. food and beverage staff).
- Working alone, in small numbers (e.g. store clerks, real estate agents), or in isolated or low traffic areas (e.g. washrooms, storage areas, utility rooms).
- Working in community-based settings (e.g. nurses, social workers and other home visitors).
- Having a mobile workplace (e.g. taxicab).

- Working during periods of intense organizational change (e.g. strikes, downsizing).

Risk of violence may be greater at certain times of the day, night or year; For example,

- late hours of the night or early hours of the morning
- tax return season
- overdue utility bill cut-off dates
- during the holidays
- pay days
- report cards or parent interviews
- performance appraisals

Risk of violence may increase depending on the geographic location of the workplace; for example,

- near buildings or businesses that are at risk of violent crime (e.g. bars, banks)
- in areas isolated from other buildings or structures

Certain occupational groups tend to be more at risk from workplace violence. These occupations include:

- health care employees
- correctional officers
- social services employees
- teachers
- municipal housing inspectors
- public works employees
- retail employees

1.2.2 Appropriate control measures to reduce risks from violence at work

It is important to evaluate the risks and decide who may be harmed and how this is likely to occur. The threats may be from the public or co-workers at the workplace or may be as a result of visiting the homes of customers. Consultation with employees or other people at risk will improve their commitment to control measures and will make the precautions much more effective. The level of training and information provided, together with the general working environment and the design of the job, all have a significant influence on the level of risk.

Those people at risk could include those working in:

- reception or customer service points;
- enforcement and inspection;
- lone working situations and community-based activities;
- front-line service delivery;
- education and welfare;
- catering and hospitality;
- retail petrol and late-night shopping operations;
- leisure facilities, especially if alcohol is sold;
- healthcare and voluntary roles;
- policing and security;
- mental health units or in contact with disturbed people;
- cash handling or control of high value goods.

Consider the following issues:

- quality of service provided;
- design of the operating environment-type of equipment used;
- designing the job.

Some violence may be deterred if measures are taken which suggest that any violence may be recorded. Many public bodies use the following measures:

- informing telephone callers that their calls will be recorded;
- displaying prominent notices that violent behaviour may lead to the withdrawal of services and prosecution;
- using closed circuit television (CCTV) or security personnel.

Quality of service provided

The type and quality of service provision has a significant effect on the likelihood of violence occurring in the workplace. Frustrated people whose expectations have not been met and who are treated in an unprofessional way may believe they have the justification to cause trouble.

Sometimes circumstances are beyond the control of the staff member and potentially violent situations need to be defused. The use of correct skills can turn a dissatisfied customer into a confirmed supporter simply by careful response to their concerns. The perceived lack of or incorrect information can cause significant frustrations.

Personal safety and service delivery are very closely connected and have been widely researched in recent years. This has resulted in many organizations altering their facilities to reduce customer frustration and enhance sales. It is interesting that most service points experience less violence when they remove barriers or screens, but the transition needs to be carefully planned in consultation with staff and other measures adopted to reduce the risks and improve their protection.

The layout, ambience, colours, lighting, type of background music, furnishings including their comfort, information, things to do while waiting and even smell all have a major impact. Queue-jumping causes a lot of anger and frustration and needs effective signs and proper queue management, which can help to reduce the potential for conflict.

Wider desks, raised floors and access for special needs, escape arrangements for staff, carefully arranged furniture and screening for staff areas can all be utilized.

Type of security equipment used

There is a large amount of equipment available and expert advice is necessary to ensure that it is suitable and sufficient for the task. Some measures that could be considered include the following:

Access control to protect people and property. There are many variations from staffed and friendly receptions, barriers with swipe-cards and simple coded security locks. The building layout and design may well partly dictate what is chosen. People inside the premises need access passes so they can be identified easily.

Closed circuit television is one of the most effective security arrangements to deter crime and violence. Because of the high cost of the equipment, it is essential to ensure that proper independent advice is obtained on the type and the extent of the system required. Alarms: there are three main types:

- intruder alarms fitted in buildings to protect against unlawful entry, particularly after working hours;
- panic alarms used in areas such as receptions and interview rooms covertly located so that they can be operated by the staff member threatened;
- personal alarms carried by an individual to attract attention and to temporarily distract the attacker. Radios and pagers can be a great asset to lone workers in particular, but special training is necessary as good radio discipline with a special language and codes are required.

Mobile phones are an effective means of communicating and keeping colleagues informed of people's movements and problems such as travel delays. Key numbers should be inserted for rapid use in **an** emergency.

Job Design

Many things can be done to improve security and the way in which the job is carried out to avoid violence. These include:

- using cashless payment methods;
- keeping money on the premises to a minimum;
- careful check of customer or client's credentials;
- careful planning of meetings away from the workplace;
- team work where suspected aggressors may be involved;
- regular contact with workers away from their base.
- There are special services available to provide contact arrangements;
- avoidance of lone working as far as is reasonably practicable;
- thinking about how staff who have to work shifts or late hours will get home. Safe transport and/or parking areas may be required;
- setting up support services to help victims of violence and, if necessary, other staff who could be affected. They may need debriefing, legal assistance, time off work to recover or counselling by experts.

A busy accident and emergency department of a general hospital, for example, has to balance the protection of staff from violent attack with the need to offer patients a calm and open environment. Protection could be given to staff by the installation of wide counters, coded locks on doors, CCTV systems, panic buttons and alarm systems. The employment of security staff and strict security procedures for the storage and issuing of drugs are two further precautions taken by such departments. Awareness training for staff so that they can recognize early signs of aggressive behaviour and an effective counselling service for those who have suffered from violent behaviour should be provided.

Take the appropriate action

The arrangements for dealing with violence should be included in the safety policy and managed like any other aspect of the health and safety procedures. Action plans should be drawn up and followed through using the consultation arrangements as appropriate. The police should also be consulted to ensure that they are happy with the plan and are prepared to play their part in providing back-up and the like.

Check that the action is effective

Ensure that the records are being maintained and any reported incidents are investigated and suitable action taken. The procedures should be regularly audited and changes made if they are not working properly.

Victims should be provided with help and assistance to overcome their distress, through debriefing, counselling, time off to recover, legal advice and support from colleagues.

1.3 Substance misuse at work

1.3.1 Types of substances misused at work

1. Alcohol - Describes alcohol consumption that puts individuals at increased risk for adverse health and social consequences. It is defined as excess daily consumption (more than 4 drinks per day for men or more than 3 drinks per day for women), or excess total consumption (more than 14 drinks per week for men or more than 7 drinks per week for women),

Alcohol misuse can result in a number of adverse health and social consequences.

- More than 700,000 Americans receive alcoholism treatment every day, but there is growing recognition that alcoholism (i.e., alcohol dependence or addiction) represents only one end of the spectrum of “alcohol misuse”
- There are approximately 79,000 deaths attributable to excessive alcohol use each year in the United States

Alcohol misuse is a risk factor for a number of adverse health outcomes including:

- Unintentional injuries (e.g., motor vehicle accidents, falls)
- Violence (e.g., homicide, suicide)
- Liver disease
- Diseases of the central nervous system (e.g., stroke, dementia)
- Heart disease including coronary artery disease, atrial fibrillation (i.e., abnormal heart rhythm), high blood pressure, and congestive heart failure
- Various cancers (e.g., breast, colorectal, and liver)
- Risky sexual behaviors and adverse pregnancy outcomes

Many problem drinkers have medical or social problems attributable to alcohol (i.e., alcohol misuse or "excessive drinking") without typical signs of dependence, and other drinkers are

at risk for future problems due to chronic alcohol consumption or frequent binges. Nondependent drinkers who misuse alcohol account for the majority of alcohol-related disability and death in the general population.

2. Legal/illegal drug - Drug misuse can harm the misuser both physically and mentally and, through the misuser's actions, other people and the environment. Historically, society regards alcohol, tobacco and caffeine differently from other drugs and the problems associated with their use are well documented. They are therefore not considered further in this booklet. However, remember that simultaneous use of alcohol and drugs is particularly dangerous.

Successfully tackling drug misuse can benefit both your business and your employees. For example by:

- saving on the cost of recruiting and training new employees to replace those whose employment might be terminated because of untreated drug misuse;
- reducing the cost of absenteeism or impaired productivity;
- creating a more productive environment by offering support to those employees who declare a drug-related problem, improving employee morale;
- reducing the risk of accidents caused by impaired judgement;
- enhancing the public perception of your organisation as a responsible employer;
- contributing to society's efforts to combat drug misuse.

3. Solvents - Some organic - that is, carbon based - compounds can produce effects similar to alcohol or anaesthetics when their vapours are inhaled. A number are used as solvents in glues, paints, nail varnish removers, dry cleaning fluids and de-greasing compounds. Others are used as propellant gases in aerosols and fire extinguishers or as fuels such as petrol or cigarette lighter gas (butane). Most households, factories and offices use a range of solvents which can be sniffed.

These products give off vapours or are gases at normal temperatures and can be inhaled through the mouth or nose to give an intoxicating effect. This is sometimes called 'glue sniffing', 'solvent abuse' or 'volatile substance abuse' (VSA). Solvents may be directly inhaled, sniffed from inside a plastic or paper bag, or put on a rag before sniffing.

In any given area, a proportion of adolescents mainly aged between 12 and 16 would have tried sniffing solvents. It is difficult to quantify, but surveys suggest that around 10 per cent

of secondary school children would have tried solvents at least once. VSA is often sporadic and isolated to hot spots or areas where it is hardly done.

VSA is more common in Scotland for example where up to a fifth of 14 and 15 year olds have sniffed or 'biffed' glue or other solvents. Solvents is the only drug where girls not only match boys, but sometimes outnumber them in taking the drug (usually around the age of 13 years). Only a minority will go on to become regular users, often sniffing alone to escape from personal problems.

The rise of ecstasy use has tended to relegate solvent use to the sidelines as far as the media is concerned and it may well be that sniffing solvents is less of a craze than it was a few years ago. However, between 70 and 100 young people are still dying from solvent sniffing every year; some of these fatalities will be first time sniffers.

1.3.2 Risks to health and safety from substance misuse at work

The misuse of drugs, including alcohol and other substances, can be a serious problem for the abuser, co-workers and the organisation itself.

Alcohol, drugs and other substances have a strongly negative effect on the brain and the body, impairing judgement and concentration and putting the abuser and co-workers at risk.

Staff who misuse drugs or alcohol are more likely to take time off, display poor performance and increase the risk of accidents. These factors weaken an organisation's overall performance.

Alcohol and drug abuse damages health and causes absenteeism and reduced productivity. The HSE is keen to see employers address the problem and offers advice in two separate booklets.

Alcohol abuse is a considerable problem when vehicle driving is part of the job, especially if driving is required on public roads. Misuse of alcohol can reduce productivity, increase absenteeism, increase accidents at work and, in some cases, endanger the public. In the UK, the HSE has estimated that between 3 per cent and 5 per cent of all absences from work are due to alcohol and result in approximately 14 million working days lost each year. Employers need to adopt an alcohol policy following employee consultation. The following matters need to be considered:

- how the organization expects employees to restrict
- their level of drinking;
- how drinking problems can be recognized and help offered; and

- at what point and under what circumstances will an employee's drinking be treated as a disciplinary rather than a health problem.

Prevention of the problem is better than remedial action after a problem has occurred. During working hours, there should be no drinking, and drinking during break periods should be discouraged. Induction training should stress this policy and managers should set it. Posters can also help to communicate the message. However, it is important to recognize possible symptoms of an alcohol problem, such as lateness and absenteeism, poor work standards, impaired concentration, memory and judgement, and deteriorating relations with colleagues. It is always better to offer counselling rather than dismissal. The policy should be monitored to check on its effectiveness.

Drug abuse presents similar problems to those found with alcohol abuse: absenteeism, reduced productivity and an increase in the risk of accidents. A study undertaken by Cardiff University found that 'although drug use was lower among workers than the unemployed. One in four workers under the age of 30 years reported having used drugs in the previous year. ... There are well documented links between drug use and impairments in cognition, perception and motor skills, both at the acute and chronic levels. Associations may therefore exist between drug use and work performance'. The following conclusions were also drawn from the study:

- about 13 per cent of working respondents reported drug use in the previous year. The rate varied with age, from 3 per cent of those over 50 years to 29 per cent of those under 30 years;
- drug use is strongly linked to smoking and heavy drinking in that order;
- there is an association between drug use and minor injuries among those who are also experiencing other minor injury risk factors;
- the project has shown that recreational drug use may reduce performance efficiency and safety at work.

1.3.3 Control measures to reduce risks from substance misuse at work

Employers have a legal responsibility to look after employees' wellbeing, health and safety. A good employer will want to help employees. In some cases, alcohol or drug misuse may be used to help cope with work-related stress. If there is a problem with alcohol or drug misuse in your workplace then this may be part of a wider stress problem.

Some employers treat alcohol and drug misuse as a medical rather than a disciplinary matter. In this case, the chances of overcoming the problem is assessed and a reasonable period of time off for recovery is agreed.

They may also consider appropriate help to treat the employee (for example, by contributing towards the cost of counselling), treat any absence for treatment and rehabilitation as normal sick leave and review the person's work to ensure that their workload is not contributing to the problem.

Preventive measures

Preventive measures generally fall into three categories, workplace design, administrative practices and work practices.

Workplace design considers factors such as workplace lay-out, use of signs, locks or physical barriers, lighting, and electronic surveillance. Building security is one instance where workplace design issues are very important. For example, you should consider:

- Positioning the reception area or sales or service counter so that it is visible to fellow employees or members of the public passing by.
- Positioning office furniture so that the employee is closer to a door or exit than the client and so that the employee cannot be cornered.
- Installing physical barriers, e.g. pass-through windows or bullet-proof enclosures.
- Minimizing the number of entrances to your workplace.
- Using coded cards or keys to control access to the building or certain areas within the building.
- Using adequate exterior lighting around the workplace and near entrances.
- Strategically placing fences to control access to the workplace.

Administrative practices are decisions you make about how you do business. For example, certain administrative practices can reduce the risks involved in handling cash. You should consider:

- Keeping cash register funds to a minimum.
- Using electronic payment systems to reduce the amount of cash available.
- Varying the time of day that you empty or reduce funds in the cash register.
- Installing and using a locked drop safe.
- Arranging for regular cash collection by a licensed security firm.

Work practices include all the things you do while you are doing the job. People, who work away from a traditional office setting, for example real estate agents or home care providers, can adopt many different work practices that will reduce their risk. For example,

- Prepare a daily work plan, so that you and others know where and when you are expected somewhere.
- Identify a designated contact at the office and a back-up.
- Keep your designated contact informed of your location and consistently adhere to the call-in schedule.
- Check the credentials of clients.
- Use the "buddy system", especially when you feel your personal safety may be threatened.
- DO NOT enter any situation or location where you feel threatened or unsafe.

Policy

Even if there is no evidence of their use, organisations can benefit from a policy on drugs, alcohol and other substances in consultation with staff or health and safety representatives.

Any policy must be suitable for the organisation. In some workplaces it will form part of the overall health and safety policy but may also be part of an occupational health policy. In some organisations a separate policy on alcohol and drugs is developed.

A successful drug misuse policy will benefit the organization and employees by reducing absenteeism, poor productivity and the risk of accidents. There is no simple guide to the detection of drug abuse, but the HSE has suggested the following signals:

- sudden mood changes;
- unusual irritability or aggression;
- a tendency to become confused;
- abnormal fluctuations in concentration and energy;
- impaired job performance;
- poor time-keeping;
- increased short-term sickness leave;
- a deterioration in relationships with colleagues, customers or management;
- dishonesty and theft (arising from the need to maintain an expensive habit).

A policy on drug abuse can be established by:

- Investigation of the size of the problem Examination of sicknesses, behavioural and productivity changes and accident and disciplinary records is a good starting point.

- **Planning actions** - Develop an awareness programme for all staff and a special training programme for managers and supervisors. Employees with a drug problem should be encouraged to seek help in a confidential setting.
- **Taking action** - Produce a written policy that includes everyone in the organization and names the person responsible for implementing the policy. It should include details of the safeguards to employees and the confidentiality given to anyone with a drug problem. It should also clearly outline the circumstances in which disciplinary and/or reported action will be taken (the refusal of help, gross misconduct and possession/dealing in drugs).
- **Monitoring the policy** - The policy can be monitored by checking for positive changes in the measures made during the initial investigation (improvements in the rates of sickness and accidents). Drug screening and testing is a sensitive issue and should only be considered with the agreement of the workforce (except in the case of pre-employment testing). Screening will only be acceptable if it is seen as part of the health policy of the organization and its purpose is to reduce risks to the misusers and others.

1.4 Safe movement of people in the workplace

1.4.1 Hazards in the workplace

The most common hazards to pedestrians at work are slips, trips and falls on the same level, falls from height, collisions with moving vehicles, being struck by moving, falling or flying objects and striking against fixed or stationary objects. Each of these will be considered in turn, including the conditions and environment in which the particular hazard may arise.

Slips, trips and falls on the same level

These are the most common of the hazards faced by pedestrians and accounted for 30% of all the major accidents every year and 20% of over 3-day injuries reported in the UK to the Health and Safety Executive (HSE). The HSE itself has reported that every 25 minutes in the UK someone breaks or fractures a bone due to slipping, tripping or falling at work (Figure 9.1). It has been estimated that the annual cost of these accidents to the nation is £750 million and a direct cost to employers of £300 million. The highest reported injuries are reported in the food and related industries. Older workers, especially women, are the most severely injured group from falls resulting in fractures of the hips and/or femur. Civil compensation claims are becoming more common and costly to employers and such claims

are now being made by members of the public who have tripped on uneven paving slabs on pavements or in shopping centres.

The UK HSE has been so concerned at the large number of such accidents that it has identified slips, trips and falls on the same level as a key risk area. The costs of slips, trips and falls on the same level are high to the injured employee (lost income and pain), the employer (direct and indirect costs including lost production) and to society as a whole in terms of health and social security costs.

Slip hazards are caused by:

- wet or dusty floors;
- the spillage of wet or dry substances - oil, water, flour dust and plastic pellets used in plastic manufacture;
- loose mats on slippery floors;
- wet and/or icy weather conditions;
- unsuitable footwear or floor coverings or sloping floors.

Trip hazards are caused by:

- loose floorboards or carpets;
- obstructions, low walls, low fixtures on the floor;
- cables or trailing leads across walkways or uneven surfaces;
- leads to portable electrical hand tools and other electrical appliances (vacuum cleaners and overhead projectors);
- raised telephone and electrical sockets -also a serious trip hazard (this can be a significant problem when the display screen workstations are reorientated in an office);
- rugs and mats -particularly when worn or placed on a polished surface;
- poor housekeeping - obstacles left on walkways, rubbish not removed regularly;
- poor lighting levels -particularly near steps or other changes in level;
- sloping or uneven floors - particularly where there is poor lighting or no handrails;
- unsuitable footwear - shoes with a slippery sole or lack of ankle support.

The vast majority of major accidents involving slips, trips and falls on the same level result in dislocated or fractured bones.

Falls from work at height

These are the most common cause of serious injury or death in the construction. These accidents are often concerned with falls of greater than about 2 m and often result in fractured bones, serious head injuries, loss of consciousness and death. Twenty-five per cent of

all deaths at work and 19 per cent of all major accidents are due to falls from a height. Falls down staircases and stairways, through fragile surfaces, off landings and stepladders and from vehicles, all come into this category. Injury, sometimes serious, can also result from falls below 2 m, for example using swivel chairs for access to high shelves or falling from vehicles.

Collisions with moving vehicles

These can occur within the workplace premises or on the access roads around the building. It is a particular problem where there is no separation between pedestrians and vehicles or where vehicles are speeding. Poor lighting, blind corners, the lack of warning signs and barriers at road crossing points also increase the risk of this type of accident. Eighteen per cent of fatalities at work are caused by collisions between pedestrians and moving vehicles with the greatest number occurring in the service sector (primarily in retail and warehouse activities).

Being struck by moving, falling or flying objects

In the UK, this causes 18 per cent of fatalities at work and is the second-highest cause of fatality in the construction industry. It also causes 15 per cent of all major and 14 per cent of over-3-day accidents. Moving objects include articles being moved, moving parts of machinery or conveyor belt systems, and flying objects are often generated by the disintegration of a moving part or a failure of a system under pressure. Falling objects are a major problem in construction (due to careless working at height) and in warehouse work (due to careless stacking of pallets on racking). The head is particularly vulnerable to these hazards. Items falling off high shelves and moving loads are also significant hazards in many sectors of industry.

Striking against fixed or stationary objects

This accounts for over 1000 major accidents every year in the UK. Injuries are caused to a person either by colliding with a fixed part of the building structure, work in progress, a machine member or a stationary vehicle or by falling against such objects. The head appears to be the most vulnerable part of the body to this particular hazard and this is invariably caused by the misjudgment of the height of an obstacle. Concussion in a mild form is the most common outcome and a medical check-up is normally recommended. It is a very common injury during maintenance operations when there is, perhaps, less familiarity with particular space restrictions around a machine. Effective solutions to these hazards need

not be expensive, time consuming or complicated. Employee awareness and common sense combined with a good housekeeping regime will solve many of the problems.

1.4.2 Control measures for the safe movement of people in the workplace

Slip resistant surfaces - Slips, trips and falls on the same level may be prevented or, at least, reduced by several control strategies. These and all the other pedestrian hazards discussed should be included in the workplace risk assessments by identifying slip or trip hazards, such as poor or uneven floor/pavement surfaces, badly lit stairways and puddles from leaking roofs. All floors should be suitable for the workplace activity, in good condition and free from obstructions. Traffic routes must be organized to enable people to move around the workplace safely.

Spillage control and drainage - Generation and implementation of effective emergency response and spill control procedures are fundamental aspects of a safety management system.

The on-site emergency plan, prepared for Regulation 9 of COMAH should address procedures for dealing with emergency situations involving loss of containment in general terms. The main points for inclusion are:

- Containing and controlling incidents so as to minimise the effects and to limit danger to persons, the environment and property;
- Implementing the measures necessary to protect persons and the environment;
- Description of the actions which should be taken to control the conditions at events and to limit their consequences, including a description of the safety equipment and resources available;
- Arrangements for training staff in the duties they will be expected to perform;
- Arrangements for informing local authorities and emergency services; and
- Arrangements for providing assistance with off-site mitigatory action.

The emergency plan should be simple and straightforward, flexible and achieve necessary compliance with legislative requirements. Furthermore separate on-site and off-site emergency plans should be prepared.

Designated walkways - Many slips and trips occur when people are walking on uneven surfaces. The risk can be reduced by providing walkways that are;

- clearly designated as a walkway;
- provided with good conditions underfoot;
- signposted and provided with adequate lighting.

You can also use mechanical lifting aids rather than carrying unwieldy loads that block the view ahead and make sure everyone wears suitable footwear with a good grip.

Fencing and guarding - Working close to moving and rotating machinery or where parts may be ejected is inherently unsafe and there is a foreseeable risk of being crushed, cut, entangled or struck. This risk must be managed by undertaking a suitable risk assessment and implementing and enforcing the necessary control measures.

It is foreseeable that an operator may be in close proximity to the machine. The use of perimeter fences and interlocked gates would prevent inadvertent access and the operator from working in close proximity to the machinery.

Fixed guards alone might not be feasible as access is required for loading and unloading the stone. The following would all offer a high standard of protection:

- a perimeter fence and interlocked guards, such as manually-actuated sliding access gates. The interlocked guards must be fitted with a locking device so that the guard remains closed and locked until any risk of injury from the hazardous machine has passed, to allow for the rundown time of the saw blade
- Electro-sensitive protective equipment e.g. light guards at the front of the enclosure in conjunction with a braking system to stop the movement before access to dangerous parts can be reached or the saw head should immediately return to a home position with a local guarding enclosure
- local retracting guards around the circular saw blade and pressure sensitive edges on the saw head and traversing table but this would have to be in conjunction with fast stopping times of the head and saw blade

Use fixed and interlocking guards or safety devices providing equivalent protection at automatic and CNC machines to ensure all dangerous movements, not only the saw blade, are guarded.

Use of signs and personal protective equipment - Making the workplace safe includes providing instructions, procedures, training and supervision to encourage people to work safely and responsibly.

Even where engineering controls and safe systems of work have been applied, some hazards might remain. These include injuries to:

- the lungs, eg from breathing in contaminated air
- the head and feet, eg from falling materials
- the eyes, eg from flying particles or splashes of corrosive liquids
- the skin, eg from contact with corrosive materials
- the body, eg from extremes of heat or cold

Employers must provide safety signs if there is a significant risk that can't be avoided or controlled in any other way, such as through safe systems of work or engineering controls.

There is no need to provide safety signs if they don't help reduce the risk or if the risk isn't significant. This applies to all places and activities where people are employed.

Employers must, where necessary:

- use road traffic signs in workplaces to regulate road traffic
- maintain the safety signs they provide
- explain unfamiliar signs to their employees and tell them what they need to do when they see safety signs

Training and Instructions - The Management of Health and Safety at Work Regulations 1999 (the Management Regulations), which make more explicit what is required of employers under the Health and Safety at Work Act

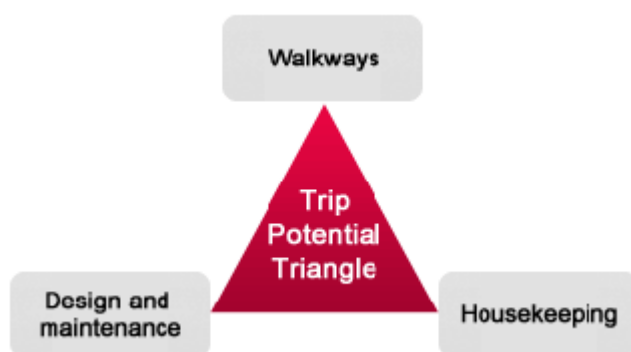
Employers have responsibility to ensure the health, safety and welfare of their workforce (with a written policy if they have more than five employees), to assess risks, to ensure implementation of necessary protection measures, to provide relevant staff training, to publicize health and safety information, to report injuries and accidents.

Employees have a duty to take reasonable care for their own health and safety and that of others, to cooperate with an employer on health and safety matters, including by use of protection equipment. Employees can refuse to do something unsafe without being threatened with disciplinary action.

Maintenance of a safe workplace

Cleaning and housekeeping requirements - It is not just good enough to have a walkway; it must be kept clear, no trailing wires, no obstructions. Employees and cleaners need to have 'a see it, sort it' attitude to ensure these and other work areas are kept clear. Is the cleaning regime effective? Are there enough bins, storage facilities etc.?

Is the floor suitable for the environment, fitted correctly and properly maintained. Are the walkways wide enough & level. Are stairs suitable, are risers consistent, are nosing highlighted where necessary, are usable handrails available. Environmental factors also fall into this category, is the lighting good enough for employees to see hazards, what about distractions that might prevent them from seeing where they are going.



Access and egress – An overview of the safety requirements for access/egress in the workplace.

The Law

The Workplace (Health, Safety and Welfare) Regulations 1992

What does the Law require?

The Law requires that:

- a) every workplace is organised in such a way that pedestrians and vehicles can circulate in a safe manner.
- b) every room where people work shall have sufficient floor area and height to allow safe movement.
- c) every floor shall be fit for purpose and kept free from obstructions and tripping hazards.

- d) every staircase shall be fitted with a handrail.
- e) doors and gates should be fitted with a viewing panel.

Practical issues

All workplaces should be designed to allow people to move in, out and within buildings in a safe manner. To achieve this the following should be in place:

- 1) External walkways and pedestrian routes should be clearly recognizable from surrounding areas and should be free from damage and defects. 2) Where a slip hazard exists at the entrance to buildings (e.g. where rain water can be brought onto a shiny building floor,) adequate matting or similar should be provided.
- 3) Pedestrian routes (corridors, stairs, office spaces, etc.) inside buildings should be kept clear and in good order. 4) Adequate access steps and/or platforms should be provided where people have to move between different levels.
- 5) Changes in level, e.g. steps and ramps, or raised edges should be highlighted. Handrails should be provided alongside steps and ramps.
- 6) Doors should not be blocked by equipment, furniture or other items. 7) Sufficient space should be provided in offices areas for people to move comfortably to and from their desks and to access items.

Environmental considerations (lighting) - Environmental issues can increase the risk of, or prevent slips and trips, so it is important to take them into consideration. But firstly, what does the term 'Environment' mean as regards slips and trips? Lighting (natural or otherwise), loud or unfamiliar noises, the weather, humidity, condensation etc.

The following gives an indication of how they can affect slips and trips

- Too much light on a shiny floor can cause glare and stop people from seeing hazards on the floor and stairs.
- Too little light will also prevent people from seeing hazards on the floor and stairs.
- Unfamiliar and loud noises may be distracting.
- If rainwater gets onto a smooth surface inside or outside of a building, it may create a slip hazard. Good entrance design (e.g. canopies) can help.
- Cold weather can cause frost and ice to form, which may create slippery surfaces.
- Condensation may make a smooth floor slippery.

1.5 Working at height

1.5.1 Examples of work activities involving a risk of injury from falling from height, and the significance of such injuries

Sometimes work often exposes people to risks from working at height:

- Steel workers erecting the steel framework of a building.
- Scaffolders erecting or striking (taking down) a scaffold.
- Roofers cladding the roof of a steel-framed building.
- Demolition workers dismantling machinery on the roof of a building.
- Welders working at the side of a deep excavation.
- Pipe fitters fixing pipework to the ceiling in a factory workshop.
- Painters painting a lamp-post or a steel-span footbridge.

Many of these tasks will involve the use of some form of access equipment (e.g. scaffolding or ladders) and those using this equipment are usually familiar with and used to such work, which can lead to complacency. Other workers may not be so used to these tasks at height, and lack competence.

The main risks associated with work at height are:

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

Falls from height:

- Account for the largest percentage of annual fatalities in the workplace.
- Can result in:
 - Fatalities.
 - Neck or spinal injury leading to permanent disability or paralysis.
 - Multiple fractures.

Falling objects can also cause severe injuries that may result in death, brain damage, paralysis or multiple fractures. The distance (vertical height) of a fall is not always the

deciding factor in the cause of injuries, but is a factor that has to be taken into account, as we will see later

1.5.2 Basic hazards and factors affecting risk from working at height

Vertical distance

There is no specific height limit for using a ladder in law, either on your own or accompanied by someone else. The Work at Height Regulations 2005 (WAHR) cover ladder use.

The Regulations require work at height to be properly planned and controlled so that it is carried out safely. The risk assessment should identify the hazards and the risks, and a safe system of work needs to be drawn up to eliminate the risk of a fall, or minimise the chance and severity of injury, if a fall occurs.

Schedule 6 of the Regulations, paragraph 9 says that where the run of a ladder rises a vertical distance of 9 or more metres, then, so far as is reasonably practicable, sufficient safe landing areas or rest platforms should be installed at suitable intervals.

The Workplace Health Safety and Welfare Regulations in Regulation 13 state that fixed ladders which are more than 2.5 metres high should, where possible, be fitted with suitable safety hoops or fall arrest systems.

However, most scaffolding or tower scaffolds erected will be accessed by ladders from within the structure, so a run of 6m as you mention should not occur.

Fragile roofs

Roof work, particularly work on pitched roofs, is hazardous and requires a specific risk assessment and method statement prior to the commencement of work.

Precautions

- Assume that roofs are fragile unless you can confirm otherwise - there may be non-visible damage caused by weathering, deterioration, etc.
- Always avoid working on a roof if it is possible to carry out the work in another way, eg approaching the roof from below.
- Never go onto any part of a fragile roof without using platforms to support your weight.
- Fit appropriate warning signs to buildings which have fragile roofs, particularly at roof access points.
- Never walk along the line of the purling bolts - it is like walking a tightrope.

- Ensure that platforms are wide enough and long enough to give adequate support across roof members and ensure that enough platforms are provided on the roof.
- Protect against falling through the fragile roof adjacent to the platform by providing:
 - a properly installed safety net, scaffolding or similar close to the underside of the roof; or
 - suitable guard rails and toe boards at the edges of the platform; or
 - further suitable coverings over all fragile materials within 2m of the working platform.

Deterioration of materials

The HSE advises that periodic inspections of platforms for deterioration should be risk-based. A competent person should consider the current condition of the platform and its associated work components, take into account the deterioration-risk factors for the platform in question, and develop an inspection regime that is fit for purpose in dealing with the likely risk of failure leading to a dangerous situation.

In a general health and safety context, the hazard is the working at height and the risk is the likelihood that a worker could fall and its consequence (death or injury). However in the context of this document, we are being more specific and treat as hazards those parts of the platform that could fail and the risk as the likelihood that they will fail and its consequence.

We need to consider if the platform was designed in the first place to cope with the rigors of stack-emission monitoring. As mentioned above, in many cases this will require a baseline assessment by a competent structural engineer to establish its current integrity and condition. If it doesn't meet an acceptable benchmark for integrity and condition, (plus any specific requirements given in Environment Agency Technical Guidance Note M1 and supplementary stack-emission monitoring standards such as BS EN 13284 and BS EN 1911) then it falls at the first hurdle and the platform needs to be redesigned.

Assuming for the moment that the platform was fit for purpose when new and still is, we now have to consider the extent to which its structural integrity is likely to be affected in the future by risk factors. These may include:

- Stress and metal fatigue due to physical forces

- Vibration - as well as causing metal to fatigue, vibration may cause bolts to loosen. This may be from plant/process vibrations and also from the effect of wind on the platform
- Resistance to environmental effects, such as climate, chemical agents, corrosive gases. There may be “normal” corrosion or there may be accelerated corrosion in especially aggressive atmospheres, whether that is due to the climate (e.g. coastal-marine environment) or sector specific pollutant emissions (e.g. SO₂)
- Likelihood of accumulation of water and condensed vapours; for example. it is known that some designs of handrail are prone to internal condensation of corrosive atmospheres leading to corrosion at their base

Unprotected edges

The Work at Height Regulations 2005 adopt a risk based approach so that measures taken to comply with the regulations are proportionate to the risks involved.

Where work is carried out at height, every employer shall take suitable and sufficient measures to prevent, so far as is reasonably practicable, any person falling a distance liable to cause personal injury.

There is also a duty to prevent injury to any person, by taking suitable and sufficient steps to prevent, so far as is reasonably practicable, the fall of any material or object.

Schedule 1 of the regulations covers existing places of work and means of access or egress. Where work is carried out at an open edge collective protection measures as mentioned in Schedule 2 must be considered before personal protection measures.

Where work is not done at the edge, demarcation barriers can be provided at a safe distance from the edge, (usually at least 2 metres) e.g. work on an air conditioning unit in the middle of a roof.

Barriers should be visible and obvious e.g. cones with tape. However, taking this action is at the bottom of the hierarchy set out in the WAHR and you will have to show that you have considered other measures to prevent a person or object falling from the edge, but that these are not justified because of the low risk.

Please note, if the roof area is accessed on a regular basis you will also need to bear in mind the requirements of the Building Regulations for edge protection.

Additionally, there are others things to consider before justifying demarcation barriers :

is access controlled i.e. only fully briefed and competent workers are allowed to access the area?;

there is no slope that workers could slide down;

appropriate levels of supervision are provided to ensure no one goes beyond the barriers;

barriers can be placed and retrieved without approaching the edge.

Weather and falling materials

Workers and passers-by can be injured by the premature and uncontrolled collapse of structures, and by flying debris.

A safe system of work is one that keeps people as far as possible from the risks. This may include:

- establishing exclusion zones and hard-hat areas, clearly marked and with barriers or hoardings if necessary
- covered walkways
- using high-reach machines
- reinforcing machine cabs so that drivers are not injured
- training and supervising site workers

Weather

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

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

Falling Materials

Objects falling from a height are capable of causing considerable damage to both people and other materials that they hit. The objects themselves may be:

- Loose structural material, e.g. tiles, bricks and timbers.
- Waste materials, e.g. stone chippings or off-cuts of wood.
- Equipment or tools which are dropped.

Circumstances which contribute to the likelihood of falling materials include:

- Deterioration of structures causing crumbling brickwork or loose tiles.
- Bad storage of materials, e.g. at the edges of scaffold platforms, or in unstable stacks.
- Poor housekeeping leading to accumulations of waste and loose materials.
- Gaps in platform surfaces or between access platforms and walls.
- Open, unprotected edges.
- Incorrect methods of getting materials, equipment or tools from ground level to the working area.
- Incorrect methods of getting materials down to ground level, e.g. throwing.

1.5.3 Methods of avoiding working at height

All work at height should be assessed. The best way to manage the risks inherent with working at height is to eliminate the need to work at height altogether. This can be achieved by:

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

In most instances in the construction industry, avoidance will not be possible and control measures for working at height will be required.

The Construction Design and Management Regulations have been implemented in the UK to ensure that designers avoid foreseeable risks when designing structures and buildings. This applies to all hazards, but is particularly relevant to avoiding work at height where possible by building in or out features which allow work at height to be avoided or carried out more safely.

The employer should apply a three-stage hierarchy to all work which is to be carried out at height. The three steps are the avoidance of work at height, the prevention of workers from falling and the mitigation of the effect on workers of falls should they occur. It follows from this hierarchy that:

- work is not carried out at height when it is reasonably practicable to carry the work out safely other than at height (e.g. the assembly of components should be done at ground level);

- when work is carried out at height, the employer shall take suitable and sufficient measures to prevent, so far as is reasonably practicable, any person falling a distance liable to cause injury (e.g. the use of guard rails);
- the employer shall take suitable and sufficient measures to minimize the distance and consequences of a fall (collective measures, for example, airbags or safety nets, must take precedence over individual measures, for example, safety harnesses).

A risk assessment will be needed to determine the controls required for any particular work at height. The risk assessment and action required to control risks from using a kick stool to collect books from a shelf should be simple (not overloading, not overstretching, etc). However, the action required for a complex construction project would involve significantly greater consideration and assessment of risk.

1.5.4 Main precautions necessary to prevent falls and falling materials

A simple hierarchy can be followed to prevent falls:

- Avoid work at height.
- Carry out work from an existing place of work.
- Provide a safe working platform with guardrails, fences, toeboards, etc. that are strong enough to prevent a fall.
- Where this is not possible, provide properly installed personnel equipment such as rope access or boatswain's chairs (see later).
- If this is not possible and a worker can approach an unprotected edge, provide equipment which will restrain or arrest falls, e.g. safety harnesses or safety nets.

A similar hierarchy can help to prevent falling objects:

- Not stacking materials near edges, and particularly unprotected edges.
- Close boarding of working platforms to minimise the gaps between scaffold boards, or placing sheeting over the boards so that material cannot fall through.
- Avoiding carrying materials up or down ladders, etc. by using hoists and chutes to move materials.
- Prevent materials from falling by using physical safeguards such as toeboards and brickguards.

- Where a risk remains, use physical safeguards to prevent falling objects hitting people below, e.g. debris netting, fans (wooden shielding angled to catch debris) and covered walkways (tunnels)
- You must make sure that all work at height is properly planned, supervised and carried out by people who are competent (someone who has the skills, knowledge and experience) to do the job. This must include the use of the right type of access equipment.
- To prevent or minimise risk when planning for work at height, consider what needs to be done and take a sensible, risk-based approach to identify suitable precautions.

Good Design

Good design is important in working at height, not only of the existing structures or materials to be worked on, but design and strength/stability of the access equipment used, and the design of the task itself.

Important design factors include the safety features of the access equipment (handrails, toeboards, fall arrest or restraint connections, etc.) and how access equipment is erected and positioned, so as to be stable on secure, firm level ground, away from vehicles and pedestrians. Task design also includes the methods used to lift and lower equipment and materials to and from work at height locations, and the security of the access equipment in difficult weather conditions.

Planning and Supervision of Work

Work at height should be planned in advance, with careful consideration given to the selection and use of work equipment. A safe system of work should be set up which takes account of:

- Levels of supervision of workers required, e.g. fall arrest equipment will require a higher level of supervision than work on a mobile scaffold tower.
- Weather conditions, e.g. carrying out maintenance on an icy roof or working in rainy conditions on a slippery surface.
- Emergency or rescue arrangements that may be required, e.g. if workers fall while using a fall arrest system. It is not acceptable just to rely on the emergency services; this needs to be covered in the risk assessment and planned beforehand

Avoidance of Work in Adverse Weather

If adverse weather such as icy, rainy or windy conditions greatly increases the risk of working at height (e.g. carrying a wide roof sheet in high wind), the work should be postponed until conditions are satisfactory. Getting a daily weather forecast is a suitable precaution. This stipulation does not apply for emergency services acting in the event of an emergency.

1.5.5 Emergency rescue

The need to plan for rescue and emergency does not necessarily mean that you need a rescue team on site. As you point out the risk assessment process should inform your decision about the level of rescue cover you might need.

In your scenario you would consider how remote the site is, what equipment is being used and how easy or difficult it would be to get a worker to ground level in the event of an emergency or if they fall and are suspended from the structure.

You should not rely on the emergency services. Other things to consider will include the level of competence required for workers involved in the rescue and any specialist equipment they may need.

The emergency planning element is often not considered when work at height is being planned.

Employers may wish to consider the following points:

- there is a lack of awareness of suspension trauma and its consequences
- employers often fail to appreciate where and when rescue provision is required
- employers often fail to provide adequate rescue equipment or appreciate what is suitable equipment for use in rescue
- because rescue operations are carried out under extreme pressure, consideration should be given to all aspects of the rescue process. Elements to consider would include the type of equipment required, the demands placed upon the rescuer, the training the rescuer will require to carry out the rescue and how the effectiveness of the rescue system as a whole can be maintained.

This guidance note offers general information about the issues which should be considered for emergency procedures for all work at height.

It does not give information or detailed guidance on specific procedures or indicate whether individual methods might be preferable. Each site and each situation will be different.

Background

There are three main reasons why employers need to make provision for rescue arrangements when working at height:

1. the Work at Height Regulations require this
2. the casualty needs to be attended to and recovered quickly
3. it is your (employer's) responsibility and not some other individual or organisation

The law

The Work at Height Regulations require employers to make specific provisions for emergency planning:

Organisation and planning – Regulation 4

(1) Every employer shall ensure that work at height is ... properly planned

(2) Planning of work includes planning for emergencies and rescue.

In addition, the following regulation requires that all activities, including rescue, must be carried out by competent persons:

Competence - Regulation 5

Every employer shall ensure that no person engages in any activity, including ... planning, and

supervision, in relation to work at height...unless [they are] competent to do

The need for a rapid response

Help must be available promptly. The survival of an injured person often depends on the speed of recovery and the level of care subsequently provided. Being suspended for any length of time after a fall can be potentially fatal owing to the effects of suspension trauma (see below).

In cases where evacuation is required, it may be essential that the operation is completed rapidly for reasons of objective danger e.g. fire.

General considerations for rescue

It is essential that there is a specific rescue plan and adequate resources in place for each worksite where work at height is carried out. These should be regularly assessed, and

updated where necessary. Resources should include not only equipment but also personnel who have been trained in the use of that equipment.

When planning for rescue, consideration should be given to the type of situation from which the casualty may need to be recovered and the type of fall protection equipment which the casualty would be using.

A distinction may be made between the terms "rescue" and "evacuation". Rescue typically involves the recovery of a casualty by another person either remotely or directly. Evacuation is typically carried out by a stranded user to escape from a remote situation such as a tower crane or narrow aisle truck.

Listed below are examples of different situations or fall protection systems from which a casualty may need to be recovered and for which suitable provision should be made. Some situations may create special difficulties, for example attaching to a remote casualty who is suspended out of reach

- steel wire fall arrest block
- textile fall arrest block
- vertical anchor line - textile
- vertical anchor line - wire
- vertical rail
- horizontal wire anchor line
- horizontal textile anchor line
- energy absorbing lanyard
- hooped ladder

All rescue planning and operations should address the following issues:

- the safety of the persons carrying out or assisting with the rescue
- the anchor points to be used for the rescue equipment.
- the suitability of equipment (anchors, harnesses, attachments and connectors) that has already arrested the fall of the casualty for use during the rescue.
- the method that will be used to attach the casualty to the rescue system.
- the direction that the casualty needs to be moved to get them to the point of safety. (raising, lowering or lateral)
- the first aid needs the casualty may have with respect to injury or suspension trauma
- the possible needs of the casualty following the rescue

The loads placed on some items of equipment during a rescue may be higher than they have been

originally designed for. If equipment is used for rescue either individually or in systems, the supplier

should verify that it has suitable performance and loading characteristics in that specific configuration.

This applies to all parts of the system including the anchors.

1.5.6 Provision of equipment, training, instruction and other measures to minimise distance and consequences of a fall

As we saw earlier, where work at height cannot be avoided we must minimise the distance a person can fall, and if not, the consequences of a fall. As we will see a bit later in this element, equipment such as fall restraint or fall arrest can be used, or soft-landing systems such as safety nets or air bags.

In all such cases operatives must receive adequate training and instruction to appreciate the dangers of working at height, the service and use of the equipment, and the correct (and incorrect) methods of use.

Control measures

There is a simple hierarchy of control measures (as described below) which you should follow to minimise the risk of a fall from height. The hierarchy should be followed systematically and only when one level is not reasonably practicable may the next level be considered.

Those in control of the work need to:

- avoid work at height where they can
- use work equipment to prevent falls where work at height cannot be avoided
- where the risk of a fall cannot be eliminated, use work equipment to minimise the distance and consequences of a fall if one occurs
- always consider measures that protect all those at risk, ie collective protection measures (scaffolds, nets, soft landing systems) before measures that only protect the individual, ie personal protection measures (a harness)

Dos and don'ts of working at height

Do....

- make sure the surface/access equipment in use is stable and strong enough to support the worker's weight and that of any equipment. Any edge protection should be wide enough and strong enough to prevent a fall
- as much work as possible from the ground or partly from the ground, for example assemble structures on the ground and lift them into position with lifting equipment
- take precautions when working on or near fragile surfaces, eg an asbestos cement roof, to prevent a fall or to minimise the distance and consequences in the event of a fall
- ensure workers can get safely to and from where they want to work at height and also consider emergency evacuation and rescue procedures
- make sure everyone involved is competent to do the work they are responsible for, including those who plan and organise it
- choose the most appropriate equipment for the type of work being done and how often it will be used
- provide protection from falling objects
- make sure equipment used for work at height is well maintained and inspected regularly

Don't...

- overload ladders – the person and anything they are taking up should not exceed the highest load stated on the ladder
- overreach on ladders or stepladders – keep your belt buckle (navel) inside the stiles and both feet on the same rung throughout the task
- use ladders or stepladders if the nature of the work is deemed to be 'heavy' or if the task will take longer than thirty minutes or so to complete
- use ladders if workers cannot maintain three points of contact (hands and feet) at the working position. If this is not possible, consider an alternative safe system of work
- let anyone who is not competent (someone who doesn't have the skills, knowledge and experience to do the job) carry out work at height

Training

Workers need the appropriate knowledge, skills and experience to work safely, or be under the supervision of someone else who has it. They need to be able to recognise the risks, understand the appropriate systems of work and be competent in the skills to carry them out such as: installing and wearing harness systems; installing edge protection; and

operating a mobile access platform. Training will usually be required to achieve these competencies. It is not sufficient to hope that workers will 'pick up safety on the job'.

Weather conditions

Do not work on roofs in icy, rainy or windy conditions. Anyone carrying a roof sheet can easily be blown off the roof if they are caught by a gust of wind.

Avoid excessive exposure to sunlight by wearing appropriate clothing and using suncreams. Too much exposure to sunlight can cause skin cancer.

Short-duration work

Short-duration work means that lasting minutes rather than hours. It may not be reasonably practicable to provide full edge protection for short-duration work but it still needs to be considered during assessment and should not be automatically discounted.

Mobile access equipment can provide both edge protection and a working platform. It can do away with the need for scaffolding and can be particularly appropriate for short-duration minor work.

Where it is not reasonably practicable to provide full edge protection, a securely attached safety harness will normally be required

Planning and supervision of work

Good planning can significantly reduce the risks involved in industrial roofing. Key elements are as follows.

1. Reduce the need for workers to travel about the roof by:

- arranging for the right sheets to be delivered as they are needed to the right place at the right time;
- arranging access points that are convenient for the working position; and
- making full use of loading bays.

2. Minimise the potential for falls by providing a safe place of work (eg properly guarded working platforms or powered access equipment) rather than relying on fall arrest equipment to restrict a fall.

1.5.7 Head protection

On almost all construction sites there are situations where head injuries could happen. The work should be organised to minimise this risk, for example: preventing objects falling by using scaffolds with toe boards and, if necessary, brickguards.

But if even after doing this, risks of head injury will normally still remain and you should:

- **Ensure all workers are provided with, and wear, suitable head protection.**
This is necessary to comply with the personal Protective Equipment Regulations 1992 which, from 6 April applies to the provision and wearing of head protection on construction sites following the revocation of the Construction (Head Protection) Regulations 1989.

Head protection should:

- Be in good condition. If it's damaged, throw it away;
- Fit the person wearing it and be worn properly;
- Not stop you wearing hearing protectors as well (when needed);
- Only be obtained from a reputable supplier – there are fake hard hats on the market

Make sure sure head protection is worn:

- By making it a site rule;
- Always wearing your hard hat to set an example;
- Checking others are wearing theirs.

If there is no risk of injury to the head, then hard hats are not required by law. However, on almost all construction sites, despite controls being put in place, there will almost always be situations where a risk of head injury remains. Where there are such risks, for example, from falling objects or hitting the head against something, suitable head protection should be provided and worn (except for turban-wearing Sikhs). Where turban-wearing Sikhs are working in areas where a significant residual risk of head injury remains, employers should pay particular attention to the control measures that they have in place.

1.5.8 Safe working practices for common forms of access equipment

Safe working at height requires that guard rails on scaffolds are at a minimum of 950 mm and the maximum unprotected gap between the toe and guard rail of a scaffold is 470 mm. This implies the use of an intermediate guard rail although other means, such as additional toe boards or screening, may be used. They also specify requirements for personal suspension equipment and means of arresting falls (such as safety nets).

When working at height, a hierarchy of measures should then be followed, to prevent falls from occurring. These measures are:

- avoid working at height, if possible;
- provide a properly constructed working platform, complete with toe boards and guard rails;
- if this is not practicable or where the work is of short duration, suspension equipment should be used;
- collective fall arrest equipment (airbags or safety nets) may be used;
- where this is not practicable individual fall restrainers (safety harnesses) should be used; only when none of the above measures is practicable, should ladders or stepladders be considered.

Much of the work which is done at height could often be done, or partly done, at ground level - thus avoiding the hazards of working at height. The partial erection of scaffolding or edge protection at ground level and the use of cranes to lift it into place at height are examples of this. The manufacture of complete window frames in a workshop and then the final installation of the frame into the building is another. By the use of suitable extension equipment high windows can be cleaned from the ground and high walls can be painted from the ground. However, in most construction work at height, the work cannot be done at ground level and suitable control measures to address the hazards of working at height will be required.

Ladders and stepladders

- Select a ladder that is the proper length for the job!
- Ladders may only be used on stable and level surfaces, unless secured to prevent accidental displacement or movement.

- Ladders may not be used on slippery surfaces, such as wet concrete floors or muddy ground, unless they are secured or slip-resistant feet provide adequate protection.
- Ladders should not be placed in any location where they can be displaced or bumped by workplace activities or traffic, such as passageways, doorways, or driveways. Secure the ladder to prevent such accidents or barricade the area to keep activities and traffic away from the ladder.
- The access area around the top and bottom of the ladder must be kept clear of scrap materials and debris.
- When ladders are used to access an upper landing surface, such as a roof or mezzanine, the ladder rails must extend at least three feet above the upper landing to provide adequate handholds.
- Ladders must be free from oil, grease, mud, and other slippery materials.
- Ladders may not be loaded beyond the maximum intended load for which they were built, nor beyond the manufacturer's rated capacity. Estimate 250 pounds per person, plus any tools, equipment, and materials which will be in use while on the ladder.
- Ladders may only be used for the purpose, and in the manner, for which they were designed. For example, most ladders are not designed to be used in a horizontal position (i.e. used as a walkboard or platform).
- When climbing up or down the ladder, always face the ladder and maintain at least three points of contact, such as two hand and one foot, or two feet and one hand. Hands should be free for climbing, and not holding tools and materials. Use a rope and bucket to pull items up or have someone hand them up.
- Do not stand on the top two rungs of a stepladder. The stability is decreased when weight is concentrated at the top of the ladder. If a taller or longer ladder is needed to perform the job safely, make arrangements to have it available before work begins.
- Metal ladders must never be used near electrical equipment. Fiberglass ladders are designed to provide adequate protection from electrical hazards.
- Ladders may not be altered or spliced in any manner.
- Ladders may not be moved, shifted, or extended while a person is on the ladder. Climb down, make the adjustment, and climb back up.
- Extension ladders must be placed at the proper angle. Use a 4:1 ratio for setting ladders (approximately 75 degrees) - for every four feet in height, the base of the ladder should be moved one foot out from the wall or structure. For example, a 20-foot ladder should be placed about five feet from the base of the wall you will be accessing.

Scaffoldings

General principles

- Always remember that you have a duty to work in a safe manner and to ensure the safety of other workers and the public.
- Always work in a logical sequence.
- Do not throw materials about. Always consider the safety of others.
- Always lower materials in a proper manner during dismantling.
- Ensure all materials are cleared from the site or job location on completion.
- Complete a daily hazard identification and controls report when on the job.

Before and during erection

- Examine all materials on arrival at the site or during unloading and put aside any defective or damaged items. These items should be removed from the site as soon as possible and should not be used in the construction of the scaffold.
- Make sure that all materials to be used are properly stacked in a safe place, especially where work over or near a public thoroughfare is being carried out.
- Take any and all necessary precautions to ensure that the public are not endangered. This may entail the erection of diversion barriers and signs.
- Special care should be taken when working in the close vicinity of overhead or adjacent power cables. All exposed cables and wires should be treated as live.
- Ensure that you are in possession of all necessary permits and instructions or information relating to the job prior to commencing erection.
- If possible contact someone in authority on site to inform them that you are commencing erection.
- Always examine the building or structure against which you are scaffolding and if you have any doubts about any aspect of the job, for example, lack of tie positions, unsafe walls or cornices, etc then seek advice.
- Take care not to obstruct essential services such as hydrants, service manholes or fire exits.
- Whenever leaving the site or job location, make sure that materials are not left in unsafe locations such as doorways, pavements, kerb sides etc. Always store materials in a safe and secure location.
- At the earliest opportunity warning signs or notices such as "INCOMPLETE SCAFFOLD" or "UNSAFE SCAFFOLD" should be prominently displayed. Once the scaffold is safe and ready for use "SAFE SCAFFOLD" signs should be displayed at access and egress points.

During the use of the scaffold

- During the use of scaffolding it is important to check that:
- The standards are correctly aligned and properly supported at their bases.
- There is no undue deflection in ledgers and transoms or putlogs.
- No essential member of the structure has been removed.
- All ties and braces are in place and are effective in stabilising the structure.
- All couplers are tightened properly.
- All scaffold planks are sound and are properly supported.
- All guardrails and toeboards are secured in place.
- All ladders are in good condition, properly supported and secured.

Before and during dismantling

- Before dismantling examine and check the scaffold to ensure that all ties and bracing are effectively in position and that the scaffold is in a stable condition. If partial dismantling is being undertaken ensure that the remaining portion is fully safe and stable.
- Suitable warning notices must be placed for public protection.
- Dismantling should be carried out progressively from the top level downwards. Ties, braces, ledgers, transoms, planks and guardrails must be removed lift by lift with standards following as joint positions are reached.
- Where a building or structure is being demolished the scaffold should be dismantled to ensure that no more than 4.0m remains standing above the last vertical tie points at any time.
- Care should be taken to avoid mishandling of materials, all of which should be lowered regularly and not "bombed" during the dismantle.
- Small amounts of material may be temporarily placed on lower lifts for convenience during dismantling but care should be taken not to allow this material to build up to an unacceptable load. Where such temporary placement at low levels is carried out, it may be necessary to place raking tubes from the ground level to the lower lift in order to stabilise the scaffold.
- During dismantling ensure that all scaffolding materials are removed from the building and that no loose materials are left on roofs or projecting cornices, etc.

Scaffolding near power lines or electrical conductors

Power lines and conductors are a potential hazard to persons erecting, working from or in the vicinity of a scaffold. No scaffold should be erected closer to any conductors of an overhead electric line at a distance, in any direction, less than that shown in table 5 (from NZECP 34.4.4).

No scaffold should be erected closer than 4.0m to power lines or electrical conductors without approval from the local electricity network company.

Mobile elevating work platforms (MEWP)

It is important to select the right MEWP for the job and site.

Have a plan for rescuing someone from a MEWP and practise it – someone on the ground should know what to do in an emergency and how to operate the machine's ground controls.

There are a number of precautions that can reduce the risk from MEWP hazards. These are:

- **Confined overhead working:** Brief operators on the dangers, and the safe system of work to be followed. If there are overhead structures against which an operator could be trapped and then pushed onto the MEWP controls, consider selecting a MEWP that has been designed to prevent such accidental contact.
MEWPs with shrouded or otherwise protected controls are available. Keeping the platform tidy will reduce the risk of the operator tripping or losing balance while in the basket.
- **Ground conditions:** The platform should be used on firm and level ground. Any temporary covers should be strong enough to withstand the applied pressure. Localised ground features, eg trenches, manholes and uncompacted backfill, can all lead to overturning.
- **Outriggers:** Outriggers must be extended and chocked before raising the platform. Spreader plates may be necessary – check the equipment manual.
- **Guardrails:** Make sure the work platform is fitted with effective guard rails and toe boards.
- **Arresting falls:** if there is still a risk of people falling from the platform a harness with a short work restraint lanyard must be secured to a suitable manufacturer provided anchorage point within the basket to stop the wearer from getting into a position where they could fall from the carrier.
- **Falling objects:** barrier off the area around the platform so that falling tools or objects do not strike people below.
- **Weather:** high winds can tilt platforms and make them unstable. Set a maximum safe wind speed for operation. Storms and snowfalls can also damage platforms. Inspect the platform before use after severe weather.
- **Handling materials:** if used to install materials check the weight and dimensions of materials and consider any manual handling and load

distribution issues. You may need additional lifting equipment to transport materials to the work position.

- **Nearby hazards:** do not operate a MEWP close to overhead cables or other dangerous machinery, or allow any part of the arm to protrude into a traffic route.

Trestles

In considering whether a platform is suitable for work at height, employers need to ensure that it is:

- of sufficient dimensions to allow safe passage and safe use of equipment and materials;
- free from trip hazards or gaps through which persons or materials could fall;
- fitted with toeboards and handrails;
- kept clean and tidy, e.g. do not allow mortar and debris to build up on platforms;
- not loaded so as to give rise to a risk of collapse or to any deformation that could affect its safe use. This is particularly relevant in relation to blockwork loaded on trestles;
- erected on firm level ground to ensure equipment remains stable during use.

1.5.9 Inspection of access equipment

Equipment for work at height needs regular inspection to ensure that it is fit for use. A marking system is probably required to show when the next inspection is due. Formal inspections should not be a substitute for any pre-use checks or routine maintenance. Inspection does not necessarily cover the checks that are made during maintenance although there may be some common features. Inspections need to be recorded but checks do not.

A weekly inspection of any scaffolding used in construction work should be undertaken by a competent person. A regular scaffold inspection is a requirement of the ILO Convention (Safety and Health).

The following information should be included in the report:

- the name and address of the person for whom the inspection was carried out;
- the location of the work equipment inspected;
a description of the work equipment inspected;
the date and time of the inspection;

- details of any matter identified that could give rise to a risk to the health or safety of any person;
- details of any action taken as a result of any matter identified above;
- details of any further action considered necessary;
- the name and position of the person making the report.

The International Labour Organisation Code of Practice C167 1998 requires work equipment (including access equipment for working at height) to be maintained and inspected to ensure its continuing safety. This would generally require:

- Visual or more rigorous inspection by a competent person for safety purposes.
- Testing where appropriate.

Work equipment includes guardrails, toeboards, barriers and similar collective means of protection. This encompasses all working platforms (including scaffolding), nets and airbags, personal fall protection systems, work positioning systems, fall arrest systems and work restraint systems. Ladders are also considered to be work equipment.

Each work at height location should be checked each time it is used, including the surface parapets and permanent rails. An inspection should be made after the equipment has been assembled and as often as is necessary to ensure safety. Pay special attention to potential deterioration of materials.

Any platform used in construction higher than two metres must be inspected in its place of use before being used. The inspection is only valid for seven days. For mobile platforms, inspection at the site is sufficient without inspection again every time it is relocated on that site.

1.6 Hazards and control measures for temporary works

Temporary works (TW) are the parts of a construction project that are needed to enable the permanent works to be built. Usually the TW are removed after use - e.g. access scaffolds, props, shoring, excavation support, false work and formwork, etc. Sometimes the TW is incorporated into the permanent works - e.g. haul road foundations and crane or piling platforms may be used for hard standing or road foundations.

It is very important that the same degree of care and attention is given to the design and construction of temporary works (TW) as to the design and construction of the permanent works. As TW may be in place for only a short while there is a tendency to assume they are less important. This is incorrect. Lack of care with design, selection, assembly, etc leaves

TW liable to fail or collapse. This places people at risk of injury and can cause the project to be delayed.

The person organising the temporary works needs to be aware of the problems that can occur at each stage of the process and how to prevent these. They need to coordinate design, selection of equipment, appointment of contractors, supervision of work, checking completion, authorisation to load and removal. Unless this is done in a thorough and systematic way problems are likely to occur. If you take this on yourself you must ensure each part of the process is correctly carried out.

British Standard 5975 sets out one way of managing temporary works (TW) that has been found to work well on medium and large projects and uses the job title Temporary Works Coordinator (TWC). There is no legal requirement to use this job title or the BS recommended process, but you should remember that BS5975 provides an industry consensus view on what is considered to be good practice. The legal requirement is that the party in control must ensure that work is allocated and carried out in a manner that does not create unacceptable risk of harm to workers or members of the public. On projects with relatively simple TW needs, you may choose not to appoint a TWC. However, you must still make sure that TW are properly managed to ensure safety.

Where the situation is small scale and straightforward there may be a “standard solution” provided for the temporary works (TW). These include, for example, use of a tower or system scaffold for access; design of a basic access scaffold to a standard configuration using existing data from tables; selection of a trench box to support a 2m excavation in firm, dry ground. In each of these cases the person organising the TW will need to assess the ground to be sure it is suitable for the equipment involved, and check that any assumptions made in the calculations for the standard solution are valid for this particular situation and the conditions on site. On a simple job the supplier’s data will allow an experienced person to consider the necessary issues without further calculation.

Propping using standard equipment such as screw props (‘Acrows’) needs careful consideration. To select the type, size, number and decide spacing, information is needed about the loads that will act on the props. This will include the wall above and the additional load from any other floor or roof beams etc that enter the wall above or close to the opening. Even with proprietary equipment, the support system must be worked out by a person who knows the correct methods of assessing the loads and designing the support arrangement. Failure of TW is often found to result from the loadings being underestimated; and in particular where loadings from the sides are not considered.

Coordinating the temporary works (TW) is not automatically the responsibility of the engineer carrying out the design work. Coordination is a much wider role that includes planning where and when TW will be needed and ensuring that they are correctly installed,

used, checked and maintained. Some design engineers may be happy to be additionally contracted to act as project Temporary Works Coordinator.

1.6.1 The impact on workplaces from hazards associated with works of a temporary nature

Works of a temporary nature includes such projects as building maintenance, renovation, demotion and excavations. These works usually take place in host organisation by contractors. The projects must be properly planned, supervised and monitored. There are many possible hazards associated with the work of a temporary nature. Some of them are:

- Slips, trips and falls
- Unfenced excavations
- Inadequate protection of holes, uneven surface, trailing leads and cables, spillage of oils and gravel
- Poor lighting and ventilation in and around the temporary works
- Noise and vibration
- Hazardous substances including dust and asbestos fibres
- Falling or flying objects
- Falling or moving objects
- Fire and/or explosions

1.6.2 Main control measures relating to the management of works of a temporary nature

The important controls of work of a temporary nature are communications and the cooperation of both contractors and host employees. A comprehensive risk assessment for the project and the management and supervision of the project to ensure that all the agreed controls are implemented.

Communication and co-operation

The organisation of liaison and consultation agreement is essential to ensure good communication with both the host employee and the contractor. This should provide the cooperation and coordination of all those responsible for the project to ensure the health and safety of everyone in the workplace and enable any concerns to be addressed. Good communication between clients, contractors and residents is an important means of controlling the risk and minimising discomfort.

Risk assessment

A detailed risk assessment should be made to cover the temporary work. This should include the identification of:

- All aspects of the work
- The people at risk from the work
- Any risk to the contractors from the business of the host organisation

Often work must be undertaken in areas which need to remain occupied. The risk assessment should indicate the nature of the perimeter of the project and how it will be maintained.

Appointment of competent people

The contractor should ensure that employees are trained, competent and authorised to drive or operate any plant or equipment that they may use, whether regularly or on an occasional basis. Training records should be maintained and may be requested by Insert Your Company Name. Such equipment shall include, but not restricted to:

- Dumpers
- Forklift Trucks
- Lorries
- Hoists
- Cranes
- Excavators
- Mobile elevating work platforms
- Hand tools

Documentary evidence of such authorisation shall be provided as required.

Only training which is specific to the actual plant or equipment to be used will be considered acceptable.

All equipment provided shall be in good order and suitable for the use for which it is intended for. The contractor shall ensure that site plant and equipment is inspected and thoroughly examined at regular intervals by person(s) who are appropriately skilled and authorised to do so and that records of such inspections/examinations are maintained in a register which may be available for examination by Insert Your Company Name upon request. When selecting equipment the contractor shall take into account the working conditions and potential site hazards.

All construction plant shall be maintained in such a manner that smoke is not emitted.

Segregation of work areas

The contractor should ensure to segregate or control access to the work area by physical barriers or warning signs. If tape is used ensure it does not become a tripping hazard itself. It might be possible for the work to take place outside normal hours, if not then the work areas must be segregated.

Amendment of emergency procedures

The emergency procedures should be amended with any amendment required to existing emergency procedures and access to the host building.

Welfare provision

The provision of welfare facilities including first-aid arrangements must be discussed and agreed prior to the commencement of the project. It may be that project contractors can have use of same facilities as the host employees, if this is not possible then separate arrangements should be included in the project specification.

Element 2 - Transport hazards and risk control

Learning outcomes

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

People are most often involved in accidents as they walk around the workplace or when they come into contact with vehicles in or around the workplace. It is therefore important to understand the various common accident causes and the control strategies that can be employed to reduce them. Slips, trips and falls account for the majority of accidents to pedestrians and the more serious accidents between pedestrians and vehicles can often be traced back to excessive speed or other unsafe vehicle practices, such as lack of driver training. Many of the risks associated with these hazards can be significantly reduced by an effective management system. As more and more workers spend a considerable amount of time travelling and commuting by road, occupational road safety becomes an important issue. Indeed the term 'commuting accident' has been defined by the ILO in the Protocol of 2002 to the Occupational Safety and Health Convention, 1981 P155, as an accident resulting in death or personal injury occurring on the direct way between the place of work and:

- (a) the worker's principal or secondary residence; or
- (b) the place where the worker usually takes a meal; or
- (c) the place where the worker usually receives his or her remuneration.

This chapter examines both pedestrian and vehicular hazards and the controls available to address them.



Figure - Internal roadway with appropriate markings (b) Unsafe stacks of heavy boxes.

2.1 Safe movement of vehicles in the workplace

Many different kinds of vehicle are used in the workplace including dumper trucks, heavy goods vehicles, all-terrain vehicles and, perhaps the most common, the forklift truck. Approximately 70 persons are killed annually following vehicle accidents in the workplace in the UK. There are also over 1000 major accidents (involving serious fractures, head injuries and amputations) caused by:

- collisions between pedestrians and vehicles;
- people falling from vehicles;
- people being struck by objects falling from vehicles;
- people being struck by an overturning vehicle;
- communication problems between vehicle drivers and employees or members of the public.

A key cause of these accidents is the lack of competent and documented driver training. The UK HSE investigations, for example, have shown that in over 30% of dumper truck accidents on construction sites, the drivers had little experience and no training. Common forms of

these accidents include driving into excavations, overturning while driving up steep inclines and runaway vehicles which have been left unattended with the engine running.

Risks of injuries to employees and members of the public involving vehicles could arise due to the following occurrences:

- collision with pedestrians;
- collision with other vehicles;
- overloading of vehicles;
- overturning of vehicles;
- general vehicle movements and parking;
- dangerous occurrences or other emergency incidents (including fire);
- access and egress from the buildings and the site;
- reversing of vehicles, especially inside buildings.

There are several other more general hazardous situations involving pedestrians and vehicles. These include the following:

- poor road surfaces and/or poorly drained road surfaces;
- roadways too narrow with insufficient safe parking areas;
- roadways poorly marked out and inappropriate or unfamiliar signs used;
- too few pedestrian crossing points;
- the non-separation of pedestrians and vehicles;
- lack of barriers along roadways;
- lack of directional and other signs;
- poor environmental factors, such as lighting, dust and noise;
- ill-defined speed limits and/or speed limits which are not enforced;
- poor or no regular maintenance checks;
- vehicles used by untrained and/or unauthorized personnel;
- poor training or lack of refresher training.
- Vehicle operations need to be carefully planned so that the possibility of accidents is minimized.

2.1.1 Hazards and factors affecting level of risk from workplace

2.1.1.1 Vehicle movement

Traffic and pedestrian movement at workplace should be designed, planned and controlled so traffic can circulate safely.

Improving workplace traffic safety systems, in addition to reducing work-related injuries, can also improve workplace efficiency and productivity.

Where are the hazards?

Workplace hazards involving vehicles and mobile plant may occur during:

- pedestrian movement;
- vehicles or plant reversing and maneuvering;
- arrivals or departures;
- loading or unloading;
- hitching or unhitching of trailers;
- mounting or dismounting from vehicles;
- securing of loads;
- movement of materials; and
- maintenance work.

Reversing, loading, unloading and pedestrian movement are the activities most frequently linked with workplace vehicle accidents.

Who is at risk?

People who work with, or near vehicles and mobile plant, such as cars, vans, forklifts, trucks, semitrailers, trailers, tractors, loaders, buses and utilities are most at risk. People also at risk may include other workers, management, self-employed people, customers and visitors at workplaces.

Controlling the risks

The *Occupational Safety and Health Act 1984* states that employers have a duty to ensure, as far as practicable, that employees and other people at the workplace are not exposed to hazards. This can be done through a regular risk management process involving three steps:

- identify hazards;
- assess the risks of injury or harm; and
- control the risks through the implementation of control measures to eliminate or reduce them.

There is a preferred order of control measures to eliminate or reduce the risks of injury or harm ranging from the most effective to the least effective. This is outlined in the table on the next page.

Vehicle movement

The movement of vehicles should be properly managed, as should vehicle maintenance and driver training. The development of an agreed code of practice for drivers, to which all drivers should sign up, and the enforcement of site rules covering all vehicular movements are essential for effective vehicle management.

All vehicles should be subject to appropriate regular preventative maintenance programmes with appropriate records kept and all vehicle maintenance procedures properly documented. Many vehicles, such as mobile cranes, require regular inspection by a competent person and test certificates.

Certain vehicle movements, such as reversing, are more hazardous than others and particular safe systems should be set up. The reversing of lorries, for example, must be kept to a minimum (and then restricted to particular areas). Vehicles should be fitted with reversing warning systems as well as being able to give warning of approach. Refuges, where pedestrians can stand to avoid reversing vehicles, are a useful safety measure. Banksmen, who direct reversing vehicles, should also be aware of the possibility of pedestrians crossing in the path of the vehicle. Where there are many vehicle movements, consideration should be given to the provision of high visibility clothing. Pedestrians must keep to designated walkways and crossing points, observe safety signs and use doors that are separate to those used by vehicles. Visitors who are unfamiliar with the site and access points should be escorted through the workplace.

Fire is often a hazard which is associated with many vehicular activities, such as battery charging and the storage of warehouse pallets. All batteries should be recharged in a separate well-ventilated area.

As mentioned earlier, driver training, given by competent people, is essential. Only trained drivers should be allowed to drive vehicles and the training should be relevant to the particular vehicle (forklift truck, dumper truck, lorry, etc.). All drivers must receive specific training and instruction before they are permitted to drive vehicles. They must also be given refresher training and medical examinations at regular intervals. This involves a management system for ensuring driver competence, which must include detailed records of all drivers with appropriate training dates and certification in the form of a driving licence or authorization. Competence and its definition was discussed in Chapter 4.

The UK HSE publications *Workplace Transport Safety. Guidance for Employers* HSG136, and *Managing Vehicle Safety at the Workplace* INDG199 (revised) provide useful checklists of relevant safety requirements that should be in place when vehicles are used in a workplace.

Driving too fast

In 2007, around 350 fatal road accidents were caused by drivers or riders exceeding the speed limit, and more than 400 were caused by driving too fast for the conditions.

When driving at higher speeds, you have less time to identify and react to what is happening around you. It takes longer to stop. And if there is a crash, it is more severe, causing greater injury to you, your passengers and any pedestrian or rider hit.

Higher speeds also magnify other errors, such as close-following or fatigue or distraction, thus multiplying the chances of causing a crash.

Drivers who 'speed' crash more often than those who don't.

Always stay within speed limits (including variable limits and temporary limits at roadwork) even if you think the limit is too low. Speed limits set the maximum speed for that road. But there are many circumstances when it is not safe to drive at that speed.

In many cases, the nature of the road does not indicate the speed limit. In urban areas, for example, dual carriageways can have limits of 30mph, 40mph, 50mph, 60mph or 70mph. When driving on street-lit roads, assume the limit is 30mph until you see a sign saying otherwise. But, remember the limit could be lower – 20mph.

Speed limit signs tend to be placed at junctions because this is often the point at which the limit changes. However, junctions are also where you need to absorb a wide range of information and it is easy to miss a speed limit sign when concentrating on one or more other things (e.g. which way am I going? Is that driver going to pull out? etc.). So get into the habit of checking for speed limit signs at junctions and looking for repeater signs after the junction, especially if the nature of the road has changed. If you are not sure assume the limit is lower until you see a sign.

Around bends

Around Bend Assessment is one of those magical advanced road driving techniques that causes great excitement, even for the most seasoned of driver, when revealed to them. Cornering technique is one of the aspects motorists never get taught as a matter of course, and yet bend work is statistically one of the highest features of road crashes. Certainly, bends are places where many drivers end up falling off the road.

The art of successful cornering is not merely a case of turning the steering wheel, but one that involves a whole range of other factors. How do you take a bend properly, effectively and safely? When out on the road with us we talk extensively about the forces acting on a car, and the effects a driver will have when doing certain things with the driving controls.

The subject of the poise and balance of the car becomes even more important here, as for a start, we do not brake or accelerate whilst cornering, because these actions will put the car out of balance, which we don't want at a time when it is already dealing with the forces required to make it travel around the bend.

Reversing

Around a quarter of all deaths involving vehicles at work occur as a result of reversing. It also results in considerable damage to vehicles, equipment and property.

The most effective way of reducing reversing incidents is to remove the need to reverse by, for example, using one-way systems. Where this is not possible, sites should be organised so that reversing is kept to a minimum. Where reversing is necessary, consider the following:

- Install barriers to prevent vehicles entering pedestrian zones.
- Plan and clearly mark designated reversing areas.
- Keep people away from reversing areas and operations.
- Use portable radios or similar communication systems.
- Increase drivers' ability to see pedestrians.
- Install equipment on vehicles to help the driver and pedestrians, eg reversing alarms, flashing beacons and proximity-sensing devices.

Poor visibility

Every workplace should have suitable and sufficient lighting, particularly in areas where:

- vehicles manoeuvre, or pedestrians and vehicles circulate and cross;
- loading and unloading takes place.

Take care to ensure there are no sudden changes in lighting levels which may lead to drivers being dazzled.

Overturning of vehicles

Vehicle overturns cause nearly a fifth of all deaths in Vehicles at Work accidents. Forklift trucks, compact dumpers, tipper lorries and tractors are all especially prone to overturning.

It is the duty of people responsible for a workplace to identify risks and to avoid them. It is the responsibility of workers to work safely. The following guidelines will help you stay safe, and meet your legal obligations.

Guidance

- There are many reasons vehicles overturn. They include:

- Travelling on slopes that are too steep.
- Going over slippery surfaces (such as oil or grease patches).
- Going over soft or uneven ground.
- Going over curbs, steps or other edges.
- Being overloaded or unevenly loaded.
- Going too fast, especially around corners.
- Not being suitable for the task.
- Carrying loads at a dangerous height (e.g. with a lift truck load fully raised).
- There is a legal requirement for most vehicles to have an ROPS (Roll-Over Protection System - such as rollcages or rollbars) and seat restraints fitted if there is a risk of them overturning.
- An ROPS can reduce the risk of injury if a vehicle overturns, but are not effective unless the driver is also wearing a suitable restraint (e.g. a seat belt). Drivers have been killed when vehicles fitted with an ROPS and restraints overturned, because they were not wearing the safety belt provided.
- A vehicle must not be used in a way that might cause it to overturn, including being driven over unsuitable ground.
- Drivers should be trained to follow safety procedures, wear proper seat restraints, spot hazards and avoid them.
- Site operators and employers should make sure that they give their employees enough information on the use of seat restraints and any other safety equipment they provide, including when to use them. This could include signs on safety areas and/or vehicles, clear floor markings, and training.
- Site operators and employers must make sure that workers are wearing seat belts when necessary, and are not taking risks that could cause vehicles to overturn.
- The following procedures will help to avoid vehicles overturning:
 - Vehicles should only be driven over the surfaces they are designed for.
 - Suitable routes for regular vehicle movements should be planned out, avoiding steep slopes, uneven or slippery surfaces, curbs and sharp turns.
 - Vehicles should be driven at a suitable speed for the task, load, ground conditions and vehicle.
 - Vehicles must NEVER be overloaded. Overloaded vehicles can become unstable, difficult to steer and be less able to brake
 - Loads should be evenly distributed across the whole vehicle and must be secure.
 - Loads must be carried in a lowered position wherever possible.
 - Loads must only be carried by suitable vehicles.
 - Speed limits must be considered and set where necessary, speed limits must be enforced.
 - Speed humps are NOT recommended, as they are an overturning hazard themselves.

- In many situations, the seat belt/restraint is simply to prevent the driver trying to jump off an overturning vehicle. If a vehicle begins to topple over, the driver should brace him/herself against the back of the driver's seat and hold firmly on a secure part inside the cab. *The driver should never try to jump out of a vehicle that is falling over.*

Hazards to pedestrians

The most common hazards to pedestrians at work are slips, trips and falls on the same level, falls from height, collisions with moving vehicles, being struck by moving, falling or flying objects and striking against fixed or stationary objects. Each of these will be considered in turn, including the conditions and environment in which the particular hazard may arise.

Collisions with moving vehicles

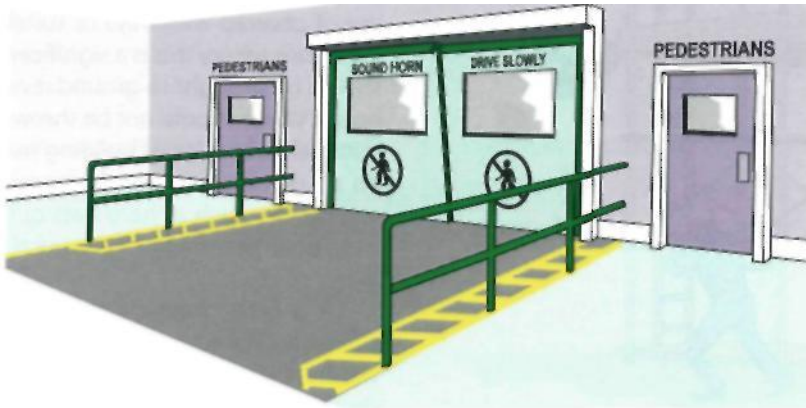
These can occur within the workplace premises or on the access roads around the building. It is a particular problem where there is no separation between pedestrians and vehicles or where vehicles are speeding. Poor lighting, blind corners, the lack of warning signs and barriers at road crossing points also increase the risk of this type of accident. Eighteen per cent of fatalities at work are caused by collisions between pedestrians and moving vehicles with the greatest number occurring in the service sector (primarily in retail and warehouse activities).

Being struck by moving, falling or flying objects

In the UK, this causes 18 per cent of fatalities at work and is the second-highest cause of fatality in the construction industry. It also causes 15 per cent of all major and 14 per cent of over-3-day accidents. Moving objects include articles being moved, moving parts of machinery or conveyor belt systems, and flying objects are often generated by the disintegration of a moving part or a failure of a system under pressure. Falling objects are a major problem in construction (due to careless working at height) and in warehouse work (due to careless stacking of pallets on racking). The head is particularly vulnerable to these hazards. Items falling off high shelves and moving loads are also significant hazards in many sectors of industry.

Striking against fixed objects

This accounts for over 1000 major accidents every year in the UK. Injuries are caused to a person either by colliding with a fixed part of the building structure, work in progress, a machine member or a stationary vehicle or by falling against such objects. The head appears to be the most vulnerable part of the body to this particular hazard and this is invariably caused by the misjudgement of the height of an obstacle. Concussion in a mild form is the most common outcome and a medical check-up is normally recommended. It is a very common injury during maintenance.



(a)



(b)

Figure - Typical warehouse vehicle loading/unloading area with separate pedestrian access (b) Barriers to prevent collision with tank surrounds/bunds.

2.1.1.2 Non-movement

Loading

To minimise the risks to those involved in loading and unloading, information should be provided on the nature of the load and how it should be properly loaded, secured and

unloaded. This information should accompany the load and be available to those involved in the loading, transportation and unloading activities.

The loading and unloading area should be:

- clear of traffic and people not involved in the activity;
- on level ground;
- segregated from other work areas;
- clear of overhead cables, pipes, or other obstructions;
- protected from bad weather where possible.

Make sure vehicles and trailers have their brakes applied and all stabilisers are in the correct position before loading or unloading.

Throughout loading and unloading there should be a safe place where drivers can wait.

Make sure you take measures to prevent vehicles being driven off during either loading or unloading at loading bays. These can include:

traffic lights on loading bays;

- vehicle or trailer restraints;
- keeping keys in a safe place, eg with a 'custody' system.

Guidance on how to secure a load safely can be found in the Department for Transport's Code of Practice *The safety of loads on vehicles*.

Securing loads

3 deaths and 160 major injuries in the 'freight by road' industry were caused by objects falling onto people in the 2009/10 work year. 740 more people received injuries severe enough to keep them off work for over three days.

Measures for reducing these accidents include:

- Follow the Department for Transport Code of Practice (see below)
- Think about how the load can be made safe for offloading, as well as while being transported on the road. Could a load shift during transit? Could this present a risk to the driver when they open back doors, release curtain sides, or undo chains or strapping?

- Ensure drivers have a safe area to observe from when the vehicle is being loaded or unloaded, not next to the vehicle where there could be hit by a fork lift truck or falling load
- Never rely on curtain sides to hold a load in place
- Encourage drivers to report near misses and damaged equipment
- Get information from companies you are delivering or collecting from about facilities and off-loading arrangements on their site, before you visit. See Vehicles at work for more information

Sheeting

Every year, about 70 people are killed and 2,500 seriously injured as a result of accidents involving vehicles in and around workplaces. 44% of falls from tipper lorries occur during sheeting and unsheeting.

Many tipper sheeting accidents could be prevented if **automated sheeting devices** were used and there was **better co-operation** between the parties involved.

Sheeting is used for a variety of reasons:

- to keep materials dry;
- to prevent loss of load during transit as required by Road Traffic Act 1991;
- to keep materials hot;
- to comply with authorisations issued under the Environmental Act 1990.

Falling may occur due to:

- slipping or tripping on the material or strappings and ropes when climbing on the load
- trimming the load when the level is uneven or too high;
- spreading or unfolding the sheet over the load;
- pulling the sheet tight;
- inadequate access to the body of the tipper resulting in poor positioning of the worker;
- high winds creating a sail-effect of the sheeting.

Coupling

Accidents and dangerous situations occur all too often when drivers of large goods vehicles (LGVs) fail to follow safe coupling and parking procedures. Unsafe practices often lead to

vehicle runaway or trailer rollaway situations. They can result in serious and fatal injury to the driver or others, and costly damage to both vehicles and property.

A risk assessment should be made of each type of vehicle the driver will use to decide if one of the generic procedures provided below can be used or if it must be adapted to suit a specific situation.

The driver should be trained in the safe system of work and simple monitoring systems should be set up to check that safe systems are followed at all times - a careless driver can be a danger to others as well as themselves.

Before parking hauliers and site operators should ensure that the area is level and firm enough to support both the trailer landing legs. Additional lighting may be necessary if operations are being carried out during hours of darkness to make sure the procedure is carried out safely and to reduce other risks such as falling from the vehicle.

Vehicle maintenance work

Employers are legally obliged to make sure that work equipment, including vehicles, is in good working order.

It is important that vehicles are maintained so that they remain mechanically sound. You should consider how to make sure that vehicles are kept in good order

You should consider how to make sure that vehicles are kept in good order. Inspections could range from basic safety checks by drivers before using the vehicle (checking that the tyres are properly inflated, etc.), to regular maintenance inspections carried out based on time or mileage.

Employers may find it helpful to provide drivers with a list of daily checks for their vehicles, for them to sign off.

Preventive maintenance is also needed to help avoid failures during use. This should be thorough, regular and frequent enough to meet the manufacturer's guidelines and common sense. Special attention needs to be paid to: the braking system; the steering system; the tyres; Mirrors; windscreen washers and wipers; any warning devices; specific safety systems, racking, securing points for ropes, etc.

Follow HSE guidelines for Safety in Motor Vehicle Repair, available separately.

Require visiting drivers to report to the site office. It should be made clear to everyone that driving in the workplace calls for the same standards as on public roads, and often requires even more skill and care.

Vehicles used at the workplace should, wherever possible, have the following important features:

- Very stable under working conditions.
- Provide a safe way to get in and out, or on and off.
- Suitable and effective brakes.
- Windows, mirrors and sometimes CCTV providing good all-round visibility.
- Suitable warning devices (for example horns, rotating beacons, reversing alarms) should be considered.
- Painting and markings to make the vehicle stand out.
- Seats and seat belts (where necessary) that are safe and comfortable.
- Guards on dangerous parts.
- Driver protection from bad weather, or an unpleasant working environment (for example low temperatures, dirt, fumes, or too much noise or vibration)
- Driver protection to prevent injury should the vehicle tip over, and to prevent the driver being hit by falling objects.

2.1.2 Control measures for safe workplace transport operations

To manage workplace transport effectively, there are three key areas to consider when carrying out your risk assessment:

- safe site (design and activity);
- safe vehicle;
- safe driver.

2.1.2.1 Safe site – design

Segregation

Every site is different and likely to present different hazards and risks. However, a well-designed and maintained site with suitable segregation of vehicles and people will make workplace transport accidents less likely.

The most effective way of ensuring pedestrians and vehicles move safely around a workplace is to provide separate pedestrian and vehicle traffic routes. Where possible,

there should also be a one-way system as this will reduce the need for vehicles to reverse, and will help pedestrians and drivers.

Your circumstances might mean that complete segregation is not possible, so you would need to have clearly marked pedestrian and vehicle traffic routes, using measures such as barriers and signs.

There should be separate entrances and exits for vehicles and pedestrians, and vision panels should be installed on doors that open onto vehicle traffic routes.

Where pedestrian and vehicle traffic routes cross, they should be clearly marked using measures such as dropped kerbs, barriers, deterrent paving etc, to help direct pedestrians to the appropriate crossing points.

Traffic routes

The general principles for safe traffic routes are as follows:

- Make sure they are wide enough for the safe movement of the largest vehicle.
- Ensure surfaces are suitable for the vehicles and pedestrians using them, eg firm, even and properly drained. Outdoor traffic routes should be similar to those required for public roads.
- Avoid steep slopes.
- Avoid sharp corners and blind bends.
- Keep them clear of obstructions.
- Make sure they are clearly marked and signposted.
- Keep them properly maintained.

Some parts of a workplace, such as cast-iron columns, storage racking, pipework and cables, are vulnerable to impact from vehicles and will need to be protected.

The law requiring traffic routes to be wide enough for traffic came into effect on 1 January 1993 but the legislation is not retrospective. On this basis, where it is not 'reasonably practicable' to widen traffic routes that existed before this date, traffic management systems and/or parking restrictions should be used if necessary.

What does 'reasonably practicable' mean?

This means balancing the level of risk against the measures needed to control the real risk in terms of money, time or trouble. However, you do not need to take action if it would be grossly disproportionate to the level of risk.

Temporary traffic routes

Temporary workplaces, eg construction and forestry sites, often have routes for vehicles and pedestrians that change as work progresses. Where possible, these routes should comply with the same basic standards as for the permanent traffic routes listed above.

Visibility

Visibility should be good enough for drivers to see hazards, and pedestrians to see vehicles. Adequate visibility for drivers is related to vehicle speed and the distance needed to stop or change direction safely. Consider having mirrors where sharp or blind bends cannot be avoided.

Speed

Reducing vehicle speed is an important part of workplace transport safety. Fixed traffic control measures such as speed humps, chicanes and 'rumble strips' can reduce vehicle speed. It is important to select the most appropriate control as the wrong measure can increase risk by, for example, reducing vehicle stability.

Speed limits can also be used, but they need to be appropriate, properly enforced and, where possible, consistent across the site.

To assess an appropriate speed limit, consider the route layout and its usage. For example, lower speeds will be appropriate where pedestrians are present or where lift trucks and road-going vehicles share a traffic route.

Signs, signals and markings

Signs for drivers and pedestrians in a workplace should be the same as those used on public roads (as shown in the Highway Code¹), wherever a suitable sign exists.

They should be well positioned and kept clean. Where driving is likely to be carried out in the dark, illuminated or reflective signs should be used.

White road markings should be used to regulate traffic flow, and yellow markings should be used for parking. Wherever possible, such markings should be reflective and maintained regularly.

2.1.2.2 Safe site – Activity

Signaling

The job of **banksmen** (or signallers) is to guide drivers and make sure reversing areas are free of pedestrians. However, in some industries, such as quarrying, banksmen are rarely used due to the size of the vehicles involved.

If you are using banksmen, make sure:

- only trained banksmen are used;
- they are clearly visible to drivers at all times;

- a clear and recognised system is adopted;
- they stand in a safe position throughout the reversing operation.

Parking

Parking areas should be clearly indicated and there should be separate parking areas for commercial and private vehicles. There should also be designated areas where commercial vehicles can be loaded and unloaded.

When vehicles are parked, their parking brakes should always be applied. On most trailers disconnecting the emergency air line does not apply the trailer parking brake.

Drivers should never leave a vehicle unattended without ensuring both the vehicle and the trailer are securely braked, the engine is off and the key to the vehicle has been removed.

Where appropriate, trailer legs should be lowered to the ground.

Coupling and uncoupling

Drivers and those who have overall control of sites (site operators) should make sure that coupling and uncoupling areas are well lit, with firm and level surfaces.

Drivers should be properly trained and have their work monitored by site operators to make sure they follow a safe system of work, involving the use of trailer and tractor unit parking brakes as appropriate.

Further guidance can be found in the Institute of Road Transport Engineers (IRTE) Code of Practice Coupling or uncoupling and parking of large goods vehicle trailers.

Loading and unloading

To minimise the risks to those involved in loading and unloading, information should be provided on the nature of the load and how it should be properly loaded, secured and unloaded. This information should accompany the load and be available to those involved in the loading, transportation and unloading activities.

The loading and unloading area should be:

- clear of traffic and people not involved in the activity;
- on level ground;
- segregated from other work areas;
- clear of overhead cables, pipes, or other obstructions;
- protected from bad weather where possible.

Make sure vehicles and trailers have their brakes applied and all stabilisers are in the correct position before loading or unloading.

Throughout loading and unloading there should be a safe place where drivers can wait.

Make sure you take measures to prevent vehicles being driven off during either loading or unloading at loading bays. These can include:

- traffic lights on loading bays;
- vehicle or trailer restraints;
- keeping keys in a safe place, eg with a 'custody' system.

Guidance on how to secure a load safely can be found in the Department for Transport's Code of Practice The safety of loads on vehicles.

Tipping

To reduce incidents where vehicles overturn during tipping operations, site operators and drivers should co-operate with each other and make sure:

- tipping is carried out on level ground;
- the tractor unit and trailer of articulated vehicles are aligned;
- wheel stops are used where possible;
- the tailgate is released and secured before tipping;
- no pedestrians are in the tipping area;
- the vehicle is not left unattended and cab doors are closed;
- there are no overhead obstacles, such as power lines.

If loads stick during tipping;

- the vehicle should not be driven to free the load (the body should be lowered and then raised);
- drivers should not climb onto the raised tipper section to free the load.

Mechanical 'vibratory discharge systems' can help to free a stuck load.

Overtipping

To minimise vehicle overturns, site operators and drivers should consider: vehicle suitability;

- the condition and slope of the surface;
- the operating speed of the vehicle;
- traffic routes that avoid sharp bends;
- the nature and positioning of the load.

Drivers should be monitored to ensure they follow safe systems of work, eg they are wearing seat belts which should be used even if a roll-over protection system (ROPS) is fitted.

Sheeting

To prevent falls from height when sheeting, follow these simple steps:

- avoid the need to work at height wherever possible, ie sheet from the ground;
- where work at height cannot be avoided, use measures such as platforms with barriers to prevent falls;
- if there is still a risk of a worker falling, use personal protective equipment to minimise both the distance and consequences in the event of a fall.

At each step, always consider measures that protect everyone who is at risk (eg barriers) before measures that only protect the individual (eg fall-arrest systems).

The walkways of working platforms should be made of non-slip material. Consult vehicle manufacturers before installing any vehicle-based sheeting system.

Housekeeping

Traffic routes should be free from obstructions and kept clean. Signage should be cleaned and maintained so that it remains visible and effective.

2.1.2.3 Safe vehicle

Suitable vehicle

Vehicles used in the workplace should be suitable for the purpose for which they are used. You should carefully consider the working environment in which a specific vehicle will be used and the suitability of that vehicle for the people using it. Consulting with those who will use it is a key part of developing a vehicle specification.

The Road Vehicles (Construction and Use) Regulations 1986 set the standard for the design and construction of vehicles used on public roads. Most vehicles used in the workplace should meet this standard, but in some cases there are specific supply standards for mobile plant (eg some lift trucks).

Warning devices such as rotating beacons and reversing alarms are often fitted, and conspicuous painting and marking can be used to make a vehicle stand out to pedestrians.

Drivers should be able to see clearly around their vehicle, so consider measures such as CCTV and special mirrors where visibility is restricted.

Vehicles should be designed so that, wherever possible, those who use them can do their work from the ground. Where people have to work at height on vehicles, suitable means of safe access onto and around vehicles should be provided.

Vehicle design

The design of vehicles used on public roads has to meet strict legal standards, and vehicles used in workplaces should be at least as good, and higher where workplaces are likely to be more dangerous (for example building sites).

Vehicles used at the workplace should, wherever possible, have the following important features:

- Very stable under working conditions.
- Provide a safe way to get in and out, or on and off.
- Suitable and effective brakes.
- Windows, mirrors and sometimes CCTV providing good all-round visibility.
- Suitable warning devices (for example horns, rotating beacons, reversing alarms) should be considered.
- Painting and markings to make the vehicle stand out.
- Seats and seat belts (where necessary) that are safe and comfortable.
- Guards on dangerous parts.
- Driver protection from bad weather, or an unpleasant working environment (for example low temperatures, dirt, fumes, or too much noise or vibration)
- Driver protection to prevent injury should the vehicle tip over, and to prevent the driver being hit by falling objects.

Maintenance/repair of vehicles

Vehicles should be maintained in good working order so they remain mechanically sound, and any devices, such as flashing beacons, function properly. Vehicles such as lift trucks and those with tail lifts must be thoroughly examined by a competent person and reports kept. Planned inspections are a vital part of preventative maintenance. These may include daily safety checks carried out by drivers and regular maintenance inspections based on time or mileage.

Drivers should be provided with a list of the daily checks to be signed off at the start of each shift. This should be monitored to ensure the checks are carried out properly.

Check the level of vehicle maintenance is adequate

<p>Is there a regular preventative maintenance programme for every vehicle, carried out at predetermined intervals of time or mileage? eg in accordance with manufacturers' instructions?</p>	<p>By law, every employer must make sure that work equipment is maintained in an efficient state, in efficient working order and in good repair.</p> <p>It is important that vehicles are maintained so that they are mechanically in good condition.</p> <p>Planned maintenance should be thorough, regular and frequent enough to meet the manufacturer's guidelines and common sense.</p>
<p>Is there a system for reporting faults on the vehicle and associated equipment and carrying out remedial work?</p>	<p>To help identify problems which may happen while the vehicle is being used, the driver will need instruction or training on carrying out appropriate checks and reporting any problems.</p> <p>Employers may find it helpful to give drivers a list of daily checks to sign off for their vehicles.</p> <p>An incident reporting system is essential to enable employers to meet their legal obligations to report some accidents. It is important that managers do not use the incident reporting system to apportion blame as this may discourage employees from using it.</p> <p>A clear and simple procedure for reporting faults and hazards can help prevent serious accidents. It is also valuable in monitoring how effective your safety measures are.</p> <p>It is likely that training will need to cover how and where to report faults or hazards; and procedures for reporting accidents.</p>
<p>Where vehicle attachments lift people or objects, are thorough examinations undertaken by a competent person (e.g. your insurance company)?</p>	<ul style="list-style-type: none"> • Simple guide to the Lifting Operations and Lifting Equipment Regulations 1998 • Simple guide to Provision and Use of Work Equipment Regulations 1998
<p>Do the drivers carry out basic safety checks before using the vehicle?</p>	<p>By law, every employer must make sure that work equipment is maintained in an efficient state, in efficient working order and in good repair.</p> <p>Inspections could range from drivers carrying out start-up safety checks before using the vehicle (such as checking that the tyres are properly inflated) to regular preventive maintenance inspections carried</p>

	out based on time or mileage. Each vehicle you purchase or hire should come with a handbook giving manufacturer's guidance on regular maintenance.
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Visibility from vehicles/reversing aids

Key messages

- Vehicles should have large enough windscreens (with wipers where necessary) and external mirrors to provide an all-round field of vision.
- Drivers should not place objects where they will impede this vision.
- assess the risks to the health and safety of using chosen work equipment.
- Where possible, the need for reversing should be eliminated

Mirrors

As well as conventional side mirrors, it is often worthwhile adding extra mirrors to reduce blind spots for drivers. Side mirrors can allow drivers of larger vehicles to see cyclists and pedestrians alongside their vehicles, and can be effective in improving visibility around the vehicle from the driving position. These mirrors are fitted to larger road-going vehicles as standard.

A clear view

Drivers should not place items in the windscreen area or in the way of mirrors or monitors, where they might impede visibility from the driving position. The area of the windscreen that is kept clear by the wipers should not be obscured, and nor should the side windows. Windows and mirrors will also normally need to be kept clean and in good repair. Dirt or cracks can make windows or mirrors less effective.

Some types of vehicle (such as straddle carriers, large shovel loaders and some large quarry vehicles) often have poor visibility from the cab. Visibility can be poor to the side or front of a vehicle as well as behind, and loads on vehicles can severely limit the visibility from the driving position.

Lift trucks and compact dumper vehicles in particular can have difficulty with forward visibility when they are transporting bulky loads. You should recognise these risks in your risk assessment, and think about ways to minimise them.

Closed-circuit television

Closed-circuit television (CCTV) may help drivers to see clearly behind or around the vehicle. CCTV can cover most blind spots. The cost of fitting CCTV systems has fallen since the technology was first developed, and the systems are more reliable. Companies who have fitted CCTV have found that it can reduce the number of reversing accidents, so the systems usually pay for themselves in a few years.

Colour systems can provide a clearer image where there is little contrast (for example, outside on an overcast day). However, black-and-white systems normally provide a better image in lower light or darkness, and usually come with infra-red, which can be more effective than standard cameras at night.

Monitors should have adjustable contrast, brightness and resolution controls to make them useful in the different light conditions in which they will be used. You may need to use a hood to shield any monitor from glare.

If possible, fit the camera for a CCTV system high up in the middle of the vehicle's rear (one camera), or in the upper corners (two cameras) This will provide a greater field of vision and a better angle for the driver to judge distance and provide. It also keeps the camera clear of dust and spray, and out of the reach of thieves or vandals.

Limitations of CCTV

- If the vehicle leaves a darker area to a more strongly lit area (for example, driving out of a building) the system may need time to adjust to the brightness.
- A dirty lens will make a camera much less effective.
- Drivers may find it difficult to judge heights and distances.

Drivers should not be complacent about safety even with CCTV systems installed. They should be trained in proper use of the equipment.

Other systems

Radar is useful as a reversing aid on open sites where the number of unwanted alarms is likely to be low.

Reversing alarms may be drowned out by other noise, or may be so common on a busy site that pedestrians do not take any notice. It can also be hard to know exactly where an alarm is coming from, and people who are less able to hear are also at greater risk. Alarms can also disturb nearby residents.

Using reversing alarms may be appropriate (based on your risk assessment) but might be most effectively used with other measures, such as warning lights.

Driver protection and restraint systems

Most mobile work equipment manufactured in recent years will already be provided with the physical measures for safety required by PUWER. However, you should still ensure that people are only carried by mobile work equipment suitable for that purpose, with features to reduce safety risks (as far as reasonably practicable) such as seats, restraints and rollover protection.

Where there is a risk of rollover, this should be minimised by stabilising the work equipment, with a structure provided - such as a ROPS (rollover protective structure) - with sufficient clearance for anyone being carried. Where there is a risk of crushing, a suitable restraint system should always be provided for anyone being carried, unless such a system would:

- increase the overall risk to safety
- make the equipment significantly more difficult to operate (and thus not be reasonably practicable)
- not be reasonably practicable to put in place (eg for very old equipment, in use at work before 5/12/1998)

Check that your selection and training procedures ensure your drivers and other employees are capable of performing their work activities safely and responsibly.

<p>Do drivers possess the necessary licences or certificates for the vehicles they are authorised to drive e.g. lift trucks, shunt vehicles, site dumpers etc?</p>	<p>The DVLA does not have responsibility for licensing lift truck operators (provided they do not drive lift trucks on public roads).</p> <p>For example:</p> <p>What licence do I need to operate mobile plant in the workplace?</p> <p>There are no government-issued licences for vehicles at work. The law requires that each operator is given adequate training by their employer so that they are competent to operate the machinery which they use (the Provision and Use of Work Equipment Regulations 1998; regulation 9).</p> <p>Do I need a valid UK car driving licence to operate plant in the workplace?</p> <p>No, driving a car and operating mobile plant are very different tasks, although they use some of the same skills. There is no legal requirement for plant operators to hold a road driving licence unless they wish to drive their vehicles on the public</p>
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	<p>highway. All plant driven on the public highway must comply with the appropriate road traffic legislation.</p>
<p>Do you check the previous experience of your drivers and assess them to ensure they are competent?</p>	<p>The amount of training each driver needs will depend on their previous experience and the type of work they will be doing.</p> <p>You should check that the information they give is true. For example, employers will usually need to check that references to training schemes and other qualifications are supported by certificates.</p> <p>You may need to assess trainees on site, even when they provide evidence of previous training or related work experience. Always check that trainees understand what they have been asked to do.</p> <p>People lose skills if they do not use them regularly. An ongoing programme of re-assessment and refresher training will usually be necessary for all drivers and other employees, to make sure their skills continue to be up to date.</p> <p>Even if drivers often operate vehicles, we recommend regular assessments of their competence and refresher training or more detailed training where necessary to ensure drivers:</p> <ul style="list-style-type: none"> • maintain good driving habits; • learn new skills where appropriate; and • reassess their abilities. <p>Your risk assessment should help decide the level and amount of training needed for each type of work.</p> <p>It is likely that training will need to cover the following:</p> <ul style="list-style-type: none"> • General information about the job, for example: <ul style="list-style-type: none"> ○ the layout of the workplace routes; ○ how and where to report faults or hazards; and ○ procedures for reporting accidents; • training and checks to make sure that people can work safely. For a driver, this is likely to include: <ul style="list-style-type: none"> ○ making sure they know how to use the vehicle and equipment safely; ○ information about, for example, particular dangers, speed limits, parking and loading areas, procedures; ○ making sure, they know what personal protective equipment they should wear for the task they are going to do, and how they should

	<p>use it. Examples might include high-visibility clothing, head protection, a driver restraint, safety boots and equipment to prevent falls;</p> <ul style="list-style-type: none"> ○ information on the structure and level of supervision that will apply, and the penalties if they fail to follow instructions and safety working practices.
<p>Do you provide site specific training on how to perform the job, and information about particular hazards, speed limits, the appropriate parking and loading areas, etc?</p>	<p>Every site is different and each site is likely to present hazards and risks.</p> <p>There should be adequate time for each trainee to have sufficient practical experience to become a safe operator and to do so under close supervision.</p> <p>The training of operators should always include the three stages of training:</p> <ul style="list-style-type: none"> • Basic training the basic skills and knowledge required for safe operation; • Specific job training knowledge of workplace and experience of any special needs and specific handling attachments; • Familiarisation training needs to be done on the job, under close supervision – to put what they have learned during training into practice in the workplace. <p>Authorisation, records and certificates</p> <p>Following satisfactory completion of training, the employee should be given written authorisation to operate the type or types of truck for which all three elements of training have been successfully completed.</p> <p>While there is no legal requirement for certificates of basic training to be issued, they are strongly recommended as a useful, practical means of providing documentary evidence of relevant training having taken place and an appropriate level of operating ability having been attained.</p>
<p>Do you have a planned programme of refresher training for drivers and others to ensure their continued competence?</p>	<p>It is important to keep training records for each employee. These should include enough information to be able to identify the employee, the full training history, planned training, and a copy or details of any certificates or qualifications gained.</p>

	<p>As an employer, if you are satisfied that an employee is competent to use a type of vehicle safely, you can store these details and refer to them when necessary to make sure that employees are trained and competent before being allowed to operate particular vehicles. This could be a simple document with details of the types of vehicles (or the specific vehicles) that a person is competent to operate.</p> <p>People should not be authorised unless the employer is satisfied that the person is competent.</p> <p>Approved Code of Practice (ACOP) and guidance: Rider operated lift trucks. Operator training and safe use</p> <p>This sets the minimum standards of basic training people should receive before they are allowed to operate certain types of lift truck.</p> <p>The ability to drive private cars or other conventional road vehicles, for example, does not remove the need for proper training on lift trucks, which have very different stability and handling characteristics as well as different controls.</p> <p>Training providers can arrange short assessment courses to judge the ability and training needs of experienced operators who have had limited formal training.</p> <p>Change of operation:</p> <p>The employee will need a certificate as evidence of training on any change of employment.</p> <p>An operator with basic training on one type of lift truck or handling attachment cannot safely operate others, for which they have not been trained, without additional conversion training.</p> <p>Where supervisors identify poor operating practices, employers should take appropriate corrective action, including considering refresher training.</p>
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2.1.2.4 Safe driver

Drivers should be competent to operate a vehicle safely and receive appropriate information, instruction and training for the vehicle they use. It is particularly important that

younger or less experienced drivers are closely monitored following their training to ensure they work safely.

Competence

Consider the following:

- **For new recruits:** Recruitment and placement procedures should be in place to ensure all new drivers are competent.
- **For existing employees:** Make sure they have, and continue to have, the skills and experience needed to operate a vehicle safely. If the work changes, drivers should receive the necessary training to carry out the modified task safely.

Selection and training of drivers

Training requirements will depend on an individual's experience and the training they have previously received. Your risk assessment should help decide the level and amount of training a person requires.

In general, newly recruited drivers have the greatest training needs but there should also be a programme of reassessment for more experienced drivers.

It is important to assess the information provided by newly appointed drivers, particularly in relation to their training and experience. They should also be monitored on-site, to establish both their actual level of competence and any further training needs.

You should keep a training record for each driver. This will help to ensure the most appropriate person is allocated a particular task and identify those requiring refresher training.

There are special requirements for the training of lift truck drivers (see HSE's Approved Code of Practice *Rider-operated lift trucks: Operator training and safe use*).

The amount of training each driver needs will depend on their previous experience and the type of work they will be doing.

You should check that the information they give is true. For example, employers will usually need to check that references to training schemes and other qualifications are supported by certificates.

You may need to assess trainees on site, even when they provide evidence of previous training or related work experience. Always check that trainees understand what they have been asked to do.

People lose skills if they do not use them regularly. An ongoing programme of re-assessment and refresher training will usually be necessary for all drivers and other employees, to make sure their skills continue to be up to date.

Even if drivers often operate vehicles, we recommend regular assessments of their competence and refresher training or more detailed training where necessary to ensure drivers:

- maintain good driving habits;
- learn new skills where appropriate; and
- reassess their abilities.

Your risk assessment should help decide the level and amount of training needed for each type of work.

It is likely that training will need to cover the following:

- General information about the job, for example:
 - the layout of the workplace routes;
 - how and where to report faults or hazards; and
 - procedures for reporting accidents;
- training and checks to make sure that people can work safely. For a driver, this is likely to include:
 - making sure they know how to use the vehicle and equipment safely;
 - information about, for example, particular dangers, speed limits, parking and loading areas, procedures;
 - making sure, they know what personal protective equipment they should wear for the task they are going to do, and how they should use it. Examples might include high-visibility clothing, head protection, a driver restraint, safety boots and equipment to prevent falls;
 - information on the structure and level of supervision that will apply, and the penalties if they fail to follow instructions and safety working practices.

Banksman (reversing assistant)

Nearly a quarter of all deaths involving vehicles at work occur during reversing. Many other reversing accidents do not result in injury but cause costly damage to vehicles, equipment and premises.

Using banksmen to control reversing operations can put the Banksman in the potential danger area of a reversing vehicle. Every year banksmen suffer serious and fatal injuries whilst at work. If you do use banksmen, make sure they are trained to carry out their duties

safely. There must be a safe system of work that ensures the Banksman and driver are using standard signals, so that they are easily understood, and that the driver knows to stop the vehicle immediately if the Banksman disappears from view.

Can we still use banksmen for reversing vehicles?

Yes, but only if trained and authorised . There is a hierarchy of control which places segregation at the top. Banksmen should only be used in circumstances where other control measures are not possible

How can we keep banksman safe?

- Ensure that they are trained and competent to direct lifting operations
- Provide a protected position from which they can work in safety
- Provide distinctive 'hi viz' clothing for identification
- Tell drivers that if they cannot see the banksman they should stop immediately
- Agree on the use of standard signals

Management systems for assuring driver competence including local codes of practice

You should ensure that self-propelled work equipment, including any attachments or towed equipment, is only driven by workers who have received appropriate training in the safe driving of such work equipment.'

In connection with lift trucks, a further Approved Code of Practice and guidance (ACOP) supporting PUWER, Rider-operated lift trucks: Operator training, specifies that:

'Employers should not allow anyone to operate, even on a very occasional basis, lift trucks within the scope of this ACOP who have not satisfactorily completed basic training and testing as described in this ACOP, except for those undergoing such training under adequate supervision.' The guidance accompanying this ACOP mentions three stages of training: 'basic', 'specific job' and 'familiarisation'.

The Rider-operated lift trucks ACOP also requires those providing the training to have undergone appropriate training in instructional techniques and skills assessment, together with sufficient industrial experience and knowledge of working environments to put their instruction in context.

There are also specific training requirements made in the ACOPs relating to woodworking machinery and power presses.

Code of Practice

Wherever possible during loading, follow these principles:

- Loads should be spread as evenly as possible during loading, moving and unloading. Unbalanced loads can make the vehicle or trailer unstable, or overload individual axles;
- Balancing the load is important to make sure the trailer moves predictably and safely;
- Generally, loads should rest as close as possible to the bulkhead;
- Department for Transport
- Safe driving: loading & unloading

2.2 Driving at work

Drivers have an important role to play in the safe use of mobile equipment. They should include the following in their safe working practice checklist:

- Make sure they understand fully the operating procedures and controls on the equipment being used.
- Only operate equipment for which they are trained and authorized.
- Never drive if abilities are impaired by, for example, alcohol, poor vision or hearing, ill-health or drugs whether prescribed or not.
- Use the seat restraints where provided.
- Know the site rules and signals.
- Know the safe operating limits relating to the terrain and loads being carried.
- Keep vehicles in a suitably clean and tidy condition with particular attention to mirrors and windows or loose items which could interfere with the controls.
- Drive at suitable speeds and follow site rules and routes at all times.
- Allow passengers only when there are safe seats provided on the equipment.
- Park vehicles on suitable flat ground with the engine switched off and the parking brakes applied; use wheel chocks if necessary.
- Make use of visibility aids or a signaller when vision is restricted.
- Get off the vehicle during loading operations unless adequate protection is provided. Ensure that the load is safe to move. Do not get off vehicle until it is stationary, engine stopped and parking brake applied. Where practicable, remove the operating key when getting off the vehicle.
- Take the correct precautions such as not smoking and switching off the engine when refuelling. Report any defects immediately.

2.2.1 Managing work-related road safety

2.2.1.1 Policy covers work-related road safety

National and international

National approaches to work-related road safety vary in form and coverage from one country to the next. Work-related road safety can fall within the framework of road traffic law, health and safety legislation and policies for the asset and quality management of road transport.

The policy tools in use include collecting data, research, legislation, national guidance to employers, stipulating safety demands in transport contracts, leading by example with safe fleet policies and encouraging effective delivery partnerships.

In Europe, most attention to work-related road safety within road traffic law has been to regulate large commercial and passenger road transport operations and the carriage of dangerous goods. Various initiatives have been taken at EU level e.g. EU driving and rest period rules, Transport of dangerous goods by road, Checks on the transport of dangerous goods by road, Safety adviser for the transport of dangerous goods. A strategy exists on occupational safety 'Adapting to change in work and society: a new Community strategy on health and safety at work 2002-2006'. However, little reference is made to work-related road safety and work at EU level beyond large commercial transport has yet to be started.

Examples of national strategies and programmes

In Sweden, Vision Zero states that public authorities should apply quality assurance principles to work-related travel. The Swedish Roads Administration has subsequently adopted a strategic approach to improving the safety of the entire national vehicle fleet through its fleet safety policies. Fleet safety is part of quality management of the transport component of an institution (whether government or private). The quality assurance of transport aims to ensure that people and goods arrive at the right place, at the right time and in the right way (i.e. without any related danger of serious injury or damage to goods or the environment). Road safety and environmental outcomes are linked and there is emphasis on ensuring the quality of outsourced transport as well as the use of owned vehicles. In specifying high safety standards, corporate purchasers of vehicles and transport services can create an economic imperative for providers of vehicles and transport services to meet these standards. The Swedish Work Environment Authority encourages employers who operate vehicles as part of their work to develop road safety policies and programmes (e.g., seat belt use, driving without alcohol and drugs), monitoring of employees compliance with these rules by the employer, and the installation of safety equipment in vehicles (e.g. seat belt reminders, alcohol ignition interlock for commercial vehicles).

Following a research programme carried out since the late 1990s, Britain is now making provision for the application of health and safety at work law to on-the-road work activities. In Britain, employers have a duty to manage risk on the road as part of their health and safety responsibilities. This entails carrying out risk assessments to see what 'reasonably practicable measures' are needed to ensure 'safe systems of work' for their employees while on the road.

British health and safety requirements for work-related road use

The Health and Safety at Work etc Act 1974 (2) requires the employer to ensure, so far as is reasonably practicable, the health and safety of all employees while at work and that others are not put at risk by the employee's work-related driving activities

The Management of Health and Safety at Work Regulations 1999 (3) sets out the requirement for employers to manage health and safety effectively. They require the carrying out of an assessment of the risks to the health and safety of employees, while they are at work, and to other people who may be affected by their work activities. The Regulations require the employer to review the risk assessment periodically so that it remains appropriate.

Consultation with employees and, where applicable, their health and safety representatives, on the health and safety issues, is covered in governmental guidance.

Health and safety law does not apply to commuting, unless the employee is travelling from their home to a location which is not their usual place of work.

These requirements of health and safety law are in addition to the duties of employers under road traffic law, e.g. the Road Traffic Act and Road Vehicle (Construction and Use) Regulations, which are administered by the police and other agencies such as the Vehicle and Operator Services Agency.

Work-related road safety management guidance in Britain

POLICY: An organization's health and safety policy statement should cover work-related road safety and should be written down if 5 or more people are employed.

RESPONSIBILITY: Top-level commitment to work-related road safety management is required with clear accountabilities set out.

ORGANIZATION AND STRUCTURE: An integrated organizational structure is needed which allows cooperation between departments with responsibilities for work-related road safety.

SYSTEMS: Adequate management systems are needed.

MONITORING: An effective monitoring system is needed

In Australia, health and safety at work legislation makes employers responsible for minimising the risks involved in driving for work. This has mainly involved implementing safety policies and procedures, ensuring vehicle safety, and providing adequate training for employees. In addition to this, 'chain of responsibility laws' have been introduced which increases the accountability of employers, managers, and all other workers involved in the chain of commercial transport.

France has implemented a programme to increase the involvement of private companies in road safety related to their use of vehicles. The French programme is documented in a publication titled "NATIONAL STEERING COMMITTEE FOR THE PREVENTION OF ROAD RISK INCURRED BY EMPLOYEES - PROGRAMME OF ACTION 2000 - 2001" which is produced by the "Occupational Accidents and Diseases Commission" of the National Health Insurance Fund for Salaried Employees (CNAM-TS). Voluntary agreements have been drawn up between government, insurance companies, the national occupational health fund and companies. The programme aims to motivate companies to undertake road safety programmes by increasing awareness of the high cost of road crashes to the company and by decreasing workers compensation and vehicle insurance premiums if programmes are implemented.

In the Netherlands, the Ministry of Transport encourages transport companies to create a safety culture and offers a range of tools to assist in this task. These include a digital safety scan with which transport companies can gain insight into their safety performance and a protocol to assist companies to earn discounts in their insurance premiums in exchange for better safety performance.

2.2.1.2 Systems to manage work-related road safety

Any control strategy involving vehicle operations will involve a risk assessment to ascertain where, on traffic routes, accidents are most likely to happen. It is important that the risk assessment examines both internal and external traffic routes, particularly when goods are loaded and unloaded from lorries. It should also assess whether designated traffic routes are suitable for the purpose and sufficient for the volume of traffic.

The following need to be addressed:

1. Traffic routes, loading and storage areas need to be well designed with enforced speed limits, good visibility and the separation of vehicles and pedestrians whenever reasonably practicable.

2. Environmental considerations, such as visibility, road surface conditions, road gradients and changes in road level, must also be taken into account.
3. The use of one-way systems and separate site access gates for vehicles and pedestrians may be required.
4. The safety of members of the public must be considered, particularly where vehicles cross public footpaths.
5. All external roadways must be appropriately marked, particularly where there could be doubt on right of way, and suitable direction and speed limit signs erected along the roadways. While there may well be a difference between internal and external speed limits, it is important that all speed limits are observed.
6. Induction training for all new employees must include the location and designation of pedestrian walkways and crossings and the location of areas in the factory where pedestrians and forklift trucks use the same roadways.
7. The identification of recognized and prohibited parking areas around the site should also be given during these training sessions.

2.2.1.3 Monitoring performance to ensure policy is effective

Collection of information

Do you monitor performance to ensure that your work-related road safety policy is effective? Are your employees encouraged to report all work-related road incidents without fear that punitive action will be taken against them? Do you collect sufficient information to allow you to make informed decisions about the effectiveness of existing policy and the need for changes?

Example: A company, with 330 people driving on business, quantified employee driving in terms of distance and time. The results revealed that there were 70 people significantly exposed to risk and they were targeted first.

Reporting of work-related road incidents

The Reporting of Injuries Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR) reg.10(2) places restrictions on the general reporting requirements in relation to accidents involving moving vehicles on roads, as defined in the Road Traffic Act 1988, s.192, that is to say a road to which the public has access. Road traffic incidents arising from the movement of a vehicle on the road are only reportable where either the injured person was engaged in, or a person was injured as a result of:

- exposure to a substance being conveyed by a vehicle;

- vehicle loading and unloading activities but not picking up or dropping off passengers;
- construction, demolition, alteration, repair or maintenance activities on or alongside public roads; and
- an accident involving a train.

The exemption from the reporting requirements of RIDDOR for most types of incident on the road means that HSE will not receive large numbers of RIDDOR notifications of road traffic incidents. However, notifications of both reportable and non-reportable work-related road incidents will be received by HSE from employers, members of the public, local authorities, the police and others.

What Types of Accidents Must be Notified to the Health and Safety Authority?

- General injuries involving employees and self-employed Accidents, where a person is injured at a place of work and cannot perform their normal work for more than 3 consecutive days, not including the day of the accident, are reportable.
- ***Road traffic/ vehicle accidents involving employees and self-employed***
Such accidents are reportable if the person was injured while driving or riding in the vehicle in the course of work, and cannot perform their normal work for more than 3 consecutive days, not including the day of the accident.
- ***General injuries involving members of the public***
Accidents related to a place of work or a work activity where a person requires treatment from a medical practitioner are reportable.
Accidents related to medical treatment or a pre-existing medical condition are not reportable.
- ***Road traffic/vehicle accidents involving members of the public***
Road traffic accidents are only notifiable if they relate to vehicle loads or to the construction or maintenance of roads or structures adjacent to roads.

2.2.1.4 Organisation and structure

In larger organisations, your aim is to ensure that you have an integrated organisational structure that allows co-operation across departments with different responsibilities for work-related road safety. In smaller businesses, your aim is to ensure you consider the links between driving activities.

The ISO 39001 standard on road traffic safety management systems (ISO, 2012) requires organisations to follow a process that starts with review of current road safety performance, quantified wherever possible, taking account of the context of the organisation, its leadership and the management functions, processes, and associated activities that can have an impact on road safety. Employers are required to assess the context for the organisation's activity in relation to the road traffic system e.g. employees' use of the road network whether on duty travel or commuting by any publicly or privately-owned or leased vehicle or on foot; goods and passenger transport carried out by the organisation or its contractors; the provision of products and services by the organisation e.g. infrastructure, vehicles, enforcement, emergency medical response and trauma care and whether the organisation's activities generate traffic to or from locations controlled or influenced by the organisation. Organisations are also required to consider the use of a range of measurable safety performance factors to address identified risks. Adoption of the long-term *Safe System* goal of zero death and long-term injury to be reached by interim, step-wide targets (including outcome and output targets) is widely accepted as good practice for organisations and is an important requirement of the draft standard.

Who is responsible?

Work-related road use is both a road safety and occupational safety issue and at the core of public and corporate shared responsibility. Road traffic law and road safety management policy provides the framework for use of public roads. Occupational health and safety law generally focuses on the duties of employers to establish safe systems of work. Work-related road safety requires careful leadership and management by governments at jurisdictional level and by the top management of organisations.

In some national occupational health and safety legislation, the vehicle is considered to be the 'workplace', if driven both on the public highway and at the organisation's site. In such cases, employers have an obligation to ensure that vehicles and their operation comprise a working environment that is safe and with as few risks to health as possible. In other countries, employers' responsibilities are confined to the site. While employers, in general, have an obligation to ensure the safety of workers who use large and dangerous machines as part of their employment, no equivalent measures are usually taken with employees who are expected to use vehicles as part of their work (Corbett, 2003; Stradling, 2001).

The different responsibilities and limited datasets for various aspects of work-related road safety have, no doubt, contributed to different levels of awareness of the importance of this issue to both road and occupational safety in Europe. There is a, however, a wide body of international research on specific issues and many are common to road safety in general. There is an increasing body of advice available to employers and growing experience of the value of evidence-based approaches. More and more countries and employers are starting to acknowledge the size and cost of the problem, the need for a systematic approach to work-related road safety and the opportunities for integrating this area into general road safety management.

2.2.1.5 Legal responsibilities of individuals on public roads

Workplace transport is any activity involving vehicles used in a workplace. Vehicles driven on public roads are excluded, except where the vehicle is being loaded or unloaded on a public road adjacent to a workplace.

This is for requirements of health and safety law. These requirements are in addition to the duties you have as an employer under road traffic law, eg the Road Traffic Act and Road Vehicle (Construction and Use) Regulations, which are administered by the police and other agencies such as the Vehicle and Operator Services Agency.

The Health and Safety at Work etc Act 1974 requires you to ensure, so far as is reasonably practicable, the health and safety of all employees while at work. You also have a responsibility to ensure that others are not put at risk by your work-related driving activities. (Self-employed people have a similar responsibility to that of employers.)

Under the Management of Health and Safety at Work Regulations 1999, you have a responsibility to manage health and safety effectively. You need to carry out an assessment of the risks to the health and safety of your employees, while they are at work, and to other people who may be affected by their work activities. The Regulations require you to periodically review your risk assessment so that it remains appropriate.

You are required to consult with your employees, and where applicable, their health and safety representatives, on the health and safety issues covered in this guidance.

Health and safety law does not apply to commuting, unless the employee is travelling from their home to a location which is not their usual place of work.

There are many specific legal duties relating to workplace transport, and some of them are quite complicated. Throughout this guide, we explain what you must do by law.

Employers must:

- take all 'reasonably practicable' precautions to ensure the health, safety and welfare of all workers in the workplace and members of the public who might be affected by their activities;
- assess the risks to the health and safety of anyone affected by what they do (including employees and members of the public). If the company consists of five or more people, the significant findings must be recorded. See the chapter *Managing the risks* for more information;
- use certain 'principles of prevention', where they take 'preventive measures' to control risks;
- effectively plan, organise, control, monitor and review the preventive and protective measures they use. If the company consists of five or more people, these arrangements must be recorded;
- so far as is 'reasonably practicable', provide and maintain safe systems of work;

- provide information, instruction, training and supervision to protect, so far as is 'reasonably practicable', employees' health and safety at work;
- maintain in a 'safe condition' (without risks to health) any workplace under their control, and the means of 'access' to and 'egress' from it (the way employees get into and out of the workplace).

If you are self-employed, you have a similar duty to that of employers – you must reduce as far as is 'reasonably practicable' risks to your own and other people's health and safety.

2.2.2 Risk assessment

A risk assessment is nothing more than a careful examination of what, in your work, could harm people, so that you can weigh up whether you have done enough or should do more to prevent harm.

By law employers must assess risks as a way of finding out whether they are meeting legal duties. By law, the risk assessment must be 'suitable and sufficient'. Carrying out a risk assessment does not usually need to be very complicated or technical. Most employers carry out risk assessments during the normal course of their work. For example, when hiring new drivers, an employer would normally identify how much information, instruction or training they need, to make sure that they are able to carry out their duties without making mistakes or causing accidents. In recognising that there are risks associated with having new drivers, and then deciding what precautions to take, the employer has carried out a risk assessment and acted on it.

It is also important that your risk assessment is thorough and accurate because you need to use it when you decide what to do to control risks. It will help you to decide what is 'reasonably practicable' because it will help you decide how serious risks are, and how much effort and cost is necessary to control them.

If your organisation employs five or more people (including managers), you must write down any significant findings from the risk assessment.

Steps to risk assessment

Step 1 - Look for hazards that may result in harm when driving on public roads. Remember to ask your employees, or their representatives, what they think as they will have first hand experience of what happens in practice. You need the views of those who drive extensively, but also get the views of those who only use the roads occasionally. The range of hazards will be wide and the main areas to think about are the driver, the vehicle and the journey. See 'Evaluating the risks' for some suggestions.

Step 2 - Decide who might be harmed. In almost all cases this will be the driver, but it might also include passengers, other road users and/or pedestrians. You should also consider whether there are any groups who may be particularly at risk, such as young or newly qualified drivers and those driving long distances.

Step 3 - Evaluate the risk and decide whether existing precautions are adequate or more should be done. You need to consider how likely it is that each hazard will cause harm. This will determine whether or not you need to do more to reduce the risk. It is likely that some risks will remain even after all precautions are taken. What you have to decide for each significant hazard is whether the remaining risk is acceptable. More detailed advice on evaluating the risks in each of the topic areas mentioned under Step 1 is given in the next section of this guidance.

Ask yourself whether you can eliminate the hazard, eg hold a telephone or videoconference instead of making people travel to a meeting. If not, you should think about how to control the risk, to reduce the possibility of harm, applying the principles set out below. These should be considered in the following order, if possible:

- Consider whether your policy on the allocation of company cars actively encourages employees to drive rather than consider alternative means of transport.
- Consider an alternative to driving, eg going at least part of the way by train.
- Try to avoid situations where employees feel under pressure, eg avoid making unrealistic claims about delivery schedules and attendance which may encourage drivers to drive too fast for the conditions, or exceed speed limits.
- Organise maintenance work to reduce the risk of vehicle failure, eg ensure that maintenance schedules are in place and that vehicles are regularly checked by a competent person to ensure they are safe.
- Ensure that drivers and passengers are adequately protected in the event of an incident, eg ensure that seatbelts, and where installed airbags, are correctly fitted, work properly and are used. For those who ride motorcycles and other two-wheeled vehicles, crash helmets and protective clothing should be of the appropriate standard.
- Ensure that company policy covers the important aspects of the Highway Code,¹ such as not exceeding speed limits.

Step 4 - Record your findings. Employers with five or more employees are required to record the significant findings of their risk assessment. If you have fewer than five employees you do not have to write anything down, though it is useful to keep a written record. You must

also tell your employees about what you have done. Your risk assessment must be suitable and sufficient. You need to be able to show that:

- a proper check was made;
- you consulted those who might be affected;
- you dealt with all the obvious hazards.

Step 5 - Review your assessment and revise it if necessary. You will need to monitor and review your assessment to ensure that the risks to those who drive, and others, are suitably controlled. For this to be effective you need to have a system for gathering, recording and analysing information about road incidents. You should also record details of driver and vehicle history.

You may also need to review your assessment to take account of changing circumstances, eg the introduction of new routes, new equipment or a change in vehicle specification. Such a review should seek the views of employees and safety representatives where appointed.

It is good practice to review your assessment from time to time to ensure that precautions are still controlling the risks effectively.

Factors associated with driving at work that increases the risk of being involved in a road traffic incident

a) Risk exposure factors

- Distance travelled and road traffic volume, including vehicle and road user type, whether influenced or not influenced by the organization;
- Volume of product and/or service provided by the organization.

b) Final safety outcome factors

- E.g. numbers of deaths and serious injuries

c) Intermediate safety outcome factors

These safety outcome factors are related to the safe planning, design and use of the road network and of the products and services within it, the conditions for entry and exit of those products, services and users, as well as the recovery and rehabilitation of road traffic crash victims:

- Road design and safe speed especially considering separation (on-coming traffic and vulnerable road users), side areas and intersection design
- Use of appropriate roads depending on vehicle type, user, type of cargo and equipment
- Use of personal safety equipment especially considering seat belts, child restraints, bicycle helmets, motorcycle helmets, and the means to see and be seen

- Using safe driving speed also considering vehicle type, traffic and weather conditions
- Fitness of drivers especially considering fatigue, distraction, alcohol and drugs
- Safe journey planning including consideration of the need to travel, the amount and mode of travel and choice of route, vehicle and driver
- The safety of vehicles especially considering the occupant protection, protection of other road users (vulnerable as well as other vehicle occupants), road traffic crash avoidance and mitigation, roadworthiness, vehicle load capacity and securing of loads in and on the vehicle.
- Appropriate authorization to drive/ride the class of vehicles being driven/ridden
- Removal of unfit vehicles and drivers/riders from the road network
- Post-crash response and first aid, emergency preparedness and post-crash recovery and rehabilitation.

2.2.3 Evaluating the risks

The following considerations can be used to check on work-related road safety management.

2.2.3.1 The driver

The driver competency

- Is the driver competent, experienced and capable of doing the work safely?
- Is his or her licence valid for the type of vehicle to be driven?
- Is the vehicle suitable for the task or is it restricted by the driver's licence?
- Does the recruitment procedure include appropriate pre-appointment checks?
- Is the driving licence checked for validity on recruitment and periodically thereafter?
- When the driver is at work, is he or she aware of company policy on work-related road safety?
- Are written instructions and guidance available?
- Has the company specified and monitored the standards of skill and expertise required for the circumstances for the job?

Training

- Are drivers properly trained?
- Do drivers need additional training to carry out their duties safely?
- Does the company provide induction training for drivers?

- Are those drivers whose work exposes them to the highest risk given priority in training?
- Do drivers need to know how to carry out routine safety checks such as those on lights, tyres and wheel fixings?
- Do drivers know how to adjust safety equipment correctly, for example seat belts and head restraints?
- Is the headrest 3.8 cm (1.5 inches) behind the driver's head?
- Is the front of the seat higher than the back and are the legs 45° to the floor?

Fitness and Health

- The driver's level of health and fitness should be sufficient for safe driving.
- Drivers of Heavy Goods Vehicles (HGVs) must have the appropriate medical certificate.
- Drivers who are most at risk should also undergo regular medicals. Staff should not drive, or undertake other duties, while taking a course of medicine that might impair their judgment.
- All drivers should have regular (every 2 years) eyesight tests. A recent survey has indicated that 25% of motorists have a level of eyesight below the legal standard for driving. Drivers should rest their eyes by taking a break of at least 15 minutes every 2 hours.

In the UK new offences under the Road Safety Act allow courts to imprison drivers who cause deaths by not paying due care to the road or to other road users. Avoidable distractions which courts will consider when sentencing motorists who have killed include:

- using a mobile phone (for either calling or sending text messages);
- drinking and eating.
- applying make-up
- anything else which takes their attention away from the road and which a court judges to have been an avoidable distraction.

Every year in the UK, over 87 000 motorists are disqualified for drink-driving or driving while under the influence of drugs and up to 20 per cent of drink-drivers are caught the morning after drinking. The Department for Transport have calculated that 5 per cent of drivers who failed a breath test after a crash were driving for work purposes at the time.

2.2.3.2 The vehicle

Suitability

All vehicles should be fit for the purpose for which they are used. When purchasing new or replacement vehicles, the employer should select those that are most suitable for driving and public health and safety. The fleet should be suitable for the job in hand. Where privately owned vehicles are used for work, they should be insured for business use and have an appropriate roadworthy certificate test (e.g. MOT test for vehicles over 3 years old, in the UK).

Are you satisfied that vehicles are fit for the purpose for which they are used?

- Do you investigate which vehicles are best for driving and public health and safety when purchasing new or replacement vehicles?
- Is your fleet suitable for the job in hand? Have you thought about supplementing or replacing it, with leased or hire vehicles?
- Do you ensure that privately owned vehicles are not used for work purposes unless they are insured for business use and, where the vehicle is over three years old, they have a valid MOT certificate?

Condition

Are you satisfied that vehicles are maintained in a safe and fit condition?

- Do you have adequate maintenance arrangements in place?
- How do you ensure maintenance and repairs are carried out to an acceptable standard?
- Is planned/preventative maintenance carried out in accordance with manufacturers' recommendations? Remember an MOT certificate only checks for basic defects and does not guarantee the safety of a vehicle.
- Do your drivers know how to carry out basic safety checks?
- How do you ensure that vehicles do not exceed maximum load weight?
- Can goods and equipment which are to be carried in a vehicle be properly secured, eg loose tools and sample products can distract the driver's attention if allowed to move around freely?
- Are windscreen wipers inspected regularly and replaced as necessary?

Safety equipment

Are you satisfied that safety equipment is properly fitted and maintained?

- Is safety equipment appropriate and in good working order?
- Are seatbelts and head restraints fitted correctly and do they function properly?

Safety critical information

Are you satisfied that drivers have access to information that will help them reduce risks?

- Have you thought of ways that information can be made readily available to drivers?

Eg:

- -recommended tyre pressures;
- -how to adjust headlamp beam to compensate for load weight;
- -how to adjust head restraints to compensate for the effects of whiplash;
- -the action drivers should take where they consider their vehicle is unsafe and who they should contact.

Ergonomic considerations

Are you satisfied that drivers' health, and possibly safety, is not being put at risk, eg from inappropriate seating position or driving posture?

- Do you take account of ergonomic considerations before purchasing or leasing new vehicles?
- Do you provide drivers with guidance on good posture and, where appropriate, on how to set their seat correctly?

2.2.3.3 The journey

Routes

Do you plan routes thoroughly?

- Could you use safer routes which are more appropriate for the type of vehicle undertaking the journey? Motorways are the safest roads and although minor roads may be fine for cars, they are less safe and could present difficulties for larger vehicles.
- Does your route planning take sufficient account of overhead restrictions eg bridges and tunnels and other hazards, such as level crossings, which may present dangers for long vehicles?

Scheduling

Are work schedules realistic?

- Do you take sufficient account of periods when drivers are most likely to feel sleepy when planning work schedules? Sleep-related accidents are most likely to occur between 2 am and 6 am and between 2 pm and 4 pm.
- Have you taken steps to stop employees from driving if they feel sleepy even if this might upset delivery schedules?
- Where appropriate, do you regularly check tachographs to ensure drivers are not cutting corners and putting themselves and others at risk?
- Do you try to avoid periods of peak traffic flow?

- Do you make sufficient allowances for new trainee drivers?

Time

Are you satisfied that sufficient time is allowed to complete journeys safely?

- Are your schedules realistic? Do journey times take account of road types and condition, and allow for rest breaks? Would you expect a non-vocational driver to drive and work for longer than a professional driver? The Highway Code¹ recommends that drivers should take a 15 minute break every two hours. Professional drivers must of course comply with drivers' hours rules.
- Does company policy put drivers under pressure and encourage them to take unnecessary risks, eg to exceed safe speeds because of agreed arrival times?
- Can drivers make an overnight stay, rather than having to complete a long road journey at the end of the working day?
- Have you considered advising staff that work irregular hours of the dangers of driving home from work when they are excessively tired? In such circumstances they may wish to consider an alternative, such as a taxi?

Distance

Are you satisfied that drivers will not be put at risk from fatigue caused by driving excessive distances without appropriate breaks?

- Can you eliminate long road journeys or reduce them by combining with other methods of transport? For example, it may be possible to move goods in bulk by train and then arrange for local distribution by van or lorry.
- Do you plan journeys so that they are not so long as to contribute to fatigue?
- What criteria do you use to ensure that employees are not being asked to work an exceptionally long day? Remember that sometimes people will be starting a journey from home.

Weather conditions

Are you satisfied that sufficient consideration is given to adverse weather conditions, such as snow or high winds, when planning journeys?

- Can your journey times and routes be rescheduled to take account of adverse weather conditions?
- Where this is possible is it done?
- Are you satisfied that vehicles are properly equipped to operate in poor weather conditions, eg are anti-lock brakes fitted?
- Are you content that drivers understand the action they should take to reduce risk, eg do drivers of high-sided vehicles know that they should take extra care if driving in strong winds with a light load?

- Are you satisfied that drivers do not feel pressurised to complete journeys where weather conditions are exceptionally difficult?

2.2.4 Control measures to reduce work-related driving risks

When developing and putting in place policies and local guidelines, organisations should work in partnership. Involving staff and Trade Unions/Professional Organisations is an important step, as they are a valuable source of information and advice. Their involvement will also help to make sure that all relevant dangers have been identified and appropriate control measures put in place. Consultation with staff and their representatives on health and safety matters is also a legal duty.

There are a number of recommended strategies that should be used by organisations to reduce the risks associated with work-related driving.

These include:

- an inspection every year of driving licences and insurance certificates;
- providing regular information for staff on driving safely;
- restrictions on using hand-held phones and other distracting activities (for example, eating and drinking) while driving;
- referring to the organisation's alcohol and drug policies and assessing the general fitness of the driver;
- providing eye tests every two years through the Occupational Health Service;
- clear limits on maximum driving distances each day and maximum unbroken driving hours (no driver should drive continuously for more than 2.5 hours without a break);
- providing guidance on planning a safe journey and procedures to be followed in the event of a breakdown or accident;
- providing guidance on carrying basic safety equipment (for example, a first-aid kit, fire extinguisher, warning triangle and torch); and
- formal procedures for reporting, recording and investigating all accidents, incidents and near misses.

Vehicles must be fit for their purpose and in a roadworthy condition. How vehicles are used may vary widely and it is essential that the correct type of vehicle is chosen. Staff who need to drive a vehicle as part of their work must have the most suitable vehicle for their needs and where necessary, vehicles should be fitted with any extra safety equipment needed (for example, a body-space safety partition, or luggage or goods-retention system).

Monitoring

Effective monitoring of the strategies in place to minimise and reduce the risks of work related driving is essential. All organisations should identify local quality indicators around risk reduction and management as good practice.

Communication

All organisations must make sure that they set up clear systems to communicate the organisation's policy on work related driving to all relevant staff within the organisation.

In order to communicate the organisational policy on work-related driving risks:

- there needs to be clear commitment and support from senior management for the policy to be fully adopted within the organisation;
- briefing sessions should be held for managers on launching the new or amended policy;
- managers must make sure that current staff realise their individual responsibility to keep to the policy; and
- new staff must be made aware of the policy and their responsibilities as part of their induction.

Measuring success

All organisations should have in place:

- a policy on reducing work-related driving risks based on a full risk assessment which is reviewed each year within the Local or Area Partnership Forums and Health and Safety Committees;
- appropriate and thorough training programmes for relevant staff based on local risk assessment and including refresher training; and
- robust and effective reporting systems which encourage staff to record all incidents and near misses.

In summary, all organisations must be able to show that everything that is reasonably practicable is being done to eliminate or reduce the risks associated with work-related driving. A major measure of success will be reducing the number of injuries, accidents and incidents resulting from these activities. This will be achieved by using best practice and a combination of safe systems of work and increased awareness of the risks involved.

Summary

Common hazards - Vehicles

- Injury caused by a vehicle collapse or overturn.
- Being struck by a moving vehicle.
- Falling from a vehicle or being hit by a load.
- Being hit against a vehicle whilst travelling in a vehicle.



What can be done to enhance transport safety?

- Vehicles are strictly managed in the workplace.
- Drivers are competent and experienced.
- Pedestrians are fully aware of the relevant safety rules.
- Safe systems of work are in place & are adhered to.

Vehicles and transport:

In almost every workplace, there are people and vehicles operating together and a consequence, there is the potential for serious accidents and injuries, which are the result of:

- Vehicles overturning.
- Falling from vehicles when loading or unloading.
- Being struck by objects falling from vehicles.
- Being hit or run over by moving vehicles.

To ensure the safety of pedestrians, ensure that vehicles and pedestrians are completely separate; this can be achieved by the use of barriers, restricting access of pedestrians to the relevant areas to certain times when vehicles are not allowed to operate in such areas.

If it is unavoidable that pedestrians and vehicles are going to operate in the same areas at the same time, then the use of barriers as well as marked walk-ways must be considered seriously. The use of training and appropriate signs can also contribute to increased safety of pedestrians.

Even in low risk areas such as office environments, employees can still get injured as a result of being hit by cars in car parks, because people assume that they are safe simply because they are off public highways.

Remember, drivers sometimes have a restricted view when reversing vehicles. To reduce the risk of injury:

- Use a one way system to minimise the need for vehicles to reverse.
- Use a banks man to watch and guide the driver while reversing.
- Make all employees aware of the risks associated with reversing vehicles.
- Consider the use of mirrors on blind corners.
- Impose strict speed limits.

As a manager, you need to ensure that vehicle risks in your area are managed effectively in your area, so ask yourself:

Do you know what vehicles are operating and what vehicles are not?

In particular you must consider:

- Vehicles reversing, loading and unloading, tipping, cleaning, maintenance and repair, cleaning and any other hazards in the workplace.
- Are your drivers competent in the use of their vehicles?, is there adequate monitoring to ensure that drivers are adhering to site rules and procedures, such as speed limits, one-way systems and pedestrian walk ways?,
- Are drivers following correct procedures when loading/ unloading, when re-fuelling and re-charging their vehicles?
- Are pedestrians similarly adhering to the designated pedestrian walk-ways?

Element 3 - Musculoskeletal hazards and risk control

Learning outcomes

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

3.1 Work-related upper limb disorders

Work-Related Upper Limb Disorders, or ULDs, is the name given to a group of clinical conditions affecting the upper limb such as Tenosynovitis, Carpal Tunnel Syndrome (CTS) and Tennis Elbow. At one time they were known as Repetitive Strain Injuries (RSI). Now they are called ULDs because it is recognised that repetition is only part of the problem; other factors are important as well. However, some doctors and others still use the term RSI, often for aches and pains that don't fit into the clinical categories. ULDs affect the shoulder and arm, including the forearm, elbow, wrist, hand and fingers.

ULDs can also include neck pain. There is a wide range of symptoms, such as tenderness, aches and pain, stiffness, weakness, tingling, numbness, cramp, or swelling.

What causes them?

Many jobs carry a slight risk of developing aches or pains in part of the arm or shoulder. If untreated, and continually aggravated, these aches can develop into a ULD. It is important to note that ULDs are not always caused by work. For example, CTS can be due to a hormone imbalance, particularly in women. However, many jobs can still aggravate pre-existing ULDs.

3.1.1 Meaning of musculoskeletal disease and work related upper limb disorders

WRULDs are caused by:

- repetitive finger, hand, or arm movements, e.g. assembly line work, key board operators
- twisting movements, e.g. meat and poultry preparation
- squeezing, e.g. using pliers, scissors
- hammering or pounding, e.g. construction activities or
- pushing, pulling, lifting or reaching movements, e.g. assembling packing boxes.

The symptoms of WRULDs are:

- numbness or tingling in fingers, etc.
- pain
- restriction of joint movement and
- soft tissue swelling.

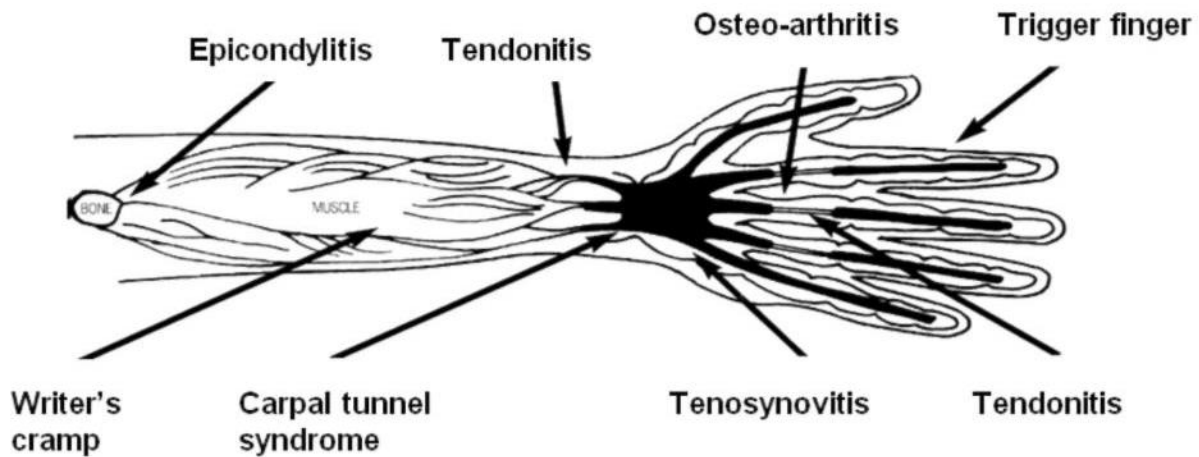
In the early stages there may be little or no visible sign of bruising or swollen joints. The onset of symptoms is often gradual and a person's response to pain and restricted mobility may result in an adaptation to the way in which work is performed. Repeated sprains and strains (the terms often used to describe over-exertion injuries) may produce a pattern of tissue inflammation that is often the forerunner of chronic injury. A permanent disability is sometimes the final result.

Examples of medical conditions are:

Injury	Symptom	Typical Cause
Bursitis: inflammation of the bursa (sack-like cavity) between the skin and bone, or bone and tendon. Can occur at the	Pain and swelling at the site of injury.	Kneeling. Pressure at the elbow. Repetitive shoulder movements.
Carpal Tunnel Syndrome: pressure on the nerve that passes up the wrist.	Tingling, pain and numbness in the thumb and fingers, especially at night.	Repetitive work with a bent wrist. Using vibrating tools.
Epicondylitis: inflammation of the area where a tendon	Pain and swelling at the site of injury.	Repetitive work, often from strenuous jobs like joinery, plastering and brick laying.
Tendonitis: inflammation of the area where the muscle and tendon are joined.	Pain, swelling, tenderness and redness of the hand, wrist and / or forearm. Difficulty in	Repetitive movements.

Tenosynovitis: inflammation of the tendon and / or tendon sheath.	Aching, tenderness, swelling, extreme pain, difficulty in using the hand.	Repetitive movements, often non-strenuous. Can be brought on by sudden increases in workload or by introduction of new processes.
Osteo-arthritis: damage to the joints resulting in swelling at the joints	Stiffness and aching in the spine, neck and other joints.	Long-term overloading of the spine and other joints
Trigger Finger.	Inability to move fingers smoothly, with	Repetitive movements. Having to grip too tightly, too long or

Figure: Examples of Medical Conditions Resulting from WRULDs



Risk Assessment

- A formal risk assessment will need to be carried out where there are the following risk factors:
- force exerted
- frequency and duration of operation
- repetition of movement without rest or recovery time
- posture, e.g. extension or flexion of joints whilst forces are exerted and
- other factors, e.g.:
- vulnerability of employees, e.g. smokers, existing medical conditions
- low temperatures, which restrict blood flow and
- constraints on space.

Control Measures

Measures to control the risk can be applied to:

- the task and
- the person.

The Task

- mechanise the task
- improve the task, for example:
 - reduce the **force** required, e.g. by keeping cutting edges of scissors sharp, distributing force requirements over several fingers rather than one, using stronger muscle groups and using clamps instead of hands to grip parts, etc.
- reduce the **frequency and duration**, e.g. by self-pacing, job rotation, reducing machine speed during maintenance and training
- improve the **posture**, e.g. by ensuring there are no space constraints, etc.
- use the correct tools and equipment
- maintain tools and equipment and
- control environmental factors, e.g. temperature, humidity and lighting.

The Person

- identify susceptible individuals and ensure personnel selection
- assessment of individuals for the task
- provide health surveillance and
- training of workers in safe postures.

However, no single approach works all the time. High risk WRULD problems may require more complex solutions, e.g. redesigning workstations, providing better tools, or supplying ready-assembled subcomponents.

Display Screen Equipment (DSE)

Display screen equipment is a range of electrical display equipment that is most often part of a computer system.

3.1.2 Examples of repetitive operations

UPPER LIMB PAINS AND DISCOMFORT

The use of DSE can cause musculoskeletal disorders and work related upper limb disorders.

These range from temporary fatigue or soreness in the limb to chronic soft tissue disorders such as tendonitis or carpal tunnel syndrome.

Prolonged static posture of the back, neck and head are known to cause musculoskeletal problems. Other factors include awkward positioning of the hands and wrist, e.g. as a result of poor working technique or inappropriate work height. Outbreaks of soft tissue disorders among display screen workers have often been associated with high workloads combined with tight deadlines.



DSE 'User'

A DSE user is an employee, and an operator is a non-employee, who can be defined as workers who 'habitually use DSE as a significant part of their normal work', i.e. uses DSE more or less continuously on most days. However, where use is less frequent, a person would generally be a user or operator where most, or all, of seven circumstances apply (see overleaf):



1. the worker depends on the use of DSE to do the job because alternative means are not readily available for achieving the same result
2. the worker has no discretion as to the use or non use of the DSE
3. the worker needs significant training and / or particular skills in the use of DSE to do the job
4. the worker uses DSE for continuous spells of more than one hour
5. the worker uses DSE more or less daily
6. fast transfer of information between the worker and the screen is an important requirement of the job and
7. the performance requirements of the system demand high levels of attention and concentration by the worker, e.g. where the consequences of error may be critical.

Laptops

'Laptop' and other portable computers have to be compact enough to be easy to carry. These result in

design compromises, e.g. smaller keyboards and screens that force poor postures. This makes portable

computers less comfortable and higher risk in prolonged use than normal DSE. Where possible, the use of portable computers for long periods should be avoided when full-sized equipment or a 'docking' station is available. A docking station may consist of a full size adjustable screen, a keyboard and a mouse. Workers who use portable computers are subject to less supervision therefore they should receive more regular and detailed training.

Training for people who habitually use a portable computer should also focus on how to minimise risks, e.g. sitting comfortably, angling the screen so it can be seen clearly with minimal reflections, and taking frequent breaks if work is prolonged. Wherever possible, portable computers should be placed on a firm surface at the right height for keying.

Using a Mouse

Intensive use of a mouse, trackball, or similar pointing device may give rise to aches and pains in the fingers, hands, wrists, arms or shoulders. This can also happen with a keyboard, but mouse work concentrates activity on one hand and arm (and one or two fingers), and this may make health problems more likely. Adopting a good posture and technique can reduce risks. There is a need to take breaks from intensive mouse work even short pauses can help, as can spells doing keyboard or non-computer work.

Software

The information should be displayed in a suitable format and at a suitable pace. Software should:

- be suitable for the task and easy to use
- be adaptable to the working pace and knowledge of the user and
- provide feedback to the user.
- No facility for checking the quantity or quality of work should be used without the worker's knowledge.

3.1.3 Matching the workplace to individual needs of workers

An ergonomic approach to workstation and job design is required. Combined with good information for DSE users and operators, the main risks associated with such work will be reduced. In addition, it should, almost invariably, enhance performance and productivity as well as improve workers' health and safety.

Analyse Workstations, and Assess and Reduce Risks

Employers should consider:

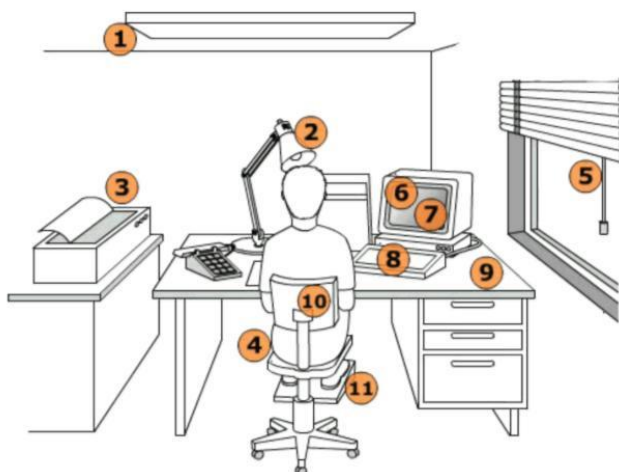
- the whole workstation including equipment, furniture, and the work environment
- the job being done and
- any special needs of individual workers (whose views may be sought as part of the assessment).

Where risks are identified, the employer should take steps to reduce them.

Ensure Workstations Meet Minimum Requirements

These requirements are good features that should normally be found in a workstation. Poor posture can cause backache and pain in the neck / shoulders, mainly due to sitting incorrectly and working for long periods in an awkward position. Although it may seem easy to sit correctly, it can take time and effort to break old habits. Maintaining a good posture (no posture is healthy if it is held for prolonged periods) and variation of work activity are important. In order to accommodate the varying dimensions of different individuals it is necessary to make provision for adjustability in the design of workstations.

Figure: Minimum Requirements for a DSE Workstation



- adequate **lighting** (1 and 2)
- distracting **noise** minimised (3)
- **legroom** and clearances to allow postural changes (4)
- **window** covering (5)
- **screen**: stable image, adequate contrast, no glare or distracting reflections, adjustable (6)
- **software**: appropriate to task, adapted to user, provides feedback on system status, no undisclosed monitoring (7)
- **keyboard**: usable, adjustable, detachable, legible (8)
- **work surface**: allow flexible arrangements, spacious, glare free (9)
- **work chair**: stable base, good lumbar support, adjustable (10) and
- **Footrest** (11).

Plan Work So There Are Breaks or Changes of Activity

The need for breaks depends on the nature and intensity of the work; therefore there is no specific timing or length for breaks or changes of activity. However, short, frequent breaks are more effective than longer, less frequent ones. Ideally the individual should have some discretion over when to take breaks. Intensive work at a display screen can cause visual discomfort that may in turn lead to problems such as headaches and even mental stress. Intensive keyboard use and static posture are contributory factors in most incidences of work related upper limb disorders.

On Request Arrange Eye Tests, and Provide Spectacles If Special Ones Are Needed

Employers should provide and pay for an eye and eyesight tests. This is a test by an optometrist or doctor. There is also an entitlement to further tests at regular intervals the optometrist doing the first test can recommend when the next should be.

Employers generally only have to pay for spectacles if special middle distance spectacles are needed and short or long distance spectacles cannot be used. This is not an entitlement for operators.

Provide Health and Safety Training and Information

Information should be provided about DSE health and safety before a worker becomes a user. This should include general background information, e.g. importance of posture, etc. DSE workers should change position regularly. They should adopt a relaxed, upright but not

rigid, position, ensuring that the forearms are almost horizontal with the keyboard, as shown in Figure 4. The hands should be kept in a natural position, without exerting excessive force whilst using the mouse.

3.1.4 The ill-health effects of poorly designed tasks and workstations

Display Screen Equipment not only plays a major part in our daily lives both at home and work. It also can be a major contributing factor towards musculoskeletal disorders, reduced concentration levels, other ill-health effects including stress that can be a result of a poorly designed work station.

Do you or your staff suffer from back, neck or shoulder pain or any other symptoms that could be related to poor posture whilst sitting at a computer? Don't leave it until it is too late!

It is a legal requirement for users and operators to have display screen equipment assessments carried out in the workplace and part of that process is to educate people in the understanding of ergonomics, postural awareness and to reduce the risk of ill health and injury.

Computer use is on the increase both for business and recreation. For business use it is a legal requirement by employers for the home workstation to be assessed.

Eye and Eyesight Effects

Medical evidence shows that using display screen equipment is not associated with damage to eyes or eyesight, nor does it make existing defects worse. However, some display screen workers may experience temporary visual fatigue, leading to a range of symptoms, e.g. impaired visual performance, red or sore eyes and headaches. Wearers of contact lenses may have a greater susceptibility to visual discomfort. This is often due to a reduced blink-rate, a perfectly normal consequence of increased concentration,



which results in drying of the lens. The drying effect is less of a problem to other users who wear spectacles.

Epilepsy

Working with DSE does not cause epilepsy and has not been known to induce an epileptic attack. However, people who suffer from photosensitive epilepsy (mostly children and young adults) may react adversely to flickering lights and striped patterns, and in a few cases a poorly adjusted screen may produce an attack.

Facial Dermatitis

Some display screen workers have reported facial skin complaints such as occasional itching or reddened skin on the face and / or neck. These complaints are relatively rare and the limited evidence available suggests they may be associated with environmental factors, such as low relative humidity or static electricity near the DSE.

The combination of central heating systems, air conditioning and the presence of electrical equipment such as visual display units (VDU) and printers can dry out the air, which affects the skin, as well as the eyes and respiratory system. Static electricity and an individual's susceptibility can be a contributing factor. Dry skin becomes itchy, and scratching it can lead to dermatitis.

Electro Magnetic Radiation and Effects on Pregnant Women

Anxiety about radiation emissions from display screen equipment and possible effects on pregnant women has been widespread. However, there is substantial evidence that these concerns are unfounded. There has been considerable public concern about reports of higher levels of miscarriage and birth defects among some groups of display screen workers, in particular due to electromagnetic radiation. Many scientific studies have been carried out, but taken as a whole their results do not offer conclusive evidence of ill-health effects.

Stress and Fatigue

It is not uncommon for display screen workers to suffer stress symptoms in addition to upper limb or visual problems. Disorders of the skin and digestive system are often associated with stress as are conditions such as anxiety and sleeplessness. Underutilisation of skills, sustained high-speed working and social isolation are all likely to increase stress to an unhealthy level.

3.1.5 The factors giving rise to ill-health conditions

There has been a rapid and continuing growth in the use of computers in all sections of industry and commerce. Different terminology is used which can be confusing – for example, visual display units (VDUs), visual display terminals (VDTs), monitors and display screen equipment (DSE). For the purposes of this chapter, the term display screen equipment or DSE for short will be used.

Millions of people in Britain use DSE for a significant part of their work or use DSE at some time during their work. The growth in the use of computers has been accompanied by increasing concerns about a range of health and safety problems that may be associated with DSE work.

Repetitive tasks

Repetitive strain injuries (RSI) is dealt with in greater detail in the chapter on Work-Related Upper Limb Disorders. Repetitive strain injuries are a major problem for users of display screen equipment. RSI is the collective name used to describe a range of muscle and tendon conditions of the neck, shoulders, elbows, wrists, hands and fingers caused by continuous, repetitive or pressurised finger, hand or arm movements such as typing. Other names used to describe these conditions include WRULDs (work-related upper limb disorders), Occupational Overuse Syndrome, and Cumulative Trauma Disorders. Symptoms include:

- pain in the fingers, wrists, arms or shoulders
- tenderness
- feeling of heaviness in the arms/wrists
- swelling
- tingling sensation at the fingertips
- numbness
- joint restriction.

In addition, using a computer mouse concentrates activity on one hand and arm, and one or two fingers. This makes aches and pains in the fingers, hands, wrists, arms and shoulders more likely.

Environment

Ensure workstations meet minimum requirements. These requirements are good features that should normally be found in a workstation, such as adjustable chairs and suitable lighting. They are set out in a schedule to the Regulations, covering the equipment, the working environment and the interface (for example, software) between the computer and the user or operator. The main requirements include:

- adequate lighting
- adequate contrast, no glare or distracting reflections
- distracting noise minimised
- leg room and clearances to allow postural changes
- window covering if needed to minimise glare
- software – appropriate to the task, adapted to the user, providing feedback on the system status, no undisclosed monitoring
- screen – stable image, adjustable, readable, glare/reflection free
- keyboard – usable, adjustable, detachable, legible
- work surface – with space for flexible arrangement of equipment and documents, glare-free chair – stable and adjustable
- footrest if user needs one.

3.1.6 Appropriate control measures

A considerable number of laws and regulations apply to DSE. General duties can be found in the following chapters of *Hazards at Work*:

- Safety Representatives and Safety Committees Regulations 1977
- Health and Safety at Work etc. Act 1974
- Management of Health and Safety at Work Regulations 1999
- Provision and Use of Work Equipment Regulations 1998 as amended
- Workplace (Health, Safety and Welfare) Regulations 1992.

Employers have an absolute duty to conduct risk assessments and implement protective and preventative measures, taking account of the ergonomic principles described above.

Provisions in the 1999 Regulations are listed below:

- making a suitable and sufficient assessment of the risks
- identifying measures needed to comply with legal requirements
- reviewing the risk assessment
- recording the assessment where there are five or more employees
- implementing preventative and protective measures using ergonomic principles as described below.

Implementing preventative and protective measures on the following basis:

- avoiding the risks
- evaluating the risk which cannot be avoided
- combating the risk at source

- adapting the work to the individual, especially as regards the design of workplaces, the choice of work equipment and the choice of working and production methods with a view, in particular to alleviating monotonous work and work at a predetermined work-rate and to reducing their effect on health
- adapting to technical progress
- replacing the dangers by the non-dangerous or the less dangerous
- developing a coherent overall prevention policy which covers technology, organisation of work, working conditions, social relationships and the influence of factors relating to the working environment
- giving collective protective measures priority over individual protective measures
- giving appropriate instructions to employees.

3.2 Manual handling hazards and control measures

The Task

- mechanise the task
- improve the task, for example:
- reduce the force required, e.g. by keeping cutting edges of scissors sharp, distributing force requirements over several fingers rather than one, using stronger muscle groups and using clamps instead of hands to grip parts, etc.
- reduce the frequency and duration, e.g. by self-pacing, job rotation, reducing machine speed during maintenance and training
- improve the **posture**, e.g. by ensuring there are no space constraints, etc.
- use the correct tools and equipment
- maintain tools and equipment and
- control environmental factors, e.g. temperature, humidity and lighting.

The Person

- identify susceptible individuals and ensure personnel selection
- assessment of individuals for the task
- provide health surveillance and
- training of workers in safe postures.

However, no single approach works all the time. High risk WRULD problems may require more complex solutions, e.g. redesigning workstations, providing better tools, or supplying ready-assembled subcomponents.

Level of Detail

It will be necessary to consider what tasks are undertaken to identify those which are high risk, exceeding the guidelines filters and therefore need to be assessed first. It is neither practicable nor necessary to conduct an individual assessment of every single movement or operation. Many tasks will be similar and frequently repeated. In these cases a generic risk assessment is likely to be acceptable. In the case of delivery operations for example, the guidance recommends listing the various types of tasks, loads and working environment concerned, and then to propose a review of a selection of them.

The assessment should identify the problems likely to arise during the kind of operations that can be foreseen and the measures necessary to deal with them. On a day-to-day basis supervisors may have to make further specific judgements when dealing with manual handling tasks. For example, in a warehouse dealing with sacks of sand, a decision may have to be made about how to lift broken sacks to prevent spillage and injury.

Who Should Assess?

The assessment should ideally be carried out by someone within the organisation who has a thorough practical understanding of the manual handling taking place. In complex or high risk cases, a team approach, possibly including a safety professional, an industrial engineer, a supervisor and an occupational health nurse is recommended.

Areas of knowledge required are:

- legal requirements
- the nature of the handling operation
- a basic understanding of human capabilities
- identification of high risk activities and
- practical steps to reduce risk.

Consulting Employees

Employees, health and safety representatives, and safety committees should be encouraged to play a positive part in the assessment process. Consulting the employees and using their

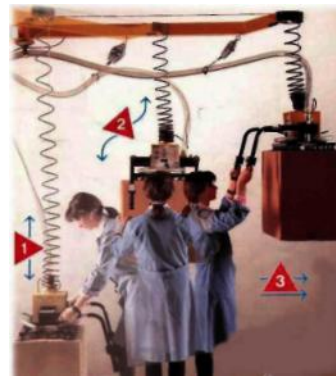
own experience of the type of work performed will often provide a valuable source of concerns, comments and suggestions.

Recording Assessments

The significant findings of the assessment should be recorded (unless the manual handling operations are straightforward, low risk, short duration or could easily be repeated and explained at any time). The record should be kept for as long as it remains relevant. The following template will help assessors to focus on these areas.

Risk Reduction

If it is not possible to eliminate manual handling tasks which involve a risk of injury, the risk assessment should result in recommendations to reduce the risk of injury.



Mechanical Assistance

Wherever possible manual handling should be replaced or reduced by the use of mechanical handling aids.

3.2.1 Common types of manual handling injury

Back Injury

The most common injury is to the back. Back injuries can be extremely painful, and if your job involves heavy manual labour, back injuries can damage your work prospects as well. You should have received training in lifting techniques such as ensuring that you adopt a good lifting posture, with slight bending of the back hips and knees, avoiding twisting and keeping the load close to the waist for as long as possible.

A worker received a back injury whilst manoeuvring a bouncy castle on his own. He was able to show that this was the common way that this task was carried out, i.e. without any help, despite a risk assessment showing that this should never be carried out alone.

Hernia Injury (Hernias)

Another common workplace injury is a hernia. These are often difficult to connect completely to work as they can be caused in a number of different ways such as a heavy workout at a gym for example. A hernia is a condition where there has been a rupture in muscle tissue causing part of the internal system to protrude. Anyone can get a hernia; hence the difficulty in proving that it has been caused by work. They can be caused by lifting pushing or pulling.

A school caretaker had a hernia which he was able to prove had been caused by lifting a heavy room divider to clean a floor. He was off work for 2 months and received compensation for the injury and the time off work. He was able to show that he should have received assistance to move the divider and could have been provided with an appropriate mechanical aid. The employer (in this case a local council) was found to be responsible.

Shoulder, Neck and Arm Injuries

These are also commonly caused as a result of the failure of safe manual handling techniques. A male worker tore tendons in his shoulder when he was asked to help move heavy equipment up some stairs which required him to lift it above head height. He had received insufficient training and the weights involved (and indeed the cramped working conditions) were all factors in his successful claim.

If you have received an injury which you feel has been caused because your employer has not paid any or any proper attention to the duties imposed when manually handling equipment then you should seek appropriate legal advice.

3.2.2 Assessment of manual handling risks

Load

To reduce the risk of the load:

- reduce the weight (this will increase the frequency of handling, but will reduce the stress placed on the body by each lift)
- provide handles, etc. where the size, surface texture, or nature of a load makes it difficult to grasp
- ensure loads in packages cannot move unexpectedly whilst being handled
- avoid sharp corners, jagged edges, rough surfaces, hot or extremely cold surfaces and
- provide information on the load, e.g. centre of gravity and weight.

Individual

The following should be considered:

- selection of employees for the task (sex, physical strengths, physique, state of health, level of training, hazards to pregnant women.)
- self pacing and
- PPE, e.g. gloves to protect against hot, cold or sharp surfaces.

The task

Where mechanical assistance cannot be provided there may be scope for changes to the layout of the task to reduce the risk of injury, e.g. by improving the flow of materials or products. An ergonomic approach to reduce the risk of the task includes:

- avoid lifting heavy loads while seated
- safe system of work
- job rotation
- team handling
- lift the load from waist height
- store lighter or less frequently used items above or below waist height
- change the layout to avoid bending, twisting, reaching and travel distances
- ensure workbenches are of uniform height
- avoid static postures and
- provide voluntary rest breaks to change the activity.

Environment

To reduce the risk from environmental factors:

- provide adequate space and headroom
- maintain good housekeeping standards to keep routes clear of spillages or obstacles, etc.
- provide adequate lighting
- provide and use level routes or use gentle slopes, etc.
- do not handle externally in poor, high wind, conditions and
- ensure a comfortable working environment, e.g. heating, ventilation, lighting, etc., to reduce the
- risks of muscle sprains and strains.

Information for Employees

Where tasks involve a risk of injury, employees should be provided with general information about the risks, precautions, safe systems of work and precise information on the:

- weight of each load and
- heaviest side of any load whose centre of gravity is not positioned centrally.

Training

Training alone is not effective to control risk. However, training programmes should include the following:

- how to recognise potentially hazardous loads how to deal with unfamiliar loads the proper use of handling aids
- the proper use of personal protective equipment, e.g. gloves, safety footwear, etc.
- features of the working environment that contribute to safe manual handling the importance of good housekeeping, e.g. keeping paths clear
- the factors affecting individual capacity and good handling techniques, e.g. kinetic handling.

3.2.3 Means of avoiding or minimising the risks from manual handling

One way to assess manual handling activities is to look at four specific areas – Task, Individual, Load and Environment (easily remembered by the acronym TILE).

As with any assessment, the workforce should be involved in the process, and use should be made of any relevant guidance available for particular industries.

Key factors to consider in each element are:

1. The Task Does the activity involve twisting, stooping, bending, excessive travel, pushing, pulling or precise positioning of the load, sudden movement, inadequate rest or recovery periods, team handling or seated work?

2. The Individual Does the individual require unusual strength or height for the activity, are they pregnant, disabled or suffering from a health problem. Is specialist knowledge or training required?

3. The Load Is the load heavy, unwieldy, difficult to grasp, sharp, hot, cold, difficult to grip, are the contents likely to move or shift?

4. The Environment Are there space constraints, uneven, slippery or unstable floors, variations in floor levels, extremely hot, cold or humid conditions, poor lighting, poor ventilation, gusty winds, clothing or Personal Protective Equipment that restricts movement?

3.2.4 Efficient movement principles for manually lifting loads to reduce risk of musculoskeletal disorders

As with any other risk, if you can eliminate or avoid the risks from manual handling, this is by far the best option. You should try to remove as many of the constraints as possible to reduce the risks to as low a level as reasonably practicable.

An ergonomic approach is recommended – look at how the task can be fitted to the individual.

Consider whether mechanical handling aids could be used, this could range from a simple trolley or sack truck to more sophisticated aids such as conveyors or fork lift trucks.

If you cannot eliminate or mechanise the manual handling tasks, you must carry out a risk assessment where the task could present a risk of injury. You need to look at ways to reduce the risks to as low a level as reasonably practicable.

Basic principles of manual handling

There are some basic principles that everyone should observe prior to carrying out a manual handling operation:

- ensure that the object is light enough to lift, is stable and unlikely to shift or move
- heavy or awkward loads should be moved using a handling aid
- make sure the route is clear of obstructions
- make sure there is somewhere to put the load down wherever it is to be moved to
- stand as close to the load as possible, and spread your feet to shoulder width
- bend your knees and try and keep the back's natural, upright posture
- grasp the load firmly as close to the body as you can
- use the legs to lift the load in a smooth motion as this offers more leverage reducing the strain on your back
- carry the load close to the body with the elbows tucked into the body

- avoid twisting the body as much as possible by turning your feet to position yourself with the load.

Guideline weights for lifting and lowering

The chart below gives guideline weights for lifting and lowering, which assumes that the handling is taking place in reasonable working conditions with a load that is easily grasped with both hands by a reasonably fit, well-trained individual.

No manual handling activity is completely safe. However, using these guidelines as part of a well thought out risk assessment will reduce the risks from manual handling activities.

Weights to be lifted may need to be reduced below the guideline values if there are environmental or other factors that could have an adverse effect on the activity or if it involves twisting or bending.

Similarly, if the task is being carried out frequently then weights should be reduced.

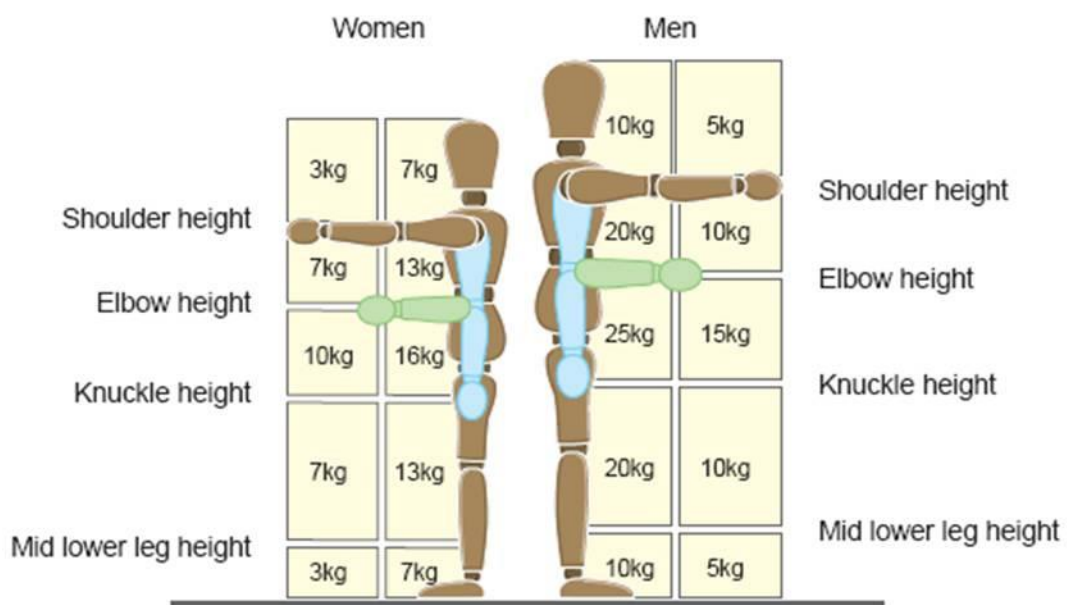


Figure – Manual handling chart

3.3 Manually operated load handling equipment

Kinetic handling is a good technique for lifting and moving loads. Although good manual handling technique is no substitute for other risk-reduction steps it forms a valuable

addition to other risk reduction methods. To be successful, good handling technique requires training and practice. The content of training in good handling technique should be tailored to particular tasks or situations.

Kinetic Handling Technique

1. assess the **load**
2. ensure that the **travel** route is clear and well lit
3. get as **close to the load** as possible
4. get a secure grip (wear gloves if necessary)
5. **position** feet apart, one foot flat to the floor at the side of the load, the other foot behind, with heel raised
6. keep the **back straight** - maintain the natural spinal curve by **lifting the head**
7. **bend the knees** - **lift** using the thigh muscles
8. keep the load **close to the body** – heaviest side to the trunk, **avoid jerking**, and make a smooth movement
9. **move the feet** - **avoid twisting** at the waist and
10. **put down**, then adjust – **slide** to desired position.

Good handling technique for lifting

There are some simple things to do before and during the lift/carry:

- Remove obstructions from the route.
- For a long lift, plan to rest the load midway on a table or bench to change grip.
- Keep the load close to the waist. The load should be kept close to the body for as long as possible while lifting.
- Keep the heaviest side of the load next to the body.
- Adopt a stable position and make sure your feet are apart, with one leg slightly forward to maintain balance

Think before lifting/handling. Plan the lift. Can handling aids be used? Where is the load going to be placed? Will help be needed with the load? Remove obstructions such as discarded wrapping materials. For a long lift, consider resting the load midway on a table or bench to change grip.

Adopt a stable position. The feet should be apart with one leg slightly forward to maintain balance (alongside the load, if it is on the ground). Be prepared to move your feet during the lift to maintain your stability. Avoid tight clothing or unsuitable footwear, which may make this difficult.

Get a good hold. Where possible, the load should be hugged as close as possible to the body. This may be better than gripping it tightly with hands only.

Start in a good posture. At the start of the lift, slight bending of the back, hips and knees is preferable to fully flexing the back (stooping) or fully flexing the hips and knees (squatting).

Don't flex the back any further while lifting. This can happen if the legs begin to straighten before starting to raise the load.

Keep the load close to the waist. Keep the load close to the body for as long as possible while lifting. Keep the heaviest side of the load next to the body. If a close approach to the load is not possible, try to slide it towards the body before attempting to lift it.

Avoid twisting the back or leaning sideways, especially while the back is bent. Shoulders should be kept level and facing in the same direction as the hips. Turning by moving the feet is better than twisting and lifting at the same time.

Keep the head up when handling. Look ahead, not down at the load, once it has been held securely.

Move smoothly. The load should not be jerked or snatched as this can make it harder to keep control and can increase the risk of injury.

Don't lift or handle more than can be easily managed. There is a difference between what people can lift and what they can safely lift. If in doubt, seek advice or get help.

Put down, then adjust. If precise positioning of the load is necessary, put it down first, then slide it into the desired position.

Duties of Employees

Employees should:

- follow safe systems of work provided
- use mechanical aids provided properly and
- follow manual handling training provided.

Review

Manual handling assessments should be made in the following circumstances:

- an accident or chronic ill-health, e.g. back strain, occurs
- where there is reason to suspect it is no longer valid

- where there has been a significant change in the manual handling task to which it relates and
- periodically.

3.4 Powered load handling equipment

Introduction

Lifting equipment is used extensively in organisations, from supermarkets to quarries. Fatalities and damage to buildings, etc. occur when lifting equipment fails due to incorrect erection, damage, lack of maintenance and poor planning. Lifting equipment includes:

1. Conveyors
2. Cranes
3. Hoists.

Conveyors

Conveyors are from supermarket checkout to quarries and construction sites.

There are 3 basic types of Conveyor and these are:-

Belt

Materials are transported on a moving belt. Trapping points are created between the belt and the rotating drum. The head and tails pulleys create the main risks. Guards can be fitted enclosing the sides or at each in-running nip.

Screw

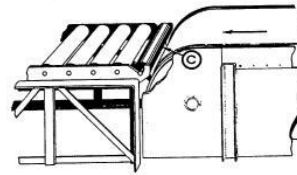
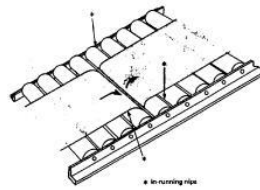
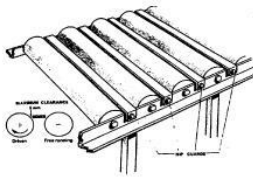
Materials are pushed forward by a rotating screw. Screw conveyors can cause terrible injuries and should be guarded or covered at all times. A locking-off system is required for maintenance and repairs.

Roller

The various types of rollers are:-

- a) *Power Driven Rollers*: guards are required on power drives and in-running nips.
- b) *Powered and Free Running Rollers*: guards are required between each pair of powered and free running rollers.

c) *Free Running Rollers*: no nips occur on these, but injuries can occur when people try to walk across them. This problem can be solved by providing walkways.



Hazards of Conveyors

- Trapping limbs can be drawn into in-running nips
- Contact with moving parts, for example, drive elements, screw conveyors
- Entanglement with roller, drive mechanisms
- Striking materials falling from heights, incorrectly handled
- Impact – e.g. striking head
- Items falling off
- Slips – fall into rollers
- Manual handling
- Noise

Hazards Control Measures

- Fixed guards on drums
- Enclosure of conveyed items by side guards
- Trip wires, if necessary, along the full length of the conveyor
- Emergency stop buttons
- Safe access at regular intervals
- Avoid loose clothing
- Restrict access
- Wearing head protection
- Regular maintenance by competent people

Cranes

Types of Crane

Cranes are used widely to move heavy equipment and materials within and outside workplaces and

construction sites. There are four main types of crane in regular use:

1. Mobile Cranes

2. Tower Cranes

3. Gantry Cranes

4. Overhead Cranes

Hazards

Cranes may fail for a number of reasons, e.g. collapse, overturn, breakage of lifting wire:

- unsuitable support or inadequate base for crane
- lack of maintenance and
- overloading.

Hazards associated with the operation of cranes include:

- contact, e.g. overhead electricity cables, other buildings, etc.
- incorrect positioning of crane, e.g. on soft ground, too far away from load
- improper methods of use of crane, e.g. use in high winds
- incorrect signals by the signaller (banksman)
- personnel working at or near the track of an overhead travelling crane
- limitations of height or reach on site
- ground bearing capacities, position of basements, underground services, weather conditions, etc.
- use and storage of fuel storage facilities and
- contact with persons below the lifting area.

In addition, the design of different types of crane may create specific hazards.

Mobile Cranes

These cranes generally incorporate telescopic booms and rotate through 360° on its chassis.

The

main hazard is overturning and it is essential that lifting takes place on solid ground and that the

mobile vehicle's outriggers are fully extended. As the boom moves out from the centre of gravity of

the crane so the load that can be lifted is reduced. Indicators within the cab warning of the load in

relation to the angle of the boom are required.

There are particular problems associated with mobile cranes and the following precautions should

be taken, although some of these are relevant to all types of cranes.

- Suitability of crane (lift capacity, reach etc.)
- Stable ground conditions
- Use of outriggers
- Avoidance of obstructions

- Overhead power lines
- Designated and protected area
- Suitable and tested lifting tackle
- Correct slinging techniques
- Competence of personnel
- Load near ground if travelling
- Good visibility and communications
- Monitoring of wind speeds

The principal hazards associated with any lifting operation using cranes are:-

- **Overturning** can be caused by weak support, operating outside the machine's capabilities and by striking obstructions (Not relevant to overhead gantry crane)
- **Overloading** by exceeding the operating capacity or operating radii, or by failure of safety devices
- **Collision** with other cranes, overhead cables or structures
- **Failure of Support** by placing over cellars and drains, outriggers not extended, made-up or not solid ground
- **Loss of Load** from failure of lifting tackle or slinging procedure
- *Failure of load Bearing Part*
- **High winds** can affect the stability of outdoor lifting operations

Tower Cranes

Accidents at tower cranes are caused by incorrect assembly of the crane and insufficient access to the jib, mast or driver's cab. Safe access to the crane is required for maintenance inspection, repair, erection and dismantling.

Hazards

Hazards associated with the use of tower cranes include:

- overturning, e.g. due to incorrect construction, swinging or unstable loads, operating outside the safe working radius
- overloading, e.g. collapse or bending of jib due to overloading or wear high wind conditions
- striking objects and people, e.g. impaired operator vision of the load and
- fall of persons and load.

Gantry Cranes

These are cranes that run on rails at ground level and are found in Docks and Container terminals.

Hazards

Hazards associated with gantry cranes include:

- overturning
- overloading
- striking objects and people, e.g. contact with crane wheels overhead, movement of loads in the vicinity of other workers and
- fall of persons and load.

Overhead Travelling Crane (GANTRY)

These cranes run along a fixed track above the workplace and the load can also be traversed from side to

side on rails which run along the crane beams. The main hazard is derailment due to overloading or

obstructions on the tracks and the absence of adequate stops at the end of the rails.

A large amount of accidents caused by OT cranes are attributed to striking personnel working on or near

the track. For this reason it is recommended that employers to take effective measures to

prevent a

crane approaching within 6 metres of any persons working on or near the track. The

measures to

be taken should be complete isolation and locking off of the electrical supply and a permit to work system.

Clear hand signals from Employees directing overhead cranes are essential for safe operation.

Hazards

Hazards associated with these types of crane include:

- overloading
- striking objects and people, e.g. restricted vision of load and travel,
- movement of loads in the vicinity of other workers
- electric shock to maintenance staff from exposed electrified rails (bus bars)
- unauthorised use by untrained personnel
- lack of maintenance and
- fall of load / persons

Precautions

Precautions for all four types of crane include:

Suitability of the Crane

Consideration will need to be given to the following factors when deciding which crane is most suitable for

the planned lift:

- weight of the load and the safe working load (SWL) of the crane
- the distance the load is away from the crane
- any wind loading that may occur
- size, shape and stability of the load
- distance to be moved
- stability or strength of the surface upon which it is going to be erected
- condition of a crane, e.g. wear
- condition of ground, e.g. on a slope, obstacles in path, etc. and
- whether it is a one-off or repeated lift.

Procedure for Safe Lifting

Prior to carrying out a lift it is necessary to assess the risks including materials, equipment, environment

and people, and develop and implement a safe lifting plan:

- use competent operators and ensure adequate training to plan the lift, drive, signal (banksman) and sling
- ensure good communication, visibility, and the use of standard hand signals or radii
- inform personnel about lift and keep area clear of other persons
- all personnel working with or near lifting equipment should wear safety helmets
- ensure the correct lifting accessories is used with the safe working load
- ensure the lifting accessories are free from defect
- ensure the weather conditions do not pose a risk, e.g. high winds, ice
- secure the load, inspect slings for damage
- ensure path is free of obstacles
- ensure the load is lifted vertically
- perform each part of the operation (lifting / slewing / moving and lowering) at a rate that maintains proper control
- during the lift ensure the load is: secure, balanced and controlled. Attach taglines where necessary
- avoid overhead power lines and
- ensure a safe position for landing, release the tension and then release the lifting tackle.

Other Considerations for Safe Lifting:

- pre-use inspections
- all lifting equipment should undergo thorough examination and test at regular intervals
- servicing, maintenance, testing, thorough examinations, etc. should be arranged as required before the crane is used on site
- ensure that overhead travelling cranes do not approach within 6m of persons working at or near the wheel track
- seek permission to conduct lifts over adjacent properties
- use purpose-made, tested stands to inspect the base of heavy loads
- if any lift, hoist, crane or excavator collapses or overturns on site or any load bearing part fails, it should be thoroughly investigated and, if local legislation requires, reported to the Enforcing Authorities as a dangerous occurrence
- cranes should be marked with their safe working load (SWL).

Hoists

Hoists are used extensively in the workplace and vary from the basic chain hoist often known as a block

and tackle to construction hoists used to carry material and people. There are also hoists which are designed to lift people in hospitals etc.

The Hazards of Hoists Are:-

- Failure of the chains, slings etc.
- Being struck by moving parts of the hoist
- Being hit by materials falling from the platforms
- Falling down the hoist way from a platform
- Striking against landing levels riding goods hoists

Precautions When Using Hoists

- Controls only operated from one position
- Clear visibility of landings
- Clear signals
- Secure objects being carried on goods hoists
- Do not overfill items being carried on goods lifts
- Do not carry loose items on goods lifts
- No passengers on goods lifts
- Safe working load clearly marked
- Hoist properly examined and tested

- Suitable fencing and gates at all levels
- Training in use of hoists

Lifting Accessories

Types of Lifting Accessory

Work equipment for attaching loads to machinery for lifting are often called lifting accessories or 'tackle'. It

includes any equipment used to connect a load to lifting equipment such as:

- lifting beams
- pulley blocks
- chain slings
- wire rope slings
- textile slings
- hooks
- rings
- shackles and
- eye bolts.

When Using Lifting Accessories the Main Hazards Are

- Overloading: - Using tackle of insufficient strength for the job. This can occur by simply picking up the wrong attachment or underestimating the load to be lifted
- Using Makeshift attachments:- All lifting accessories have to be tested after manufacture or repair
- Incorrect slinging arrangements:- Not properly attaching accessory e.g. to wide an angle on chain sling
- Damaged attachments. Chains can be deformed, cracked or stretched. Wire ropes can have broken wires or kinks and textile slings can be cut or abraded
- Uninspected attachments:- All lifting accessories should be inspected by a competent person every 6 months
- Damage to accessories during use:- This can mean not using padding at sharp corners leading to the accessory being damaged
- Failure to examine accessory before use
- Lack of training

Precaution When Using Accessories

- All accessories properly certificated and tested
- Properly inspected by a competent person at regular intervals
- Safe Working Load (SWL) clearly marked
- Inspection prior to use

- No repair to accessories on site
- Not used be used purposes not intended
- Packing between accessory and load
- Properly stored after use
- Training provide for staff in safe use

Lifting Equipment

Employers should ensure that all lifting equipment is:

- Sufficiently strong, stable and suitable for the proposed use. Similarly, the anchorage, load and anything attached (e.g. timber pallets, lifting points) should be suitable
- thoroughly examined by a competent person
 - after installation and before being put into service for the first time
 - after assembly and before being put into service at a new site or in a new location
 - at least every 12 months (6 months when used for lifting persons, and lifting accessories) or
 - in accordance with an examination scheme and
 - each time that exceptional circumstances, which are liable to jeopardise the safety of the lifting equipment, have occurred
- inspected by a competent person at suitable intervals between thorough examinations
- marked accordingly where it is used for lifting people and is safe for such a purpose, e.g. all
- necessary precautions have been taken to eliminate or reduce any risk
- visibly marked, with any appropriate information to be taken into account for its safe use, e.g. safe
- working loads. Accessories, e.g. slings, clamps, etc. should be similarly marked.

Following a thorough examination or inspection of any lifting equipment, a report is submitted by the competent person to the employer to take the appropriate action.

Lifting Operations

Employers should ensure that before any lifting operations are considered, the following precautions are undertaken:

- lifting operations are planned, supervised and carried out in a safe manner by people who are competent

- lifting equipment is positioned or installed to prevent the risk of injury, e.g. from the equipment or the load falling or striking people
- loads are not carried or suspended over areas occupied by persons. Where this is not practicable a safe system of work should be established to minimise the risks to persons who may need to be below the load
- where it is necessary to leave loads suspended, access to the danger zone is prevented, ensuring that the load has been secured properly
- if the operator of lifting equipment cannot observe the full path of the load, either directly or by means of auxiliary devices, the employer should ensure that a responsible person has appropriate means of communication to guide the operator.

The person planning the lifting operation should have adequate practical and theoretical knowledge and experience of planning lifting operations. The plan should address the risks identified by a risk assessment and identify the resources required, the procedures, and the responsibilities so that the operation is carried out safely.

Element 4 - Work equipment hazards and risk control

Learning outcomes

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

4.1 General requirements for work equipment

Work Equipment

Work equipment has been defined as:

Any machinery, appliance, apparatus, tool or installation for use at work.

The definition covers virtually every piece of equipment used at work from hammers to production lines.

4.1.1 Types of work equipment

Hand held tools

Work equipment includes hand tools and hand-held power tools. This section deals with hand tools. These tools need to be correct for the task, well maintained and properly used by trained people.

Five basic safety rules can help prevent hazards associated with the use of hand-held tools:

- keep all tools in good condition with regular maintenance;
- use the right tool for the job;
- examine each tool for damage before use and do not use damaged tools;
- use tools according to the manufacturer's instructions;
- provide and use properly the right personal protective equipment (PPE).

Hazards of hand tools

Hazards from the misuse or poor maintenance of hand tools include:

- broken handles on files/chisels/screwdrivers/hammers which can cause cut hands or hammer heads to fly off;
- incorrect use of knives, saws and chisels with hands getting injured in the path of the cutting edge;

- tools that slip causing stab wounds;
- poor-quality uncomfortable handles that damage hands;
- splayed spanners that slip and damage hands or faces;
- chipped or loose hammer heads that fly off or slip;
- incorrectly sharpened or blunt chisels or scissors that slip and cut hands. Dull tools can cause more injuries than sharp ones. Cracked saw blades must be removed from service;
- flying particles that damage eyes from breaking up stone or concrete;
- electrocution or burns by using incorrect or damaged tools for electrical work;
- use of poorly insulated tools for hot work in the catering or food industry;
- use of pipes or similar equipment as extension handles for a spanner which is likely to slip causing hand or face injury;
- mushroomed headed chisels or drifts which can damage hands or cause hammers (not suitable for chisels) and mallets to slip;
- use of spark-producing or percussion tools in flammable atmospheres;

Power tools

This section deals mainly with other physical hazards and safeguards relating to hand-held power tools.

The section covers, in particular, electric drills, sanders, and chainsaws which are commonly used in the workplace.

General hazards of hand-held power tools

The general hazards involve:

- mechanical entanglement in rotating spindles or sanding discs;
- waste material flying out of the cutting area;
- coming into contact with the cutting blades or drill bits;
- risk of hitting electrical, gas or water services when drilling into building surfaces;
- electrocution/electric shock from poorly maintained equipment and cables or cutting the electrical cable;
- manual handling problem with a risk of injury if the tool is heavy or very powerful;
- hand-arm vibration, especially with pneumatic drill and chainsaws, disc cutters and petrol-driven units;
- tripping hazard from trailing cables, hoses or power supplies;
- eye hazard from flying particles;
- injury from poorly secured or clamped work pieces;

- fire and explosion hazard with petrol-driven tools or when used near flammable liquids, explosive dusts or gases;
- high noise levels with pneumatic chisels, planes

Machinery

Most machinery has the potential to cause injury to people, and machinery accidents figure prominently in official accident statistics. These injuries may range in severity from a minor cut or bruise, through various degrees of wounding and disabling mutilation, to crushing, decapitation or other fatal injury. It is not solely powered machinery that is hazardous, for many manually-operated machines (e.g. hand-operated guillotines and fly presses) can still cause injury if not properly safeguarded.

Machinery movement basically consists of rotary, sliding or reciprocating action, or a combination of these. These movements may cause injury by entanglement, friction or abrasion, cutting, shearing, stabbing or puncture, impact, crushing, or by drawing a person into a position where one or more of these types of injury can occur. The hazards of machinery are set out in ISO 12100 Part 1:2003, which covers the classification of machinery hazards and how harm may occur. The following mechanical hazards follow this standard.

A person may be injured at machinery as a result of:

- a **crushing hazard** through being trapped between a moving part of a machine and a fixed structure, such as a wall or any material in a machine;
- a **shearing hazard** which shears part of the body, typically a hand or fingers, between moving and fixed parts of the machine, or between two or more moving parts;
- a **cutting or severing hazard** through contact with a cutting edge, such as a band saw or rotating cutting disc;
- an **entanglement hazard** with the machinery which grips loose clothing, hair or working material, such as emery paper, around revolving exposed parts of the machinery. The smaller the diameter of the revolving part, the easier it is to get a wrap or entanglement;
- a **drawing-in or trapping hazard** such as between in-running gear wheels or rollers or between belts and pulley drives;
- an **impact hazard** when a moving part directly strikes a person, such as with the accidental movement of a robot's working arm when maintenance is taking place;
- a **stabbing or puncture hazard** through ejection of particles from a machine or a sharp operating component like a needle on a sewing machine;
- contact with a **friction or abrasion hazard**, for example, on grinding wheels or sanding machines;

- a **high-pressure fluid injection (ejection hazard)**, for example, from a hydraulic system leak.

In practice, injury may involve several of these at once, for example, contact, followed by entanglement of clothing, followed by trapping.

4.1.2 Suitability as it relates to provision of equipment

Prior to using work equipment risk assessments need to be carried out to see that the work equipment is properly designed and is fit for the purpose for which it is to be used and it meets all relevant safety requirements. The employer should also ensure that it should only be used for the purpose for which it is intended.

- Work equipment should be constructed or adapted as to be suitable for the purpose for which it is provided taking into account the working conditions
- Work equipment should be properly maintained and if logs are required they are kept up to date
- Work equipment should be inspected after installation and before use and thereafter at regular intervals and after exceptional circumstances
- Where there is a specific risk, the use of work equipment should be restricted to specified people who should be adequately trained

As an example prior to installing new machinery in the workplace the factors we need to consider are:

- What are the hazards? i.e.
 - Are there heat or cold problems?
 - Chemicals
 - Biological
- Is it suitably guarded?
- The location of the equipment
- Is it capable of being isolated / locking off?
- Is there safe access and egress?
- Are personnel trained and competent?
- Any other specific risks?

Safe Operation of Work Equipment

To ensure that operation of work equipment e.g. machinery is as safe as possible a number of factors may have to be considered such as:

- The equipment should have appropriate protection against risks to employees from failure of or in work equipment. This includes risk of ejection of parts or fire and explosion
- Measures should be taken by employers to ensure that people do not come into contact with work equipment and the materials therein likely to burn or scald
- Clear layout of controls, e.g. for starting, or making a change in operating conditions and readily identifiable and readily accessible emergency stops
- All work equipment should be provided with means to isolate it from its source of energy
- Work equipment should be sufficiently stable to avoid risks to health or safety
- Places where work equipment is used should be adequately lit by appropriate means in line with the work to be carried out
- It should be possible to carry out maintenance operations while the work equipment is stopped. If this is not possible then other protective measures should be taken
- Work equipment should have the appropriate markings for purposes of health and safety
- Work equipment should have appropriate warnings or warning devices for purposes of health and safety.

4.1.3 Prevention of access to dangerous parts of machinery

(a) Guarding

The exposed moving parts of power tools need to be safeguarded. Belts, gears, shafts, pulleys, sprockets, spindles, drums, flywheels, chains or other reciprocating, rotating or moving parts of equipment must be guarded. Machine guards, as appropriate, must be provided to protect the operator and others from the following:

- point of operation;
- drawing running nip points;
- rotating parts;
- flying chips and sparks.

Safety guards must never be removed when a tool is being used. Portable circular saws, for example, must be equipped at all times with guards. An upper guard must cover the entire blade of the saw. A retractable lower guard must cover the teeth of the saw, except where it makes contact with the work material. The lower guard must automatically return to the covering position when the tool is withdrawn from the work material.

(b) Operating controls and switches

Most hand-held power tools should be equipped with a constant-pressure switch or control that shuts off the power when pressure is released. On/off switches should be easily accessible without removing hands from the equipment.

Handles should be designed to protect operators from excessive vibration and keep their hands away from danger areas. In some cases handles are also designed to activate a brake of the cutting chain or blade, for example in a chainsaw. Equipment should be designed to reduce lifting and manual handling problems, with special harnesses being used as necessary, for example when using large strimmers.

(c) Safe operations/instructions

When using power tools, the following basic safety measures should be observed to protect against electrical shock, personal injury, ill-health and risk of fire. Operators should read these instructions before using the equipment and ensure that they are followed:

- maintain a clean and tidy working area that is well lit and clear of obstructions;
- never expose power tools to rain. Do not use power tools in damp or wet surroundings;
- do not use power tools in the vicinity of combustible fluids, dusts or gases unless they are specially protected and certified for use in these areas;
- protect against electric shock (if tools are electrically powered) by avoiding body contact with grounded objects such as pipes, scaffolds and metal ladders (see Chapter 14 for more electrical safety precautions);
- keep children away;
- do not let other persons handle the tool or the cable. Keep them away from the working area;
- store tools in a safe place when not in use where they are in a dry, locked area which is inaccessible to children;
- tools should not be overloaded as they operate better and more safely in the performance range for which they were intended;
- use the right tool. Do not use small tools or attachments for heavy work. Do not use tools for purposes and tasks for which they were not intended;
- for example, do not use a hand-held circular saw to cut down trees or cut off branches;
- wear suitable work clothes. Do not wear loose-fitting clothing or jewellery. They can get entangled in moving parts. For outdoor work, rubber gloves and non-skid footwear are recommended. Long hair should be protected with a hair net;
- use safety glasses;

4.1.4 The need to restrict the use and maintenance of equipment with specific risks

Isolation, cleaning, adjustment and lubrication should be addressed at the design stages. Maintenance of machinery after breakdown which is a major cause of accidents needs to be considered.

Some pieces of work equipment involve specific risks to health and safety where it is not possible to control adequately the hazards by physical measures alone, for example the use of a bench-mounted circular saw or an abrasive wheel. In all cases the hierarchy of controls should be adopted to reduce the risks by, eliminating the risks; or, if this is not possible:

- taking physical measures to control the risks such as guards, but if the risks cannot be adequately controlled;
- taking appropriate software measures, such as a safe system of work.

The use of such equipment should be restricted to the persons designated to use it. These people need to have received sufficient information, instruction and training so that they can carry out the work using the equipment safely. Use is normally restricted to persons over 18 years old but this may vary across different national jurisdictions.

Repairs, modifications, maintenance or servicing is also restricted to designated persons. A designated person may be the operator if he/she has the necessary skills and has received specific instruction and training. Another person specifically trained to carry out a particular maintenance task, for example dressing an abrasive wheel, may not be the operator but may be designated to do this type of servicing task on a range of machines.

4.1.5 Extent of information, instruction and training to be provided in relation to specific risks and persons at risk

Those who use work equipment should have available to them adequate health and safety information and where appropriate, written instructions relevant to the work equipment.

This may include:-

- The conditions in which and the methods by which the work equipment may be used.
- Any foreseeable abnormal situations and actions to be taken
- Any conclusions to be drawn from experience in using the equipment

It is essential that this information is made available to those who supervise or manage the use of work equipment so that they fully understand the risks and procedures to prevent them.

Training

All users of work equipment should receive adequate training for purposes of health and safety including training in the method to be adopted when using the equipment. Also training in any foreseeable risks and the precautions to be taken.

Supervisors of people using work equipment should be given adequate health and safety training on work equipment including training in the method to be adopted when using the equipment. Training should also include training in any foreseeable risks and what appropriate precautions are to be taken.

There may also be training required for specialised work such as the use of chainsaws. Training and proper supervision of young person's is particularly important because of their relative immaturity and unfamiliarity with the working environment.

Training needs are likely to be greatest on recruitment but training may be required if:-

- The risks to which people are exposed change due to a change in their working tasks
- New technology or equipment is introduced
- The system of work changes

Refresher training should be provided if necessary.

Responsibility of Users

The users of work equipment should not put themselves or others at risk because of their actions or omissions. They should use any safe system of work and precautions provided for them, e.g. machine guards, eye protection, ear protectors, and immediately report any problems with the equipment to their employer.

Statutory Examination

In many Countries some specified work equipment often requires statutory inspection by a competent person (usually an insurance company). The table below gives examples of some common work equipment with example inspection frequencies that are required in the United Kingdom.

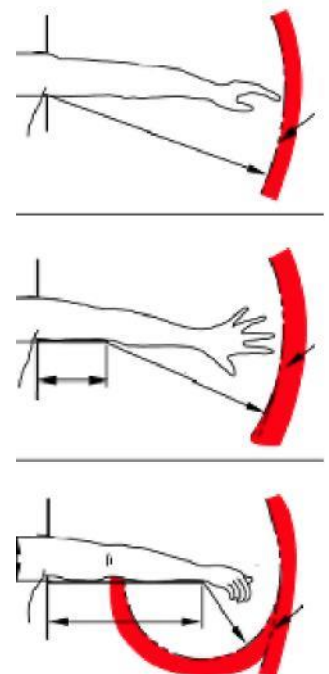
Equipment	Inspections of	Frequency
Cranes, hoists and lifting equipment	All equipment used for lifting people and lifting accessories.	6 months
	Other lifting equipment.	12 months
Pressure systems	Steam plant (boilers).	14 months
	Steam receivers.	26-38 months
	Air receivers.	24-48 months
Power presses	Fixed guards.	12 months
	Other guards.	6 months
	Inspection of guards and protective devices during work.	4 hourly

The Safeguarding Of Machinery

Safety may be achieved by use of the many types of guard available, the selection depending on the dangers from which personnel must be protected.

All guards and protection devices shall be:

- Suitable for the purpose for which they are provided
- Of good construction, sound material and adequate strength
- maintained in an efficient state and working order and in good repair
- Not give rise to any increased risk to health or safety
- Not be easily bypassed or disabled
- Be situated at sufficient distance from the danger zone
- Not unduly restrict the view of the operating cycle of the machinery, where such a view is necessary
- Remove the possibility of any part of a worker's body accidentally coming into contact with such parts.
- Be compatible with the process, e.g. resistant to dust, chemical, etc.;
- Allows maintenance without removing the guard, e.g. by provision of lubrication / greasing points outside the guard;

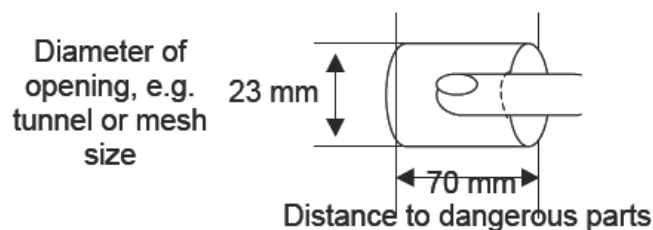


Minimum (safe reach) Distances for Fixed Guards

The aim of minimum reach distances is that no part of the body can reach the hazard. The distances are determined by anthropometric tables, (i.e. measurements of parts of the body such as the length and thickness of fingers and arms). The distances are statistically calculated so that 99.9% of the working population would be safe at the given distance.

The safe distance is determined from the start of entry / exit, e.g. a tunnel guard, to the position of the dangerous moving parts. In the case of mesh or slatted guards the distance of the guard from the hazard depends on the size of the gap.

Figure: Example of Safety Distance



To prevent machinery accidents the following areas should be considered:

Machinery Design

If the machine can be designed in a way to remove all causes of danger it should be. Where this is not practicable dangerous parts should be made inaccessible. All moving parts of the machine should be enclosed where possible. To reduce manual handling the use of automatic feeds and ejection systems should be considered.

Controls

Thought should be given to control layout for ease of operation, positioning correctly, type of switch or button used, shrouded or unshrouded. There should be a direct link between controls and machinery operation (left button to move machine left). Switches should be easily distinguishable by the size, feel or colour.

Failure to Safety

If failure occurs care should be taken to ensure the machine comes to a rest in a safe condition. Such devices should include; arrester devices to halt movement after failure, latches, failsafe limit switches, etc.

4.1.6 The need for equipment to be maintained and for maintenance to be conducted safely

Maintenance and inspection

Work equipment needs to be correctly maintained so that it continues to operate safely and in the way it was designed to perform. The amount of maintenance will be stipulated in the manufacturer's instructions and will depend on the amount of use, the working environment and the type of equipment. High-speed, high-risk machines, which are heavily used in an adverse environment like salt water, may require very frequent maintenance, whereas a simple hand tool, like a shovel, may require very little (Figure 11.5).

Maintenance management schemes can be based around a number of techniques designed to focus on those parts which deteriorate and need to be maintained to prevent health and safety risks. These techniques include the following types of maintenance:

- **Preventative planned maintenance** - this involves replacing parts and consumables or making necessary adjustments at preset intervals normally set by the manufacturer, so that there are no hazards created by component deterioration or failure. Vehicles are normally maintained on this basis.
- **Condition-based maintenance** - this involves monitoring the condition of critical parts and carrying out maintenance whenever necessary to avoid hazards which could otherwise occur.
- **Breakdown-based maintenance** - here maintenance is only carried out when faults or failures have occurred. This is only acceptable if the failure does not present an immediate hazard and can be corrected before the risk is increased. If, for example, a bearing overheating can be detected by a monitoring device, it is acceptable to wait for the overheating to occur as long as the equipment can be stopped and repairs carried out before the fault becomes dangerous to persons employed.

In the context of health and safety, maintenance is not concerned with operational efficiency but only with avoiding risks to people. It is essential to ensure that maintenance work can be carried out safely. This will involve the following:

- competent, well-trained maintenance people; the equipment being made safe for the maintenance work to be carried out. In many cases, the normal safeguards for operating the equipment may not be sufficient as maintenance sometimes involves going inside guards to observe and subsequently adjust, lubricate or repair the equipment. Careful design that allows adjustments, lubrication and observation from outside the guards, for example, can often eliminate the hazard. Making equipment safe will usually involve disconnecting the power supply and then preventing anything moving, falling or starting during the work. It may also involve waiting for equipment to cool down or warm up to room temperature;
- a safe system of work being used to carry out the necessary procedures to make and keep the equipment safe and perform the maintenance tasks. This can often involve

a formal 'permit-to-work' scheme to ensure that the correct sequence of safety critical tasks has been performed and all necessary precautions taken;

- correct tools and safety equipment being available to perform the maintenance work without risks to people. For example special lighting or ventilation may be required.

Inspection of high-risk equipment

Complex equipment and/or high-risk equipment will probably need a maintenance log and may require a more rigid inspection regime to ensure continued safe operation. This is covered by the Provision and Use of Work Equipment Regulations (PUWER) 98, Regulation 6.

PUWER requires, where safety is dependent on the installation conditions and/or the work equipment is exposed to conditions causing deterioration, which may result in a significant risk and a dangerous situation developing, that the equipment is inspected by a competent person. In this case the competent person would normally be an employee, but there might be circumstances where an outside competent person would be used.

The inspection must be done:

- after installation for the first time;
- after assembly at a new site or in a new location and thereafter;
- at suitable intervals;
- each time exceptional circumstances occur which could affect safety.

The inspection under PUWER will vary from a simple visual inspection to a detailed comprehensive inspection, which may include some dismantling and/or testing. The level of inspection required would normally be less rigorous and intrusive than thorough examinations under the Lifting Operations and Lifting Equipment Regulations 1998 (LOLER) for certain lifting equipment. In the case of boilers and air receivers the inspection is covered by the Pressure Systems Safety Regulations 2000, which involves a thorough examination. The inspection under PUWER would only be needed in these cases if the examinations did not cover all the significant health and safety risks that are likely to arise.

4.1.7 Importance of operation and emergency controls, stability, lighting, markings and warnings, clear unobstructed workspace

To operate work equipment safely it must be fitted with easily reached and operated controls, kept stable, properly lit, kept clear and provided with adequate markings and warning signs. These are covered by ISO 12100 Part 2, which applies to all types of machinery.

Controls

Equipment should be provided with efficient means of:

- starting or making a significant change in operating conditions;
- stopping in normal circumstances;
- emergency stopping as necessary to prevent danger.

All controls should be well positioned, clearly visible and identifiable, so that it is easy for the operator to know what each control does. Markings should be clearly visible and remain so under the conditions met at the workplace.

(a) Start controls

It should only be possible to start the work equipment by using the designed start control. Equipment may well have a start sequence which is electronically controlled to meet certain conditions before starting can be achieved, for example preheating a diesel engine, or purge cycle for gas-fed equipment. Restarting after a stoppage will require the same sequence to be performed.

Stoppage may have been deliberate or as a result of opening an interlocked guard or tripping a switch accidentally. In most cases it should not be possible to restart the equipment simply by shutting the guard or resetting the trip. Operation of the start control should be required.

Any other change to the operating conditions such as speed, pressure or temperature should only be done by using a control designed for the purpose.

(b) Stop controls

The action of normal stopping controls should bring the equipment to a safe condition in a safe manner. In some cases immediate stopping may cause other risks to occur. The stop controls do not have to be instantaneous and can bring the equipment to rest in a safe

sequence or at the end of an operating cycle. It is only the parts necessary for safety, that is, accessible dangerous parts, that have to be stopped. So, for example, suitably guarded cooling fans may need to run continuously and be left on.

In some cases where there is, for example, stored energy in hydraulic systems, it may be necessary to insert physical scotches to prevent movement and/or to exhaust residual hydraulic pressure. These should be incorporated into the stopping cycle, which should be designed to dissipate or isolate all stored energy to prevent danger.

It should not be possible to reach dangerous parts of the equipment until it has come to a safe condition, e.g. stopped, cooled, electrically safe.

(c) Emergency stop controls

Emergency stop must be provided where the other safeguards in place are not sufficient to prevent danger to operatives and any other persons who may be affected. Where appropriate, there should be an emergency stop at each control point and at other locations around the equipment so that action can be taken quickly. Emergency stops should bring the equipment to a halt rapidly but this should be controlled where necessary so as not to create any additional hazards. Crash shutdowns of complex systems have to be carefully designed to optimize safety without causing additional risks.

Emergency stops are not a substitute for effective guarding of dangerous parts of equipment and should not be used for normal stopping of the equipment.

Emergency stop buttons should be easily identified, reached and operated. Common types are mushroom-headed buttons, bars, levers, kick-plates or pressure-sensitive cables. They are normally red and should need to be reset after use. With stop buttons this is either by twisting or a security key.

Mobile work equipment is normally provided with effective means of stopping the engine or power source. In some cases large equipment may need emergency stop controls away from the operator's position.



Figure – Emergency stop buttons

(d) Isolation of equipment

Equipment should be provided with efficient means of isolating it from all sources of energy. The purpose is to make the equipment safe under particular conditions, for example when maintenance is to be carried out or where adverse weather conditions may make it unsafe to use. On static equipment isolation will usually be for mains electrical energy; however, in some cases there may be additional or alternative sources of energy. The isolation should cover all sources of energy such as diesel and petrol engines, LPG, steam, compressed air, hydraulics, batteries and heat. In some cases special consideration is necessary where, for example, hydraulic pumps are switched off, so as not to allow heavy pieces of equipment to fall due to gravity. An example would be the loading shovel on an excavator.

Stability and lighting

Stability is important and is normally achieved by bolting equipment in place or, if this is not possible, by using clamps. Some equipment can be tied down, counterbalanced or weighted, so that it remains stable under all operating conditions. If portable equipment is weighted or counterbalanced, it should be reappraised when the equipment is moved to another position. If outriggers are needed for stability in certain conditions, for example to stabilise mobile access towers, they should be employed whenever conditions warrant the additional support. In severe weather conditions it may be necessary to stop using the equipment or reappraise the situation to ensure stability is maintained.

The quality of general and local lighting will need to be considered to ensure the safe operation of the equipment. The level of lighting and its position relative to the working

area are often critical to the safe use of work equipment. Poor levels of lighting, glare and shadows can be dangerous when operating equipment. Some types of lighting, for example sodium lights, can change the colour of equipment, which may increase the level of risk. This is particularly important if the colour coding of pipe work or cables is essential for safety.

Markings and warnings

Markings on equipment must be clearly visible and durable. They should follow international conventions for some hazards like radiation and lasers and, as far as possible, conform to the ISO 7010:2003, Graphical symbols: Safety colours and safety signs - Safety signs used in workplaces and public areas. The contents, or the hazards of the contents, as well as controls, will need to be marked on some equipment.

There are many circumstances in which marking of equipment is appropriate for health or safety reasons. Stop and start controls for equipment need to be identified. The maximum rotation speed of an abrasive wheel should be marked upon it. The maximum safe working load (rated capacity) should be marked on lifting equipment. Gas cylinders should indicate (normally by colour) the gas in them. Storage and feed vessels containing hazardous substances should be marked to show their contents, and any hazard associated with them. Pipework for water and compressed air and other mains services should be colour-coded to indicate contents.

Any other marking that might be appropriate for the users own purposes should be considered, for example numbering machines to aid identification, particularly if the controls or isolators for the machines are not directly attached to them and there could otherwise be confusion.

Warnings or warning devices may be appropriate where risks to health or safety remain after other hardware measures have been taken. They may be incorporated into systems of work (including permit-to-work systems), and can enforce measures of information, instruction and training. A warning is normally in the form of a notice or similar. Examples are positive instructions ('hard hats must be worn'), prohibitions ('not to be operated by people under 18 years'), restrictions ('do not heat above 60 °C). A warning device is an active unit giving a signal; the signal may typically be visible or audible, and is often connected into equipment so that it is active only when a hazard exists.

Warning devices can be:

- (a) audible, for example reversing alarms on construction vehicles;
- (b) visible, for example a light on a control panel that a fan on a microbiological cabinet has

- broken down or a blockage has occurred on a particular machine;
- (c) an indication of imminent danger, for example machine about to start, or development of a fault condition (i.e. pump failure or conveyor blockage indicator on a control panel);
or
- (d) the continued presence of a potential hazard (for example, hotplate or laser on).

Work space and operating stations

The controls at a machine should be so designed and positioned that an operative has adequate vision for control of the process being carried out. The operator should have adequate clear space in their working position and have all controls within comfortable reach. Where operatives have to stand or sit to operate, machinery platforms or seats should be provided that are situated so that they are protected from dangerous parts of the machine.

Machinery shall bear all markings which are necessary:

- (a) for its unambiguous identification, at least:
- name and address of the manufacturer;
 - designation of series or type;
 - serial number, if any;
- (b) in order to indicate its compliance with mandatory requirements:
- marking;
 - written indications (e.g. for machines intended for use in potentially explosive atmosphere);
- (c) for its safe use, e.g.:
- maximum speed of rotating parts;
 - maximum diameter of tools;
 - mass (expressed in kilograms) of the machine itself and/or of removable parts;
 - maximum working load;
 - necessity of wearing personal protective equipment;
 - guard adjustment data;
 - frequency of inspection.

Information printed directly on the machine should be permanent and remain legible throughout the expected life of the machine. Signs or written warnings only saying 'danger' shall not be used.

Markings, signs and written warnings shall be readily understandable and unambiguous, especially as regards the part of the function(s) of the machine which they are related to. Readily understandable signs (pictograms) should be used in preference to written warnings.

Signs and pictograms should only be used if they are understood in the culture in which the machinery is to be used.

Written warnings shall be drawn up in the language(s) of the country in which the machine will be used for the first time and, on request, in the language(s) understood by operators.

Where work platforms are used, they should be designed to prevent slipping and should be large enough and provide a level standing space. Suitable guard rails and access steps/bridges should be provided where needed.

4.1.8 Responsibilities of users

Under the ILO code of practice workers have the duty, in accordance with their training, the instructions and the means given by their employers:

- (a) to comply with prescribed safety and health measures;
- (b) to take all reasonable steps to eliminate or control hazards or risks to themselves and to others from hazardous ambient factors at work, including proper care and use of protective clothing, facilities and equipment placed at their disposal for this purpose;
- (c) to report forthwith to their immediate supervisor any situation which they believe could present a hazard or risk to their safety and health or that of other persons arising from hazardous ambient factors at work, and which they cannot properly deal with themselves;
- (d) to co-operate with the employer and other workers to permit compliance with the duties and responsibilities placed on the employer and workers pursuant to national laws and regulations.

It is not always possible to eliminate every hazard or design safeguards that protect people against all machinery hazards, particularly during commissioning, setting, adjustment cleaning and maintenance. Safe working practices, in some cases even permits-to work need to be adopted and followed by machinery operators or maintenance staff. These should be considered at the machine design and installation stages as the production of special jigs, fixtures, controls and isolation facilities may be needed.

Where mechanical hazards cannot be avoided there are many precautions which should be observed by properly trained and supervised people, these include:

- keeping the area around the machine clear and free of obstructions,
- wearing suitable clothing and footwear that does not have loose ends which could become entangled;
- avoiding the use of neckties, rings, necklaces and other jewellery;
- appropriate eye protection where there is a risk of particles being ejected;
- using precautions against kickback of work pieces such as riving knives on circular saws, work rests on abrasive wheels, cutting speeds are correct for the task and cutting tool;
- taking precautions against bursting of abrasive wheels by ensuring they are not damaged and are running within their design speed; limiting closeness of approach to machines like overhead cranes, or removing work from the rear of circular saws;
- using manual handling devices such as tongs for hot steel handling or push sticks for pushing timber through a circular saw; using jigs or holders for work pieces.

4.2 Hazards and control of hand-held tools

4.2.1 Hazards and misuse of hand held tools whether powered or not; requirements for safe use, condition and fitness for use, suitable for purpose and location to be used in (e.g. flammable atmosphere)

Hazards from the misuse or poor maintenance of hand tools include:

- broken handles on files/chisels/screwdrivers/hammers which can cause cut hands or hammer heads to fly off;
- incorrect use of knives, saws and chisels with hands getting injured in the path of the cutting edge;
- tools that slip causing stab wounds;
- poor-quality uncomfortable handles that damage hands;
- splayed spanners that slip and damage hands or faces;
- chipped or loose hammer heads that fly off or slip;
- incorrectly sharpened or blunt chisels or scissors that slip and cut hands. Dull tools can cause more injuries than sharp ones. Cracked saw blades must be removed from service;
- flying particles that damage eyes from breaking up stone or concrete;
- electrocution or burns by using incorrect or damaged tools for electrical work;

- use of poorly insulated tools for hot work in the catering or food industry;
- use of pipes or similar equipment as extension handles for a spanner which is likely to slip causing hand or face injury;
- mushroomed headed chisels or drifts which can damage hands or cause hammers (not suitable for chisels) and mallets to slip;
- use of spark-producing or percussion tools in flammable atmospheres;

Hand tools safety considerations

Use of hand tools should be properly controlled including those tools owned by employees. The following controls are important.

Suitability

All tools should be suitable for the purpose and location in which they are to be used. Using the correct tool for the job is the first step in safe hand tool use. Tools are designed for specific needs. That is why screwdrivers have various lengths and tip styles and pliers have different head shapes. Using any tool inappropriately is a step in the wrong direction. To avoid personal injury and tool damage, select the proper tool to do the job well and safely.

High-quality professional hand tools will last many years if they are taken care of and treated with respect. Manufacturers design tools for specific applications. Use tools only for their intended purpose.

Suitability will include:

- specially protected and insulated tools for electricians;
- non-sparking tools for flammable atmospheres and the use of non-percussion tools and cold cutting methods;
- tools made of suitable quality materials which will not chip or splinter in normal use;
- the correct tools for the job, for example using the right-sized spanner and the use of mallets not hammers on chisel heads. The wooden handles of tools must not be splintered;
- safety knives with enclosed blades for regular cutting operations;
- impact tools such as drift pins, wedges and cold-chisels being kept free of mushroomed heads;
- spanners not being used when jaws are sprung to the point that slippage occurs.

4.2.2 Hazards of portable power tools

The general hazards involve:

- mechanical entanglement in rotating spindles or sanding discs;
- waste material flying out of the cutting area;
- coming into contact with the cutting blades or drill bits;

- risk of hitting electrical, gas or water services when drilling into building surfaces;
- electrocution/electric shock from poorly maintained equipment and cables or cutting the electrical cable;
- manual handling problem with a risk of injury if the tool is heavy or very powerful;
- hand-arm vibration, especially with pneumatic drill and chainsaws, disc cutters and petrol-driven units;
- tripping hazard from trailing cables, hoses or power supplies;
- eye hazard from flying particles;
- injury from poorly secured or clamped work pieces;
- fire and explosion hazard with petrol-driven tools or
- when used near flammable liquids, explosive dusts or gases;
- high noise levels with pneumatic chisels, planes and
- saws in particular ;
- dust and fumes given off during the use of the tools levels

Typical safety controls and instructions

(a) Guarding

The exposed moving parts of power tools need to be safeguarded. Belts, gears, shafts, pulleys, sprockets, spindles, drums, flywheels, chains or other reciprocating, rotating or moving parts of equipment must be guarded. Machine guards, as appropriate, must be provided to protect the operator and others from the following:

- point of operation;
- drawing running nip points;
- rotating parts;
- flying chips and sparks.

Safety guards must never be removed when a tool is being used. Portable circular saws, for example, must be equipped at all times with guards. An upper guard must cover the entire blade of the saw. A retractable lower guard must cover the teeth of the saw, except where it makes contact with the work material. The lower guard must automatically return to the covering position when the tool is withdrawn from the work material.

(b) Operating controls and switches

Most hand-held power tools should be equipped with a constant-pressure switch or control that shuts off the power when pressure is released. On/off switches should be easily accessible without removing hands from the equipment.

Handles should be designed to protect operators from excessive vibration and keep their hands away from danger areas. In some cases handles are also designed to activate a brake of the cutting chain or blade, for example in a chainsaw. Equipment should be designed to reduce lifting and manual handling problems, with special harnesses being used as necessary, for example when using large strimmers.

Means of starting engines and holding equipment should be designed to minimize any musculoskeletal problems.

(c) Safe operations/instructions

When using power tools, the following basic safety measures should be observed to protect against electrical shock, personal injury, ill-health and risk of fire. Operators should read these instructions before using the equipment and ensure that they are followed:

- maintain a clean and tidy working area that is well lit and clear of obstructions;
- never expose power tools to rain. Do not use power tools in damp or wet surroundings;
- do not use power tools in the vicinity of combustible fluids, dusts or gases unless they are specially protected and certified for use in these areas;
- protect against electric shock (if tools are electrically powered) by avoiding body contact with grounded objects such as pipes, scaffolds and metal ladders;
- keep children away;
- do not let other persons handle the tool or the cable. Keep them away from the working area;
- store tools in a safe place when not in use where they are in a dry, locked area which is inaccessible to children;
- tools should not be overloaded as they operate better and more safely in the performance range for which they were intended;
- use the right tool. Do not use small tools or attachments for heavy work. Do not use tools for purposes and tasks for which they were not intended; for example, do not use a hand-held circular saw to cut down trees or cut off branches;
- wear suitable work clothes. Do not wear loose-fitting clothing or jewellery. They can get entangled in moving parts. For outdoor work, rubber gloves and non-skid footwear are recommended. Long hair should be protected with a hair net;
- use safety glasses;
- also use filtering respirator mask for work that generates dust;

- do not abuse the power cable;
- do not carry the tool by the power cable and do not use the cable to pull the plug out of the power socket. Protect the cable from heat, oil and sharp edges;
- secure the work-piece. Use clamps or a vice to hold the work-piece. It is safer than using hands and it frees both hands for operating the tool;
- do not overreach the work area. Avoid abnormal body postures. Maintain a safe stance and maintain a proper balance at all times;
- maintain tools with care. Keep your tools clean and sharp for efficient and safe work. Follow the maintenance regulations and instructions for the changing of tools. Check the plug and cable regularly and in the case of damage, have them repaired by a qualified service engineer. Also inspect extension cables regularly and replace if damaged;
- keep the handle dry and free of oil or grease;
- disconnect the power plug when not in use, before servicing and when changing the tool, that is blade, bits, cutter, sanding disc, etc;
- do not forget to remove the key. Check before switching on that the key and any tools for adjustment are removed;
- avoid unintentional switch-on. Do not carry tools that are connected to power with your finger on the power switch. Check that the switch is turned off before connecting the power cable;
- when working outdoors, use extension cables, and only those which are intended for such use and marked accordingly;
- stay alert, keep eyes on the work. Use common sense. Do not operate tools when there are significant distractions;
- check the equipment for damage. Before further use of a tool, check carefully the protection devices or lightly damaged parts for proper operation and performance of their intended functions. Check movable parts for proper function, for whether there is binding or for damaged parts. All parts must be correctly mounted and meet all conditions necessary to ensure proper operation of the equipment;
- damaged protection devices and parts should be repaired or replaced by a competent service centre unless otherwise stated in the operating instructions. Damaged switches must be replaced by a competent service centre. Do not use any tool which cannot be turned on and off with the switch;

Electric drills

Hazards are:

- entanglement, particularly of loose clothing or long hair in rotating drill bits;
- high noise levels from the drill or attachment;

- eye injury from flying particles and chips, particularly from chisels;
- injury from poorly secured work-pieces;
- electrocution/electric shock from poorly maintained equipment;
- electric shock from drilling into a live hidden cable;
- hand-arm vibration hazard in hammer mode;
- dust given off from material being worked on;
- tripping hazard from trailing cables;
- upper limb disorder from powerful machines with a strong torque, particularly if they jam and kick back;
- foot injury hazards from dropping heavy units onto unprotected feet;
- manual handling hazards, particularly with heavy machines and intensive use or using at awkward heights and/or reaches;
- fire and explosion hazard when used near flammable liquids, explosive dusts or gases;
- using equipment in poor weather conditions with **wet**, slippery surfaces, poor visibility and **cold** conditions.

Sanders

There is a large range of hand-held sanders on the market, from rotating discs, random orbital, rectangular orbital, belt sanders and heavy-duty floor sanders of both the rotating drum and, recently, the orbital floor sander. The high-speed rotating discs and drum types are the most hazardous but they all need using with care. Hazards include:

- high noise levels from the sander in operation;
- injury from poorly secured work-pieces;
- electrocution/electric shock from poorly maintained electrical equipment;
- potential of entanglement with rotating disc and drum sanders;
- sanding attachments can become loose in the chuck and fling off;
- injury from contact with abrasive surfaces, particularly with course abrasives and high-speed rotating sanding discs and drums;
- hand-arm vibration hazard, particularly from reciprocating equipment;
- health hazards from extensive dust given off from material being worked on;
- fire and health hazards from overheating of abraded surfaces, particularly if plastics are being sanded;
- tripping hazard from trailing cables;
- large powerful sanders suddenly gripping the surface and pulling the operative off their feet;

- foot injury hazards from dropping heavy units onto unprotected feet;
- manual handling hazards, particularly with heavy machines and intensive use or using at awkward heights and/or reaches;
- fire and explosion hazard when used near flammable liquids, explosive dusts or gases;
- using equipment in poor weather conditions with wet, slippery surfaces, poor visibility and cold conditions.

Specific control measures include the following:

- work-pieces must be securely clamped or held in position during sanding. In some cases a jig will be necessary. The direction of spin of disc sanders (normally anti-clockwise) is important to ensure that a small work-piece is pushed towards a stop or fence which is normally at the left side of the work-piece, particularly when clamping is impossible;
- abrasive sanding belts, discs and sheets should be properly and firmly attached to the machine without any torn parts or debris underneath. The manufacturer's instructions and fixing accessories should be used to ensure correct attachment of the abrasive. Operators should be trained, competent and registered to fit abrasive discs;
- old nails and fixings should be sunk below the surface or removed to prevent the sander snagging;
- always hold the equipment by the proper handles and particularly on large disc and floor sanders always use both hands. Excessive pressure should not be used as the surface will be rutted and the machine may malfunction;
- ensure that the dust extraction is working properly and has been emptied when about one-third full. Some extraction systems draw dust and air through the sanding sheet, which must have correctly prepunched holes to allow the passage of air;
- operators should wear suitable dust respirators, eye protection and, where necessary, hearing protection;
- operators should wear suitable clothing avoiding loose garments, long hair and jewellery, which could catch in the equipment. Protective gloves and foot wear are recommended.

4.3 Mechanical and non-mechanical hazards of machinery

4.3.1 Main mechanical and other hazards as identified in BS EN ISO 12100 -1 and how harm may arise

Most machinery has the potential to cause injury to people, and machinery accidents figure prominently in official accident statistics. These injuries may range in severity from a minor cut or bruise, through various degrees of wounding and disabling mutilation, to crushing, decapitation or other fatal injury. It is not solely powered machinery that is hazardous, for many manually-operated machines (e.g. hand-operated guillotines and fly presses) can still cause injury if not properly safeguarded.

Machinery movement basically consists of rotary, sliding or reciprocating action, or a combination of these. These movements may cause injury by entanglement, friction or abrasion, cutting, shearing, stabbing or puncture, impact, crushing, or by drawing a person into a position where one or more of these types of injury can occur. The hazards of machinery are set out in ISO 12100 Part 1:2003, which covers the classification of machinery hazards and how harm may occur. The following mechanical hazards follow this standard.

A person may be injured at machinery as a result of:

- a **crushing hazard** through being trapped between a moving part of a machine and a fixed structure, such as a wall or any material in a machine;
- a **shearing hazard** which shears part of the body, typically a hand or fingers, between moving and fixed parts of the machine, or between two or more moving parts;
- a **cutting or severing hazard** through contact with a cutting edge, such as a band saw or rotating cutting disc;
- an **entanglement hazard** with the machinery which grips loose clothing, hair or working material, such as emery paper, around revolving exposed parts of the machinery. The smaller the diameter of the revolving part, the easier it is to get a wrap or entanglement;
- a **drawing-in or trapping hazard** such as between in-running gear wheels or rollers or between belts and pulley drives;
- an **impact hazard** when a moving part directly strikes a person, such as with the accidental movement of a robot's working arm when maintenance is taking place;
- a **stabbing or puncture hazard** through ejection of particles from a machine or a sharp operating component like a needle on a sewing machine;
- contact with a **friction or abrasion hazard**, for example, on grinding wheels or sanding machines;
- a **high-pressure fluid injection (ejection hazard)**, for example, from a hydraulic system leak.

- In practice, injury may involve several of these at once, for example, contact, followed by entanglement of clothing, followed by trapping.

Non mechanical hazards

Non-mechanical hazards include:

- access: slips, trips and falls;
- falling and moving objects;

- obstructions and projections;
- lifting and handling;
- electricity (including static electricity): shock, burns;
- burns and other injuries from fire and explosion;
- noise and vibration;
- pressure and vacuum;
- high/low temperature;
- dust/fume/mist;
- suffocation;
- radiation: ionizing and non-ionizing;
- biological: viral or bacterial;

- physiological effects (e.g. musculoskeletal disorders);
- psycho-physiological effects (e.g. mental overload or underload);
- human errors;
- hazards from the environment where the machine is used (e.g. temperature, wind, snow, lightning).

In many cases it will be practicable to install safeguards which protect the operator from both mechanical and non-mechanical hazards.

For example a guard may prevent access to hot or electrically live parts as well as to moving ones. The use of guards which reduce noise levels at the same time is also common.

As a matter of policy, machinery hazards should be dealt with in this integrated way instead of dealing with each hazard in isolation.

The Hierarchy of Controls for Machinery Guarding

Employers should take effective steps to prevent access to the dangerous parts of a machine or stop their movement before any part of the person enters a danger zone.

The measures ranked in order are:

- Fixed enclosing guards
- Other guards or protection devices such as interlocked guards and pressure mats
- Protective appliances such as jigs, holders, push sticks, etc.
- The provision of information, instruction training and supervision

BS EN ISO 12100-2:2003 lists 2 main hazards of machinery which are:-

1. Mechanical Hazards
2. Non mechanical hazards

4.3.2 Hazards presented by a range of equipment including office machinery

1) Mechanical Hazards

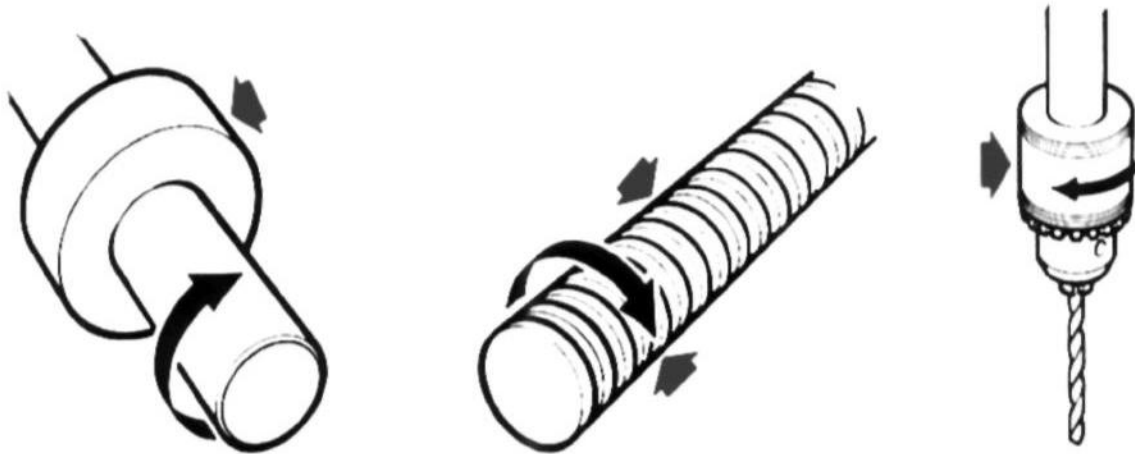
Mechanical hazards are those that can be caused by the machinery itself and are:-

- a) ENtanglement**
- b) Traps** (Includes shearing, drawing-in and crushing)
- c) Impact**
- d) Contact** (includes friction/abrasion, cutting, stabbing/puncture)
- e) Ejection**

To remember the main types of mechanical hazards use the acronym ENTICE.

A) Entanglement

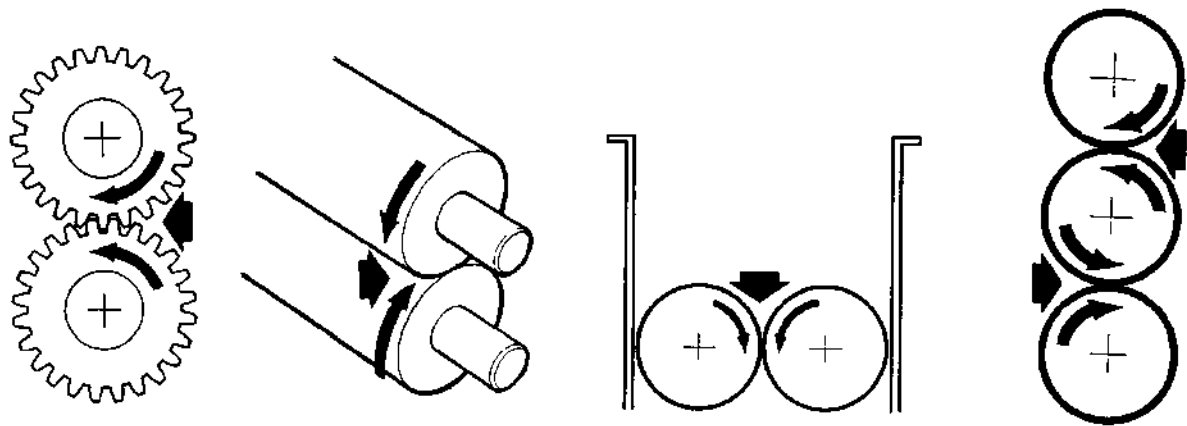
Entanglement involves hair, clothing rings, limbs etc, becoming entangled in revolving shafts drills etc.



b) Traps

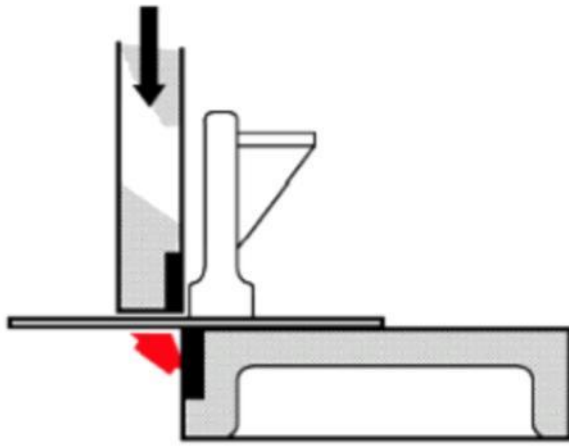
This means being drawing in between the machine and any rotating parts such as two revolving rollers The trapping point is known as “an in running nip”.

Examples of Drawing-in Traps



In-running nips

Trapping can also lead to shearing and crushing.



Shearing (Crushing)

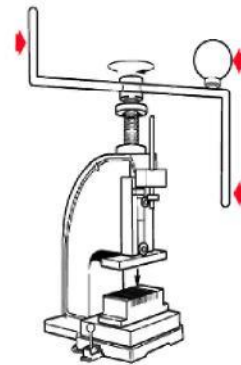
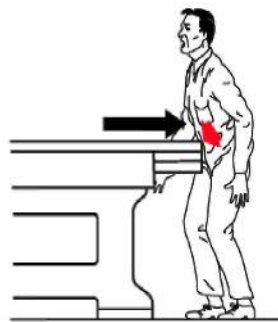
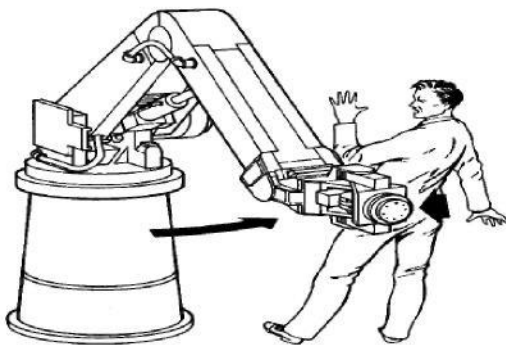


Shearing (Crushing)

c) Impact

Impact means being struck by the movement of a machine part e.g. robot arm, movement of machine bed etc.

Example of Impact



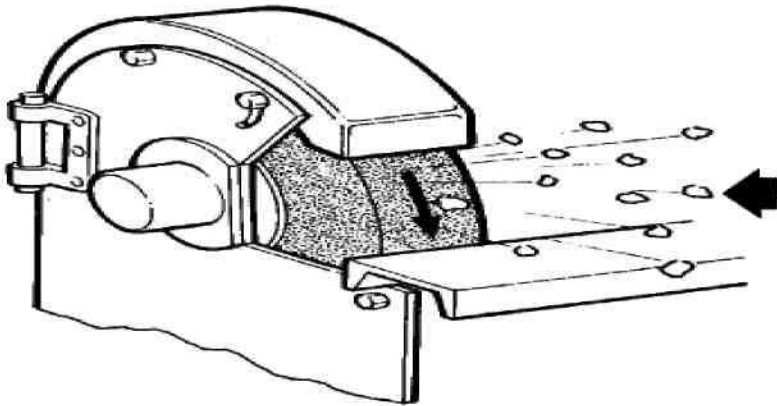
d) Contact

This means part of the body coming in to contact with the machine e.g.

- Burns from exposed surfaces
- Lacerations from sharp edges
- Friction and abrasion from abrasive wheels etc
- Puncture wounds from drills, sewing machines etc
- Cutting by contact with circular saws, band saws or edges of moving sheet metal

e) Ejection

This means being struck by particles ejected from the material being worked on or a part of the machine itself e.g. abrasive wheel.



2) Non-Mechanical Hazards

Machinery may also present other hazards. The nature of the hazard will determine the measures taken to protect people from them. The various sources of danger other than mechanical hazards include the following:-

- Electricity – shock and burns
- Hot surfaces/fire also cold surfaces
- Dust and fumes
- Fire/explosion
- Noise
- Vibration
- Biological
- Hazardous chemicals
- Radiation
- Access and Egress
- Obstructions and projections
- Manual handling
- Splinters

4.4 Control measures for reducing risks from machinery hazards

Guards

The British Standard gives a preferred order of guarding incorporating the four main types which can be remembered by using the acronym **FIAT**

- **Fixed**
- **Interlock**
- **Automatic**
- **Trip**

Fixed Guard

This is the type of guard to be used whenever practicable. This guard prevents access to a dangerous part of a machine and provides a physical barrier with no moving parts, is not linked to the controls or motion of the machine and requires a tool to remove it.

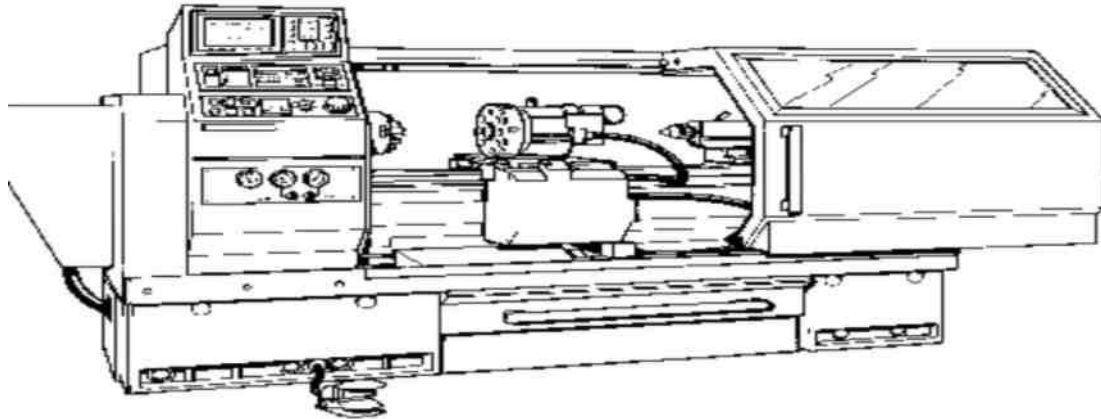
Advantages of fixed guards

- Creates a physical barrier
- Requires a tool to remove it
- No moving parts therefore requires very little maintenance
- Easy to inspect

Disadvantages of Fixed Guards

- No protection if removed
- Requires a tool to remove
- If solid hampers visual inspection
- If solid may cause problems with heat

Interlock Guard



the machine will not operate and either the guard remains locked closed until the dangerous movement has ceased or, where overrun is sufficient to create danger, **opening the guard disengages the drive**. Interlocking systems may be mechanical, electrical, hydraulic or pneumatic or combinations of these.

Advantages of Interlock Guards

- Convenient for access
- Give flexibility of design
- A time delay can be built in

Disadvantages of Interlock Guards

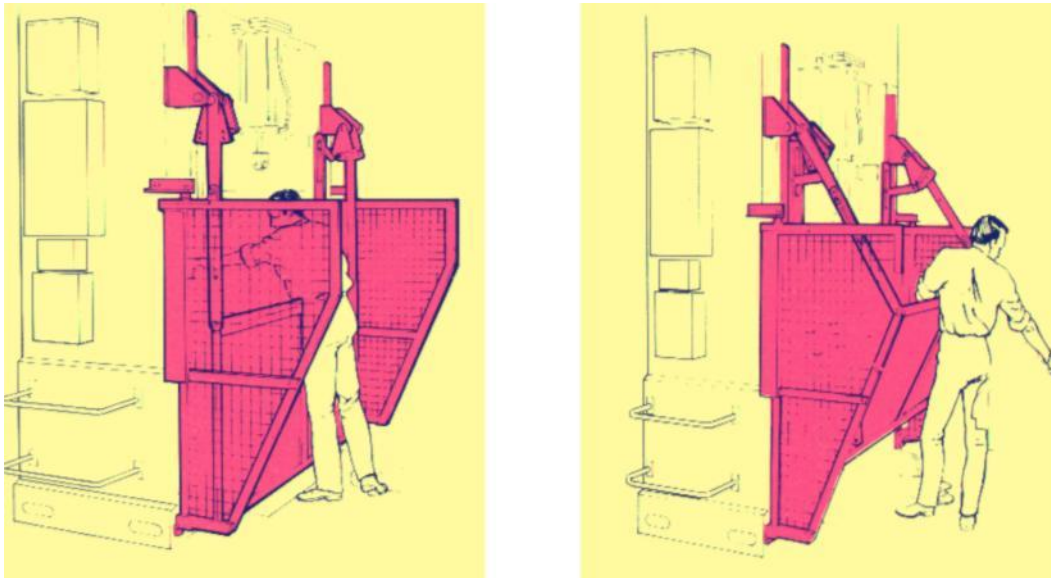
- More complex and therefore, potentially unreliable/can fail to unsafe condition
- More difficult to inspect/test
- Difficult to maintain/subject to wear
- Subject to operator abuse
- If a gate operator can step inside

Examples of Interlock guards can be found in the home, e.g. Microwave opening door stops machine and the washing machine which prevents access until the drum has stopped spinning.

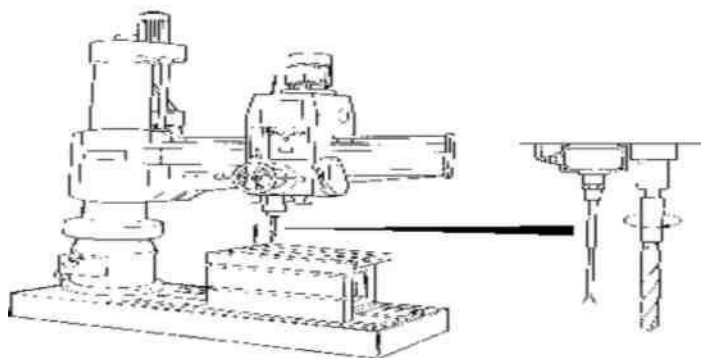
Automatic (Pushaway) Guard

This is a guard designed to **physically remove from danger any part of a person exposed to that danger**. These guards are often called 'push away guards' because on operation of the machine the guard moves backwards and upwards physically pushing the operator away. This type of guard is used on large power presses with slow long strokes and some guillotines etc.

The use of these guards is limited to slow moving machines.



Trip Guard



These include suitably located bars, telescopic probes, trip wires, **pressure sensitive mats** or pressure sensitive cables which, **if operated, either brake or stop the machine (whether not with an accidental braking system).**

Note: Trip guards are really safety devices. The accident is already underway when the device operates and so it minimises the injury.

Other Types of Guard

a) Adjustable

This is basically a “craftsman’s” guard being used mainly in tool rooms, machine shops and wood working shops where frequent adjustment of the guard is necessary owing to different sized jobs.

This type of guard is very much open to abuse and requires supervision to ensure correct use.

b) Self Adjusting Guard

This is a guard which prevents accidental access of a person to a danger point. The guard automatically returning to its closed position when the operation is completed.

Protective devices

Two Hand Control Devices

These devices force the operator to use both hands to operate the machine controls. These devices only protect the operator. When these are used the controls should be spaced well apart and shrouded.

Photo electric devices

These operate with a beam of light from a light source. If the beam is broken by any interruption, the machine automatically stops working. This can be effective in preventing unwanted accident / incident if the machine is stopped before the person is able to cross the prohibited zone to reach the dangerous machinery.

Pressure Sensitive Pads

The devices operate by pressure. If an operator is standing on the pad this prevents the machine from operating.

To ensure adequate maintenance of guards during normal operations the guards should be inspected by operators, supervisors, or if thought necessary, maintenance personnel. Whoever carries out the inspection must have received sufficient information and/or instruction on what to look for during the inspection. Defects, whether of a minor or major nature, should be reported immediately. Regular and more detailed examinations should be carried out as part of a planned maintenance system. Such a system will enable defects to be corrected before a serious situation arises.

Jigs, holders, push-sticks

A jig is a device into which the work piece can be fitted and takes into the dangerous part of the machine in the correct position.

Holders

A holder is a hand held device that secures the work piece in such a way that it can be placed in to the dangerous part of the machine without risk to the operator’s hands e.g. tongs.

Push Stick

A push stick is a device which is used to push the item being used into the dangerous part of the machine without danger to the operator’s hands e.g. a stick used to push wood into a circular saw.

Other Machinery

In all types of business there is machinery used. Some of these are:

- **Office machinery (photocopiers / shredders)**
- **Manufacturing / maintenance machinery (grinder / pedestal drill)**
- **Agricultural / Horticultural (strimmers / mowers / chain saws)**
- **Retail machinery (compactors, checkout conveyors)**
- **Construction machinery (cement mixers, bench top circular saws)**

There will be common hazards to each type in the industrial sectors referred to and there will also be particular hazards both mechanical and non-mechanical to each type of equipment. *Mechanical hazards are in italic.*

Office Machinery

Office machinery: photocopier and shredder

Common hazards:

- Electricity
- Ergonomic
- Noise
- Stability of machine

Other Hazards:

Photocopier	Document shredder
<i>Drawing in</i>	<i>Drawing in to cutters</i>
<i>Trap between moving parts</i>	<i>Contact with cutters</i>
Chemicals	Dust
Ultra violet light/heat	
Manual handling	

Manufacturing/Maintenance Machinery Bench top grinder/pedestal drill Common hazards:

- Electricity
- Ergonomics
- Dust
- Stability of machine
- Manual handling

Other hazards:

Bench top grinder	Pedestal drill
<i>Contact with rotating wheel</i>	<i>Entanglement (Hair/Clothing)</i>
<i>Drawing into the trap between the tool rest and wheel</i>	<i>Contact (Stabbing/puncture) (Hand under drill)</i>
<i>Ejected parts of wheel or workpiece</i>	<i>Impact from an unsecured workpiece</i>
Fire and sparks	<i>Cutting from swarf</i>
Vibration/Noise	<i>Ejection of a bit or materials</i>

Agricultural/Horticultural Machinery

(Cylinder mower, strimmer and chainsaw)

Common Hazards

- Biological e.g. animal droppings
- Chemicals e.g. herbicides
- Electricity
- Fire/explosion if petrol
- Ergonomics
- Manual handling
- Noise and vibration
- Ejection of materials

Other Hazards

Cylinder mower	Strimmer/chainsaw
<i>Contact with rotating blades</i>	<i>Contact with cutter/saw</i>
<i>Entanglement in blades</i>	<i>Entanglement with cutter/saw</i>

Mowers and strimmers are used to maintain roadside verges and the additional hazards of this type of operation are:-

- Struck by vehicles

- Vehicle fumes

PPE is required when using this equipment and common to all is:

- **Hearing protection**
 - Safety helmet/Full face visor
 - Gloves
 - Footwear

However for chainsaws other clothing required is:-

- **Specialist body clothing**
- **Forestry boots**

Apart from PPE other control measures when using chainsaws may include:-

- **Barriers**
- **Properly maintained equipment**
- **Suitable equipment**
- **Trained and competent staff**

Retail Machinery

Waste compactor / checkout conveyor

Common hazards

- Electricity
- Ergonomics
- Manual handling

Other Hazards

Waste Compactor	Checkout Conveyor
<i>Impact</i>	<i>Drawing in traps</i>
<i>Crush</i>	Non-ionising radiation (scanner)
Biological infection from waste	

Construction Machinery Cement mixer/circular saw

Common Hazards

- Dust
- Electricity
- Stability of machine
- Ergonomics

- *Trapping between fixed and moving parts*
- Noise
- Manual handling

Other Hazards

Cement Mixer	Circular Saw
Entanglement	<i>Drawing into rotating blade</i>
Chemicals	<i>Contact</i>
Manual handling	<i>Ejection of materials</i>
	Vibration

Hand-Held And Portable Power Tools

Hand-held tools

Hand-held tools are used throughout industry. Most people will be familiar with them as although they may not use them in work they will have used them at home. They are tools such as screwdrivers, hammers, chisels, spanners, pliers etc.

Using hand tools for a purpose for which it was not intended is commonplace in the workplace and common examples could be:

- Using a flat screwdriver to remove a Phillips (Socket) screw
- Using a screwdriver as a chisel
- Using a chisel or claw hammer to lever something off a wall

There are many more examples that you may think of.

The misuse of hand-held tools often results in injuries such as lacerations, cuts and may cause amputations of fingers.

One of the problem areas regarding hand held tools is that they are generally in the possession of the individual employee and are not inspected. If the tools are supplied by the employer this may not be a problem but if supplied by the employee they are inclined to hold on to them even if they are damaged.

It is important that the employer has a system for the inspection of hand-held tools for defects which can include:

- Chisels which have become blunt
- Handles in hammers which have not been properly fitted which allows the head to be loose
- Spanners which have become rounded

- Hammer heads which have become worn

Portable Power Tools

Portable power tools are another source of hazard in the workplace. They use a number of different power sources such as electricity, compressed air (pneumatic) and hydraulic which are the most common.

Common types of portable power tools are drills, cutters and grinders, etc.

The power source itself may lead to hazards such as electric shock as well as the hazards from the use of the tool.

Precautions for the Portable Power Tools The precautions include:

- With electrical tools ensure RCDs are used
- Ensure that the lead is suitably protected
- Disconnect from the power supply when not in use
- With compressed air tools ensure properly connected

- Do not pull the lead or airline remove the tool
- Have procedures to avoid accidental starting.
- If possible secure all work pieces to prevent movement
- Suitable PPE such as eye protection to be worn
- All tools to be regularly inspected and maintained
- Damaged tools to be removed from use
- Procedure for reporting and replacing damaged tools

Safety in Maintenance Operations

The HSE report 'Deadly Maintenance' identified multiple causational factors in fatalities to maintenance workers, but one predominant cause was singled out, **the absence of a safe system of work**. The report's conclusions where:-

- Safe working procedures should be planned and not left to chance
- Personnel should receive instruction and training
- Suitable safety equipment should be provided
- The management organization should cater for the activity effectively

We should consider maintenance under two distinct areas.

- 1. Planned, Scheduled Maintenance**
- 2. Breakdown, Emergency Maintenance**

1) Planned Scheduled Maintenance

This form of maintenance should be the safest. The job is planned and the necessary tools, access and safety procedures are provided. In many cases the jobs have been done previously and potential hazards have been eliminated or precautions taken.

2) Breakdown, Emergency Maintenance

This form of maintenance has the potential for accidents. In many cases the jobs have not been done previously so there are no procedures or systems in place. A major problem involved is pressure on the personnel due to the urgency to get the plant back in production.

Maintenance Hazards

During maintenance work, conditions are very different from those normally encountered and it is essential that everyone concerned is aware of any hazards and of the correct precautions. Examples may be:-

- Entry into vessels, confined spaces or machines
- Hot work which may cause explosion or fire
- Construction work such as work on roofs or in excavations
- Cutting into pipe work carrying hazardous substances
- Mechanical or electrical work requiring isolation of power or fuel supplies

Work on plant, boilers etc which must be effectively cut off from the possible entry of fumes, gas, liquids or steam.

Machinery Maintenance

Whilst undertaking routine maintenance of machinery the hazards could be:-

- Unintentional starting of machinery
- Release of stored energy e.g. pressure, electricity.

- Movements due to gravity
- Residual high or low pressure
- Restricted access/egress
- Residues e.g. chemicals, flammables, corrosives
- Mechanical hazards
- Heat or cold
- Biological hazards
- Confined spaces
- Working at height

Prior to undertaking maintenance on machinery, factors to be considered include:

- The location of the equipment
- Is it capable of being isolated / locked off
- Can stored energy be dissipated
- Can we segregate the work area from other areas
- Are there safe means of access and egress
- Is PPE required
- Are personnel trained and competent
- Are there heat or cold problems
- Are there chemical residues and biological hazards

The practical precautions when undertaking machinery maintenance could be:

- Isolate electrical power
- Permit to work system
- Isolation of any services or pipelines to the machine
- Allow hot machinery to cool
- Release loads
- Segregation by providing barriers and warning signs
- Provision of safe means of access. Provide adequate lighting, means of access, etc.
- Ensuring availability and suitability of PPE
- Ventilate work area
- Adequate supervision
- Ensuring only skilled & competent staff are used

Element 5 - Electrical safety

Learning outcomes

- ✚ Outline the principles, hazards and risks associated with the use of electricity in the workplace
- ✚ Outline the control measures that should be taken when working with electrical systems or using electrical equipment in all workplace conditions.

Introduction

Electricity is a widely used, efficient and convenient. but potentially hazardous method of transmitting and using energy. It is in use in every factory, workshop, laboratory and office in the country. Any use of electricity has the potential to be very hazardous with possible fatal results. legislation has been in place for many years to control and regulate the use of electrical energy and the activities associated with its use. Such legislation provides a framework for the standards required in the design, installation, maintenance and use of electrical equipment and systems and the supervision of these activities to minimize the risk of injury. Electrical work from the largest installation to the smallest job must be carried out by people known to be competent to undertake such work. New installations always require expert advice at all appropriate levels to cover both design aspects of the system and its associated equipment. Electrical systems and equipment must be properly selected. installed, used and maintained.

In the UK, approximately 8 per cent of all fatalities at work are caused by electric shock. Over the last few years, there have been 1000 electrical accidents each year and 25 people die of their injuries. The majority of the fatalities occur in the agriculture, extractive and utility supply and service industries, whereas the majority of the major accidents happen in the manufacturing, construction and service industries. Only voltages up to and including mains voltage (220/ 240 V) and the three principal electrical hazards electric shock, electric burns and electrical fires and explosions - are considered in detail in this chapter.

5.1 Principles, hazards and risks associated with the use of electricity at work

5.1.1 Basic circuitry for current to flow: relationship between voltage, current and resistance

Potential Difference (or voltage)

Voltage is the difference of electrical potential between two points of an electrical network, expressed in volts. It is a measure of the capacity of an electric field to cause an electric current in an electrical conductor. Between two points in an electric field, such as exists in an electrical circuit, the difference in their electrical potentials is known as the electrical potential difference. This difference is proportional to the electrostatic force that tends to push electrons or other charge-carriers from one point to the other. Potential difference, electrical potential, and electromotive force are measured in volts, leading to the commonly used term voltage. Voltage is usually represented in equations by the symbols V , U or E . (E is often preferred in academic writing, because it avoids the confusion between V and the SI symbol for the volt, which is also V). Electrical potential difference can be thought of as the ability to move electrical charge through a resistance. At a time in physics when the word force was used loosely, the potential difference was named the electromotive force or emf—a term which is still used in certain contexts.

Voltage is a property of an electric field, not individual electrons. An electron moving across a voltage difference experiences a net change in energy, often measured in electron-volts. This effect is analogous to a mass falling through a given height difference in a gravitational field.

When using the term 'potential difference' or voltage, one must be clear about the two points between which the voltage is specified or measured. There are two ways in which the term is used. This can lead to some confusion.

Voltage is a measure of how much energy a charged particle has in relation to another place, most commonly ground. Compare voltage, which is measured in energy per charged particle (Joules per Coulomb) to potential energy ($PE=mgh$) which is the weight of an object times its height. These quantities would be about the same conceptually if you divided PE per unit mass. Think of an electron in a circuit compared to a rollercoaster car at the top of a hill.

Differences between High And Low Voltage

The International Electro technical Commission and its national counterparts define 'High voltage' circuits as those with more than 1,000 V for alternating current and at least 1,500 V for direct current. Such circuits are distinguished from low voltage (50 – 1,000 V AC or 120 – 1500 V DC) and extra-low voltage (<50 V AC or <120 V DC) circuits. This is in the context of building wiring and the safety of electrical apparatus.

However, figures vary so it is necessary to review national regulations for local definitions. For example, in the USA, 'High voltage' is deemed to be any voltage over 600V. For present purposes, high voltage may be taken as being anything over 1,000 volts.

The phrase 'High voltage' means different things to different people and depends to some extent on the context. For example, those who work in the electricity generation and distribution industries routinely deal with transmission voltages of 11,000 Volts (11Kv) and higher. In those cases, their threshold for what is termed 'High voltage' may be 11Kv or 33Kv. 'Extra high voltage' is a term reserved for power transmission equipment designed for more than 345,000 volts.

The distinction between 'High' and 'Low' voltage may mislead some to feel that 'Low' voltages are in some way safer. This is not the case; people can be killed by shocks from 230V supplies.

Current, Resistance and Impedance

Current

Electric current is by definition the flow of electric charge. The SI (International System of Units) unit of electric current is the ampere (A), which is equal to a flow of one coulomb of charge per second. 1 coulomb is the amount of electric charge carried by a current of 1 ampere flowing for 1 second.

Resistance and Impedance:

Electrical resistance is a measure of the degree to which an object opposes the passage of an electric current. The SI unit of electrical resistance is the ohm. Its reciprocal quantity is electrical conductance measured in siemens.

The quantity of resistance in an electric circuit determines the amount of current flowing in the circuit for any given voltage applied to the circuit.

$$R = \frac{V}{I}$$

where

R is the resistance of the object, usually measured in ohms , equivalent to J·s/C²

V is the potential difference across the object, usually measured in volts

I is the current passing through the object, usually measured in amperes

For a wide variety of materials and conditions, the electrical resistance does not depend on the amount of current flowing or the amount of applied voltage. V can either be measured directly across the object or calculated from a subtraction of voltages relative to a reference point. The former method is simpler for a single object and is likely to be more accurate. There may also be problems with the latter method if the voltage supply is AC and the two measurements from the reference point are not in phase with each other.

Ohm's Law:

Ohm's law states that, in an electrical circuit, the current passing through most materials is directly proportional to the potential difference applied across them.

In mathematical terms, this is written as:

$$I = \frac{V}{R}$$

where I is the current, V is the potential difference, and R is a proportionality constant called the resistance. The potential difference is also known as the voltage drop, and is sometimes denoted by E or U instead of V.

The SI unit of current is the ampere; that of potential difference is the volt; and that of resistance is the ohm, equal to one volt per ampere. The law is named after the physicist Georg Ohm (1789-1854), who published it in 1827.

Identification of basic electrical circuitry

An electrical circuit is a network that has a closed loop, giving a return path for the current. A network is a connection of two or more components, and may not necessarily be a circuit.

To design any electrical circuits, electrical engineers need to be able to predict the voltages and currents in the circuit. Linear circuits can be analysed to a certain extent by hand because complex number theory gives electricians the ability to treat all linear elements using a single mathematical representation.

Many electricians utilise special software to design and simulate circuits before building them. This method increases both time and cost efficiency since it does not require the engineer to build every circuit prototype in order to test it. The development of technologies such as VHDL has also eased the burden from engineers by simulating and automatically generating circuit designs.

Earthing principles

The term ground or earth usually means a common return path in electrical circuits. The terms 'earth return' and 'ground return' are also common meanings.

In electrical engineering, the term ground or earth has the following meanings:

An electrical connection to earth. The part directly in contact with the earth (the earth electrode) can be as simple as a metal (usually copper) rod or stake driven into the earth, or a connection to buried metal water piping. Or it can be a complex system of buried rods and wires. The resistance of the electrode-to-earth connection determines its quality, and is improved by increasing the surface area of the electrode in contact with the earth, increasing the depth to which it is driven, using several connected ground rods, increasing the moisture of the soil, improving the conductive mineral content of the soil, and increasing the land area covered by the ground system. This type of ground applies to radio antennae and to lightning protection systems.

In a main (AC power) wiring installation, the grounding is the wire that carries currents away under fault conditions. This power ground grounding wire is (directly or indirectly) connected to one or more earth electrodes. These may be located locally, be far away in the suppliers network or in many cases both. This grounding wire is usually but not always connected to the neutral wire at some point and they may even share a cable for part of the system under some conditions. The ground wire is also usually bonded to pipe work to keep it at the same potential as the electrical ground during a fault. Water supply pipes often used to be used as ground electrodes but this was banned in some countries when plastic pipe such as PVC became popular.

In an electrical circuit operating at signal voltages (usually less than 50 V or so), a common return path is the zero voltage reference level for the equipment or system. This signal ground may or may not actually be connected to a power ground. A system where the system ground is not actually connected to earth is often referred to as a floating ground.

Any excess charges deposited on the inner surface of a Faraday cage will migrate to the outer surface of the cage, where they can produce no electric fields within the enclosure. For this reason, the inside surface of a Faraday cage behaves like an infinite sink for electrical charge from the perspective of objects within. Even if the Faraday cage itself is not connected to the Earth, the inner surface of the cage can be used in place of an earth connection.

A ground conductor on a lightning protection system used to dissipate the strike into the earth.

The significance of direct and alternating currents

Direct Current (DC):

Direct current (DC or "continuous current") is the constant flow of electrons from low to high potential. This is typically in a conductor such as a wire, but can also be through semiconductors, insulators, or even through a vacuum as in electron or ion beams. In direct current, the electric charges flow in the same direction, distinguishing it from alternating current (AC). A term formerly used for direct current was Galvanic current. Within Electrical Engineering, the term DC is a synonym for constant. For example, the voltage across a DC voltage source is constant as is the current through a DC current source. The DC solution of an electric circuit is the solution where all voltages and currents are constant. It can be shown that any voltage or current waveform can be decomposed into a sum of a DC component and a time-varying component. The DC component is defined to be the average value of the voltage or current over all time. The average value of the time-varying component is zero.

Although DC stands for "Direct Current", DC sometimes refers to "constant polarity." With this definition, DC voltages can vary in time, such as the raw output of a rectifier or the fluctuating voice signal on a telephone line.

Some forms of DC (such as that produced by a voltage regulator) have almost no variations in voltage, but may still have variations in output power and current.

Direct current installations usually have different types of sockets, switches, and fixtures, mostly due to the low voltages used, from those suitable for alternating current. It is usually important with a direct current appliance not to reverse polarity unless the device has a diode bridge to correct for this. (Most battery-powered devices don't.)

High voltage direct current is used for long-distance point-to-point power transmission and for submarine cables, with voltages from a few kilovolts to approximately one megavolt.

DC is commonly found in many low-voltage applications, especially where these are powered by batteries, which can produce only DC, or solar power systems, since solar cells can produce only DC. Most automotive applications use DC, although the alternator is an AC device which uses a rectifier to produce DC. Most electronic circuits require a DC power supply. Applications using fuel cells (mixing hydrogen and oxygen together with a catalyst to produce electricity and water as by-products) also produce only DC.

Most telephones connect to a twisted pair of wires, and internally separate the AC component of the voltage between the two wires (the audio signal) from the DC component of the voltage between the two wires (used to power the phone).

Alternating Current:

An alternating current (AC) is an electrical current whose magnitude and direction vary cyclically, as opposed to direct current, whose direction remains constant. The usual waveform of an AC power circuit is a sine wave, as this results in the most efficient transmission of energy. However in certain applications, different waveforms are used, such as triangular or square waves.

Used generically, AC refers to the form in which electricity is delivered to businesses and residences. However, audio and radio signals carried on electrical wire are also examples of alternating current. In these applications, an important goal is often the recovery of information encoded (or modulated) onto the AC signal.

William Stanley (1858-1916) designed one of the first practical devices to transfer AC power efficiently between isolated circuits. Using pairs of coils wound on a common iron core, his design, called an induction coil, was an early precursor of the modern transformer. The system used today was devised by many contributors including Nikola Tesla (1856-1943), George Westinghouse (1846-1914), Lucien Gaulard (1850-1888), John Dixon Gibbs, and Oliver Shallenger from 1881 to 1889. AC systems overcame the limitations of direct current systems, such as that which

Thomas Edison first used it to distribute electricity commercially.

The first long-distance transmission of alternating current took place in 1891 near Telluride, Colorado, followed a few months later in Germany. Thomas Edison strongly advocated the use of direct current (DC), having many patents in that technology, but eventually alternating current came into general use.

The first modern commercial power plant using three-phase alternating current was at the Mill Creek hydroelectric plant near Redlands, California in 1893. Its designer was Almirian Decker (1852-1893). Decker's innovative design incorporated 10,000 volt three phase transmission and established the standards for the complete system of generation, transmission and motors used today. Through the use of alternating current, Charles Proteus Steinmetz (1865-1923) of General Electric was able to solve many of the problems associated with electricity generation and transmission.

AC voltage can be stepped up or down by a transformer to a different voltage. Modern high-voltage, direct current electric power transmission systems contrast with the more common alternating-current systems as a means for the bulk transmission of electrical power over long distances. However, these tend to be more expensive and less efficient than transformers, and did not exist when Edison, Westinghouse and Tesla were designing their power systems.

Use of a higher voltage leads to more efficient transmission of power. The power losses in a conductor are a product of the square of the current and the resistance of the conductor, described by the formula $P = I^2R$. This means that when transmitting a fixed power on a given wire, if the current is doubled, the power loss will be four times greater.

Since the power transmitted is equal to the product of the current, the voltage and the cosine of the phase difference f ($P = IV\cos f$), the same amount of power can be transmitted with a lower current by increasing the voltage. Therefore it is advantageous when transmitting large amounts of power to distribute the power with high voltages (often hundreds of kilovolts). However, high voltages also have disadvantages, the main ones being the increased insulation required, and generally increased difficulty in their safe handling. In a power plant, power is generated at a convenient voltage for the design of a generator, and then stepped up to a high voltage for transmission. Near the loads, the transmission voltage is stepped down to the voltages used by equipment. Consumer voltages vary depending on the country and size of load, but generally motors and lighting are built to use up to a few hundred volts between phases.

Three-phase electrical generation is very common. Three separate coils in the generator stator are physically offset by an angle of 120° to each other. Three current waveforms are produced that are equal in magnitude and 120° out of phase to each other.

If the load on a three-phase system is balanced equally between the phases, no current flows through the neutral point. Even in the worst-case unbalanced (linear) load, the neutral current will not exceed the highest of the phase currents. For three-phase at low (normal mains) voltages a four-wire system is normally used. When stepping down three-phase a transformer with a Delta primary and a Star secondary is often used so there is no need for a neutral on the supply side.

For smaller customers (just how small varies by country and age of the installation) only a single phase and the neutral or two phases and the neutral are taken to the property. For larger installations all three phases and the neutral are taken to the main distribution panel. From the three-phase main panel, both single and three-phase circuits may lead off.

Three-wire single phase systems, with a single centre-tapped transformer giving two live conductors, is a common distribution scheme for residential and small commercial buildings in North America. A similar method is used for a different reason on construction sites in the UK. Small power tools and lighting are supposed to be supplied by a local centre-tapped transformer with a voltage of 55V between each power conductor and the earth. This significantly reduces the risk of electric shock in the event that one of the live conductors becomes exposed through an equipment fault, whilst still allowing a reasonable voltage for running the tools.

A third wire is often connected between non-current carrying metal enclosures and earth ground. This conductor provides protection from electrical shock due to accidental contact of circuit conductors with the case of portable appliances and tools.

Some definitions

Certain terms are frequently used with reference to electricity and the more common ones are defined here.

Low voltage - A voltage normally not exceeding 600 V ac between conductors and earth or 1000 V ac between phases. Mains voltage falls into this category.

High voltage - A voltage normally exceeding 600 V ac between conductors and earth or 1000 V ac between phases.

Mains voltage - The common voltage available in domestic premises and many workplaces and normally taken from three pin socket points. In the UK, it is distributed by the national grid and is usually supplied between 220 and 240V ac and at 50 cycles/s.

Maintenance - A combination of any actions carried out to retain an item of electrical equipment in, or restore it to, an acceptable and safe condition. **Testing** - A measurement

carried out to monitor the conditions of an item of electrical equipment without physically altering the construction of the item or the electrical system to which it is connected.

Inspection - A maintenance action involving the careful scrutiny of an item of electrical equipment, using, if necessary, all the senses to detect any failure to meet an acceptable and safe condition. An inspection does not include any dismantling of the item of equipment.

Examination - An inspection together with the possible partial dismantling of an item of electrical equipment, including measurement and non-destructive testing as required, in order to arrive at a reliable conclusion as to its condition and safety. **Isolation** - Involves cutting off the electrical supply from all or a discrete section of the installation by separating the installation or section from every source of electrical energy. This is the normal practice so as to ensure the safety of persons working on or in the vicinity of electrical components which are normally live and where there is a risk of direct contact with live electricity.

Competent electrical person - A person possessing sufficient electrical knowledge and experience to avoid the risks to health and safety associated with electrical equipment and electricity in general.

5.1.2 Hazards, risks and danger of electricity

Electricity is a safe, clean and quiet method of transmitting energy. However, this apparently benign source of energy, when accidentally brought into contact with conducting material, such as people, animals or metals, permits releases of energy which may result in serious damage or loss of life. Constant awareness is necessary to avoid and prevent danger from accidental releases of electrical energy.

The principal hazards associated with electricity are:

- electric shock;
- electric burns;
- electrical fires and explosions;
- arcing;
- secondary hazards.

The use of portable electrical equipment can lead to a higher likelihood of these hazards occurring.

5.1.2.1 Electric shock and its effect on the body; factors influencing severity

Electric shock is the convulsive reaction by the human body to the flow of electric current through it. This sense of shock is accompanied by pain and, in more severe cases, by burning. The shock can be produced by low voltages, high voltages or lightning. Most incidents of electric shock occur when the person becomes the route to earth for a live conductor. The effect of electric shock and the resultant severity of injury depend upon the size of the electric current passing through the body which, in turn, depends on the voltage and the electrical resistance of the skin and body. If the skin is wet, a shock from mains voltage (220/240V) could well be fatal. The effect of shock is very dependent on conditions at the time but it is always dangerous and must be avoided. Electric burns are usually more severe than those caused by heat, since they can penetrate deep into the tissues of the body.

The effect of electric current on the human body depends on its pathway through the body (e.g. hand to hand or hand to foot), the frequency of the current, the length of time of the shock and the size of the current. Current size is dependent on the duration of contact and the electrical resistance of body tissue. The electrical resistance of the body is greatest in the skin and is approximately 100 000 ohm; however, this may be reduced by a factor of 100 when the skin is wet. The body beneath the skin offers very little resistance to electricity due to its very high water content and, while the overall body resistance varies considerably between people and during the lifetime of each person, it averages at 1000 ohms. Skin that is wounded, bruised or damaged will considerably reduce human electrical resistance and work should not be undertaken on electrical equipment if damaged skin is unprotected.

An electric current of 1 mA is detectable by touch and one of 10mA will cause muscle contraction which may prevent the person from being able to release the conductor, and if the chest is in the current path, respiratory movement may be prevented, causing asphyxia. Current passing through the chest may also cause fibrillation of the heart (vibration of the heart muscle) and disrupt the normal rhythm of the heart, though this is likely only within a particular range of currents. The shock can also cause the heart to stop completely (cardiac arrest) and this will lead to the cessation of breathing. Current passing through the respiratory centre of the brain may cause respiratory arrest that does not quickly respond to the breaking of the electrical contact. These effects on the heart and respiratory system can be caused by currents as low as 25mA. It is not possible to be precise on the threshold current because it is dependent on the environmental conditions at the time, as well as the age, sex, body weight and health of the person.

Burns of the skin occur at the point of electrical contact due to the high resistance of skin. These burns may be deep, slow to heal and often leave permanent scars. Burns may also

occur inside the body along the path of the electric current, causing damage to muscle tissue and blood cells.

Treatment of electric shock and burns

There are many excellent posters available which illustrate first-aid procedures for treating electric shock and such posters should be positioned close to electrical junction boxes or isolation switches. The recommended procedure for treating an unconscious person who has received a **low-voltage** electric shock is as follows:

- On finding a person suffering from electric shock, raise the alarm by calling for help from colleagues (including a trained first aider).
- Switch off the power if it is possible and/or the position of the emergency isolation switch is known. Call for an ambulance.
- If it is not possible to switch off the power, then push or pull the person away from the conductor using an object made from a good insulator, such as a wooden chair or broom.
- Remember to stand on dry insulating material, for example, a wooden pallet, rubber mat or wooden box.
- If these precautions are not taken, then the rescuer will also be electrocuted.
- If the person is breathing, place him/her in the recovery position so that an open airway is maintained and the mouth can drain if necessary.
- If the person is not breathing, apply mouth-to-mouth resuscitation and, in the absence of a pulse, chest compressions. When the person is breathing normally place them in the recovery position.
- Treat any burns by placing a sterile dressing over the burn and secure with a bandage. Any loose skin or blisters should not be touched nor any lotions or ointments applied to the burn wound. If the person regains consciousness, treat for normal shock.
- Remain with the person until they are taken to a hospital or local surgery.

Prepared with the assistance of The British Red Cross

Electric Shock Emergency Action

- 1** Switch off power. **2** Call for assistance.
- 3** If power cannot be switched off, push or pull the casualty clear of the electrical source, using any dry non conductive material available to safeguard yourself.
- 4** Check for response - if no response, open the airway and remove any obvious obstructions in the mouth.

Emergency Resuscitation Treatment

1 Tilt head backwards. Lift chin upwards.

2 Maintain position as in diagram 1. Check breathing. Look, listen for breathing for 10 seconds.

3 If no breathing, phone for an ambulance. Give two breaths and then look for signs of circulation, such as breathing, coughing and movement.

5 Circulation and breathing present. Treat life threatening injuries and place in recovery position.

4 No breathing. No circulation. Give two breaths, commence chest compressions, 15 compressions, then 2 breaths. Continue until help arrives.

4 No breathing. But circulation present. Give breaths at rate of approx. 10 per min. Check circulation after every 10 breaths. then continue until help arrives.

EMERGENCY SERVICES	DOCTOR	
	AMBULANCE	
	NEAREST FIRST AID	

Figure - A poster about electric shock (courtesy of Stock signs)

It is important to note that electrocution by high-voltage electricity is normally instantly fatal. On discovering a person who has been electrocuted by high-voltage electricity, the police and electricity supply company should be informed. If the person remains in contact with or within 18 m of the supply, then he/she should not be approached to within 18 m by others until the supply has been switched off and clearance has been given by the emergency services. High-voltage electricity can 'arc' over distances less than 18 m, thus electrocuting the would-be rescuer.

5.1.2.2 Electrical fires: common causes

Over 25 per cent of all fires have a cause linked to a malfunction of either a piece of electrical equipment or wiring or both. Electrical fires are often caused by a lack of reasonable care in the maintenance and use of electrical installations and equipment. The electricity that provides heat and light and drives electric motors is capable of igniting insulating or other combustible material if the equipment is misused, is not adequate to carry the electrical load or is not properly installed and maintained. The most common causes of fire in electrical installations are short circuits, overheating of cables and equipment, the ignition of flammable gases and vapours and the ignition of combustible substances by static electrical discharges.

Short circuits happen, as mentioned earlier, if insulation becomes faulty, and an unintended flow of current between two conductors or between one conductor and earth occurs. The amount of the current depends upon, among other things, the voltage, the condition of the insulating material and the distance between the conductors. At first the current flow will be low, but as the fault develops the current will increase and the area surrounding the fault will heat up. In time, if the fault persists, a total breakdown of insulation will result and excessive current will flow through the fault. If the fuse fails to operate or is in excess of the recommended fuse rating, overheating will occur and a fire will result. A fire can also be caused if combustible material is in close proximity to the heated wire or hot sparks are ejected. Short circuits are most likely to occur where electrical equipment or cables are susceptible to damage by water leaks or mechanical damage. Twisted or bent cables can also cause breakdowns in insulation materials.

Inspection covers and cable boxes are particular problem areas. Effective steps should be taken to prevent the entry of moisture as this will reduce or eliminate the risk. Covers can themselves be a problem especially in dusty areas where the dust can accumulate on flat insulating surfaces resulting in tracking between conductors at different voltages and a subsequent insulation failure. The interior of inspection panels should be kept clean and dust-free by using a suitable vacuum cleaner.

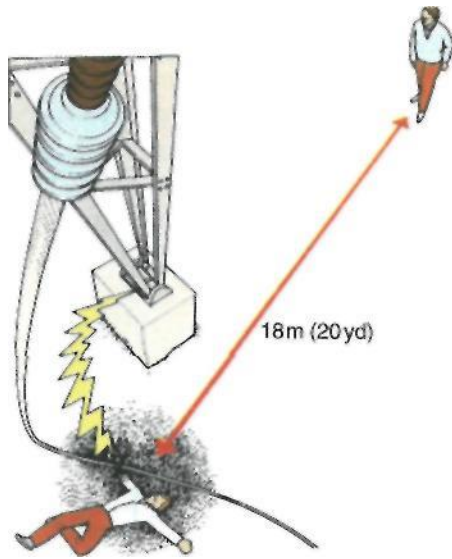
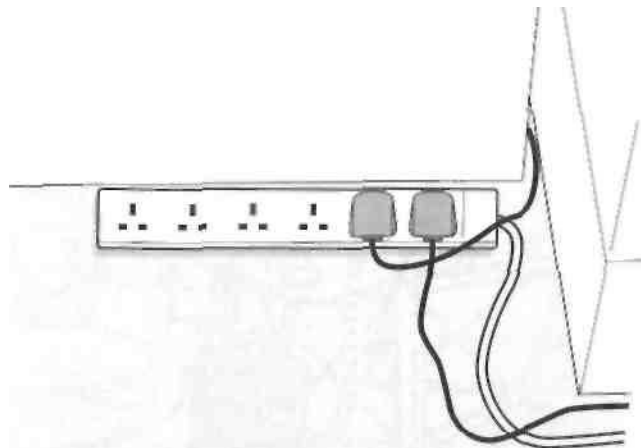


Figure - Keep 18m clear of high voltage lines
malfunction



Figure - Over 25% of fires are caused by electrical

Overheating of cables and equipment will occur if they become overloaded. Electrical equipment and circuits are normally rated to carry a given safe current which will keep the temperature rise of the conductors in the circuit or appliance within permissible limits and avoid the possibility of fire. These safe currents define the maximum size of the fuse (the fuse rating) required for the appliance. A common cause of circuit overloading is the use of



equipment and cables which are too small for the imposed

Figure - Modern UK multi-plug. European multi-plugs are very similar

electrical load. This is often caused by the addition of more and more equipment to the circuit, thus taking it beyond its original design specification. In offices, the overuse of multi-socket incorrectly fused outlet adaptors can create overload problems (sometimes known as the Christmas tree effect). The more modern multi-plugs are much safer as they lead to

one fused plug and cannot be easily overloaded. Another cause of overloading is mechanical breakdown or wear of an electric motor and the driven machinery. Motors must be maintained in good condition with particular attention paid to bearing surfaces. Fuses do not always provide total protection against the overloading of motors and, in some cases, severe heating may occur without the fuses being activated.

Loose cable connections are one of the most common causes of overheating and may be readily detected (as well as overloaded cables) by a thermal imaging survey (a technique which indicates the presence of hot spots). The bunching of cables together can also cause excessive heat to be developed within the inner cable leading to a fire risk. This can happen with cable extension reels, which have only been partially unwound, used for high-energy appliances like an electric heater.

Ventilation is necessary to maintain safe temperatures in most electrical equipment and overheating is liable to occur if ventilation is in any way obstructed or reduced. All electrical equipment must be kept free of any obstructions that restrict the free supply of air to the equipment and, in particular, to the ventilation apertures.

Most electrical equipment either sparks in normal operation or is liable to spark under fault conditions. Some electrical appliances such as electric heaters, are specifically designed to produce high temperatures. These circumstances create fire and explosion hazards, which demand very careful assessment in locations where processes capable of producing flammable concentrations of gas or vapour are used, or where flammable liquids are stored.

It is likely that many fires are caused by static electrical discharges. Static electricity can, in general, be eliminated by the careful design and selection of materials used in equipment and plant, and the materials used in products being manufactured. When it is impractical to avoid the generation of static electricity, a means of control must be devised. Where flammable materials are present, especially if they are gases or dusts, then there is a great danger of fire and explosion, even if there is only a small discharge of static electricity. The control and prevention of static electricity is considered in more detail later in the chapter.

The use of electrical equipment in potentially flammable atmospheres should be avoided as far as possible. However, there will be many cases where electrical equipment must be used and, in these cases, the construction of the equipment should comply with the national standards.

Before electrical equipment is installed in any location where flammable vapours or gases may be present, the area must be zoned in accordance with national standards and records of the zoned areas must be marked on building drawings and revised when any zoned area is changed. The installation and maintenance of electrical equipment in potentially flammable atmospheres is a specialized task. It must only be undertaken by specially-trained electricians or instrument mechanics.

In the case of a fire involving electrical equipment, the first action must be the isolation of the power supply so that the circuit is no longer live. This is achieved by switching off the power supply at the mains isolation switch or at another appropriate point in the system. Where it is not possible to switch off the current, the fire must be attacked in a way which will not cause additional danger. The use of a non-conducting extinguishing medium, such as carbon dioxide or powder, is necessary. After extinguishing such a fire, careful watch should be kept for renewed outbreaks until the fault has been rectified. Re-ignition is a particular problem when carbon dioxide extinguishers are used, although less equipment may be damaged than is the case when powder is used.

Finally, the chances of electrical fires occurring are considerably reduced if the original installation was undertaken by competent electricians working to recognized standards, such as the UK Institution of Electrical Engineers' Code of Practice. It is also important to have a system of regular testing and inspection in place so that any remedial maintenance can take place.

5.1.2.3 Workplace electrical equipment including portable

Portable and transportable electrical equipment is defined by the UK Health and Safety Executive as 'not part of a fixed installation but may be connected to a fixed installation by means of a flexible cable and either a socket and plug or a spur box or similar means'. It may be hand-held or hand-operated while connected to the supply, or is intended or likely to be moved while connected to the supply. The auxiliary equipment, such as extension leads, plugs and sockets, used with portable tools, is also classified as portable equipment. The term 'portable' means both portable and transportable.

Almost 25 percent of all reportable electrical accidents involve portable electrical equipment (known as portable appliances). While most of these accidents were caused by electric shock, over 2000 fires each year are started by faulty cables used by portable appliances, caused by a lack of effective maintenance. Portable electrical tools often present a high risk of injury, which is frequently caused by the conditions under which they are used. These conditions include the use of defective or unsuitable equipment and, indeed, the misuse of equipment. There must be a system to record the inspection, maintenance and repair of these tools.



Where plugs and sockets are used for portable tools, sufficient sockets must be provided for all the equipment and adaptors should not be used. Many accidents are caused by faulty flexible cables, extension leads, plugs and sockets, particularly when these items become damp or worn. Accidents often occur when contact is made with some part of the tool which has become live (probably at mains voltage), while the user is standing on, or in contact with, an earthed conducting surface. If the electricity supply is at more than 50V ac, then the electric shock that a person may receive from such defective equipment is potentially lethal. In adverse environmental conditions, such as humid or damp atmospheres, even lower voltages can be dangerous. Portable electrical equipment should not be used in flammable atmospheres if it can be avoided and it must also comply with any standard relevant to the particular environment. Air-operated equipment should also be used as an alternative whenever it is practicable.

5.1.2.4 Secondary effects (e.g. falls from height)

It is important to note that there are other hazards associated with portable electrical appliances, such as abrasion and impact, noise and vibration. Trailing leads used for portable equipment and raised socket points offer serious trip hazards and both should be used with great care near pedestrian walkways. Power drives from electric motors should always be guarded against entanglement hazards.

Secondary hazards are those additional hazards which present themselves as a result of an electrical hazard. It is very important that these hazards are considered during a risk assessment. An electric shock could lead to a fall from height if the shock occurred on a scaffold or it could lead to a collision with a vehicle if the victim collapsed on to a roadway.

Similarly, an electrical fire could lead to all the associated fire hazards (e.g. suffocation, burns and structural collapse) and electrical burns can easily lead to infections.

5.1.2.5 Use of poorly maintained electrical equipment

It is important that the right electric power tools be available when needed. However, this is of no value if the tools are not in good working order and able to effectively and safely perform the work.

Portable electric power tools not maintained and in good working order are first and foremost a safety hazard. Secondly, poorly maintained portable electric power tools will affect both the productivity and morale of those using them. The cost of providing adequate and well-maintained portable electric power tools to field personnel is small compared to the cost of lost productivity or a resulting accident.

Where does good tool maintenance start?

Good tool maintenance starts with the proper use of tools at the work site. Field personnel must know how to select the right tool for the job and then understand how to use it properly. Training in proper selection and use of these tools is key to trouble-free use and long tool life.

Inspect before using

It should be standard operating procedure for field personnel to perform visual inspection of portable electric power tools before using them. Taking a moment to visually inspect the tool can reveal problems that could result in a safety hazard or serious damage if not corrected before use. Some of the things that should be looked for on visual inspection include:

- Cracked or otherwise damaged casings and enclosures
- Broken or damaged chucks or attachment mechanisms for bits, blades, or dies
- Missing, damaged, tampered-with, or improperly operating safety guards, shields, or other safety features
- Properly operating on-off switches
- Excessive dirt, grease, or other buildup on any part of the portable electric power tool, including ventilation openings

- Cut, frayed, spliced, or otherwise damaged power cords
- Cracked or damaged attachment plugs, including missing or deformed grounding pins

5.1.2.6 Work near overhead power lines; contact with underground power cables during excavation work

Overhead power lines

Accidental contact with live overhead power lines kills people and causes many serious injuries every year. People are also harmed when a person or object gets too close to a line and a flashover occurs. Work involving high vehicles or long equipment is particularly high risk, such as;

In Construction – Lorry mounted cranes (such as Hiabs), Mobile Elevated Work Platforms (MEWP's), scaffold poles, tipper vehicles, cranes, ladders;

In Agriculture – combines, sprayer booms, materials handlers, tipper vehicles, ladders, irrigation pipes, polytunnels; Remember:

- going close to a live overhead line can result in a flashover that may kill. Touching a power line is not necessary for danger;
- voltages lower than 230 volts can kill and injure people;
- do not mistake overhead power lines on wooden poles for telephone wires; and
- electricity can bypass wood, plastic or rubber, if it is damp or dirty, and cause fatal shocks. Don't rely on gloves or rubber boots to protect you.

What you need to do

Plan and manage work near electric overhead power lines so that risks from accidental contact or close proximity to the lines are adequately controlled.

Safety precautions will depend on the nature of the work and will be essential even when work near the line is of short duration.

Safety can be achieved by a combination of measures:

- Planning and preparation
- Eliminating the danger
- Controlling the access
- Controlling the work

Contact with underground power cables during excavation work

When underground cables are damaged, people can be killed and injured by electric shock, electrical arcs (causing an explosion), and flames. This often results in severe burns to hands, face and body, even if protective clothing is being worn.

Damage can be caused when a cable is:

- cut through by a sharp object such as the point of a tool; or
- crushed by a heavy object or powerful machine.

Cables that have been previously damaged but left unreported and unrepaired can cause incidents.

What you need to do

If you are digging or disturbing the earth you should take care to avoid damaging underground services. Underground electrical cables can be particularly hazardous because they often look like pipes and it is impossible to tell if they are live just by looking at them.

Damage to underground electrical cables can cause fatal or severe injury and the law link to external website says you must take precautions to avoid danger.

Excavation work should be properly managed to control risks, including:

- Planning the work
- Using cable plans
- Cable locating devices
- Safe digging practices

Planning the work

Most service cables belong to a Distribution Network Operator (DNO). However, some cables belong to other organisations such as the highways authority, Ministry of Defence or Network Rail.

You should check nearby for equipment owned by the organisations listed above, and if you suspect there are underground cables, ask them for plans to confirm their location. If underground cables are nearby you may need to ask someone from the organisation to come and accurately locate them for you.

5.1.2.7 Use of electrical equipment in wet environments

In wet surroundings, unsuitable equipment can become live and make its surroundings live too. Fuses, circuit-breakers and other devices must be correctly rated for the circuit they protect. Isolators and fuse-box cases should be kept closed and, if possible, locked.

Cables, plugs, sockets and fittings must be robust enough and adequately protected for the working environment. Ensure that machinery has an accessible switch or isolator to cut off the power quickly in an emergency.

5.2 Control measures when working with electrical systems or using electrical equipment in all workplace conditions

The principal control measures for electrical hazards are applicable to all electrical equipment and systems found at the workplace and impose duties on employers, employees and the self-employed. The following issues need to be addressed:

- the design, construction and maintenance of electrical systems, work activities and protective equipment;
- the strength and capability of electrical equipment;
- the protection of equipment against adverse and hazardous environments;
- the insulation, protection and placing of electrical conductors;
- the earthing of conductors and other suitable precautions;
- the integrity of referenced conductors;
- the suitability of joints and connections used in electrical systems;
- means for protection from excess current;
- means for cutting off the supply and for isolation;
- the precautions to be taken for work on equipment made dead;
- working on or near live conductors;
- adequate working space, access and lighting;
- the competence requirements for persons working on electrical equipment to prevent danger and injury.

Detailed safety standards for designers and installers of electrical systems and equipment are given a code of practice, published by the UK Institute of Electrical Engineers (now the Institution of Engineering and Technology), known as the IEE Wiring Regulations. While these Regulations are not legally binding, they are recognized as a code of good practice and widely used as an industry standard.

The risk of injury and damage inherent in the use of electricity can only be controlled effectively by the introduction of employee training, safe operating procedures (safe systems of work) and guidance to cover specific tasks.

Training is required at all levels of the organization ranging from simple on-the-job instruction to apprenticeship for electrical technicians and supervisory courses for experienced electrical engineers. First-aid training related to the need for cardiovascular resuscitation and treatment of electric burns should be available to all people working on electrical equipment and their supervisors.

A **management system** should be in place to ensure that the electrical systems are installed, operated and maintained in a safe manner. All managers should be responsible for the provision of adequate resources of people, material and advice to ensure that the safety of electrical systems under their control is satisfactory and that **safe systems of work** are in place for all electrical equipment.

For small factories and office or shop premises where the system voltages are normally at mains voltage, it may be necessary for an external competent person to be available to offer the necessary advice. Managers must set up a high-voltage permit-to-work system for all work at and above 600V. The system should be appropriate to the extent of the electrical system involved. Consideration should also be given to the introduction of a permit system for voltages under 600V when appropriate and for all work on live conductors.

The additional control measures that should be taken when working with electricity or using electrical equipment are summarised by the following topics:

- the selection of suitable equipment;
- the use of protective systems;
- inspection and maintenance strategies.

These three groups of measures will be discussed in detail.

5.2.1 Control measures

5.2.1.1 Protection of conductors

Electrical conductors shall be of a sufficient size and current-carrying capacity to ensure that a rise in temperature resulting from normal operations will not damage the insulating materials. Electrical conductors exposed to mechanical damage shall be protected.

All electric conductors shall be sufficient in size and have adequate current carrying capacity and be of such construction that a rise in temperature resulting from normal operation will not damage the insulating materials.

Issues to Consider in Determining Compliance:

- Are conductors large enough so that they will not heat up and damage the insulating materials?
- Are conductors protected from mechanical damage such as vehicular traffic, chafing points on conveyor frames, motors, etc.?
- If conductors are exposed to mechanical damage, are they protected with suitable conduit, bridging, outer jackets, slings, etc.?

5.2.1.2 Strength and capability of equipment

The Provision and Use of Work Equipment (Regulation 4) should be used as guidance in this matter, inasmuch as the following is stated in relation to the suitability of equipment:

- (a) its initial integrity;
- (b) the place where it will be used; and
- (c) the purpose for which it will be used.

The selection of suitable work equipment for particular tasks and processes makes it possible to reduce or eliminate many risks to the health and safety of people at the workplace. This applies both to the normal use of the equipment as well as to other operations such as maintenance.

5.2.1.3 Advantages and limitations of protective systems

Fuses

In electronics and electrical engineering a fuse, short for 'fusible link', is a type of over-current protection device. It has as its critical component a metal wire or strip that will melt when heated by a prescribed electric current, opening the circuit of which it is a part, and so protecting the circuit from an over-current condition.

Reduced Voltage Systems.

Reduced voltage systems are particularly appropriate for portable and transportable equipment, in highly-conducting locations such as boilers and tunnels where the risk of mechanical damage to equipment and trailing cables is high, where the body may be damp and have large areas of contact with the conducting location and on construction sites. One example is that of building or construction site supply systems operating at 55-0-55V A.C. single phase, or at 110V three phase with a phase earth voltage of 64V A.C. Another example is that of an extra-low voltages system operating at or below 50V A.C. or 120V D.C. as recommended internationally. Supply systems like these are referenced to earth and are therefore a special case of systems operating at reduced voltage for which bonding and earthing of all metallic enclosures are still recommended.

Isolation.

Using methods of isolation will help reduce the risk of electric shock, although you must keep in mind that other measure should be utilized as a first instance.

Residual Current Devices.

A residual current device (RCD), or residual current circuit breaker (RCCB), is an electrical wiring device that disconnects a circuit whenever it detects that the flow of current is not balanced between the phase ("hot") conductor and the neutral conductor. The presumption is that such an imbalance may represent current leakage through the body of a person who is grounded and accidentally touching the energised part of the circuit. A shock, possibly lethal, is likely to result from these conditions; RCDs are designed to disconnect quickly enough to prevent such shocks.



Double Insulation.

A Class II or double-insulated electrical appliance is one which has been designed in such a way that it does not require (and must not have) a safety connection to electrical earth (US: ground) (UK Plugs: It has no Earth Wire).

The basic requirement is that no single failure can result in dangerous voltage becoming exposed so that it might cause an electric shock and that this is achieved without relying on an earthed metal casing. This is usually achieved at least in part by having two layers of insulating material surrounding live parts or by using reinforced insulation.

There are also strict requirements relating to the maximum insulation resistance and leakage to any functional earth or signal connections of such appliances.

In Europe, a double-insulated appliance must be labelled "Class II", "double insulated" or bear the double insulation symbol (a square inside another square):



Earth Free Zones.

These are zones (or environments) whereby no danger will arise in the event of a conductor(s) becoming charged. This is a costly exercise, and as such is used in specialised areas – such as test areas.

3.4 BS 7671:2008

BS 7671:2008 includes changes necessary to maintain technical alignment with CENELEC harmonisation documents.

BS 7671:2008 Requirements for Electrical Installations came into effect on 1st July 2008. Installations designed after 30th June 2008 are to comply with BS 7671:2008.

BS 7671 (The IEE Wiring Regulations) are the national standard to which all domestic and industrial wiring must conform. The 17th edition contains substantial changes to align with European documents.

The 17th Edition reflects significant changes to both the technical content and structure. Key changes include:

- A change allowing a socket outlet in bathrooms (if 3m from the edge of a bath or shower and rcd protected).
- Extension of the Regulations to cover new 'special locations': exhibition shows, photovoltaic (pv) power supply systems, floor and heating systems, marinas and fairgrounds and amusements parks.
- Re-numbering and re-structuring of chapters to align with international standards.

The Regulations move from being the 16th to the 17th edition – a major shift in name and perception of its contents. The 16th edition had been in place since 1991.

The contents of the IEE 17th Edition are outlined here:

1 Scope, objects and fundamental requirements for safety.

2 Definitions.

3 Assessment of general characteristics.

4 Protection for safety.

5 Selection and erection of equipment.

6 Inspection and testing.

7 Special installations or locations – particular requirements.

5.2.1.4 Use of competent persons

User checks.

Advice on user checks is that the person using the electrical equipment should complete the following checks:

- Damage (apart from light scuffing) to the cable sheath.
- Damage to the plug, for example the casing is cracking or the pins are bent.
- Inadequate joints, including taped joints in the cable; the outer sheath of the cable is not effectively secured where it enters the plug or the equipment. Obvious evidence would be if the coloured insulation of the internal cable cores were showing.
- The equipment has been subjected to conditions for which it is not suitable, e.g. it is wet or excessively contaminated.
- Damage to the external casing of the equipment or there are some loose parts or screws; evidence of overheating (burn marks or discolouration).

These checks also apply to extension leads and associated plugs and sockets. The user should make visual checks when the equipment is taken into use and during use.

Formal Visual Inspections.

The most important component of a maintenance regime is usually the formal visual inspection, carried out routinely by a trained person. Such inspections can pick up most potentially dangerous faults and the maintenance regime should always include this component.

To control the risks and to monitor the user checks, a competent person should carry out regular inspections that include visual checks similar to those listed above but undertaken in a more formal and systematic manner.

Additional checks could include:

- Removing the plug cover and ensuring that a fuse is being used (e.g. it is a fuse not a piece of wire or a nail etc.).
- Checking that the cord grip is effective.
- Checking that the cable terminations are secure and correct, including an earth where appropriate, and there is no sign of internal damage, overheating or ingress of liquid or foreign matter.

The formal visual inspection should not include taking the equipment apart. This should be confined, where necessary, to the combined inspection and testing. The trained person can normally be a member of staff who has sufficient information and knowledge of what to look for, and what is acceptable, and who has been given the task of carrying out the inspection. To avoid danger, trained people should know when the limit of their knowledge and experience has been reached. Simple, written guidance relating to the visual inspection can be produced that summarises what to look for and which procedures to follow when faults are found or when unauthorised equipment is found in use.

The formal visual inspections should be carried out at regular intervals. The period between inspections can vary considerably, depending on the type of equipment, the conditions of use and the environment. For example, equipment used on a construction site or in a heavy steel fabrication workshop will need much more frequent inspection than equipment such as floor cleaners in an office. In all cases, however, the period between inspections should be reviewed in the light of experience. Faulty equipment should be taken out of service and not used again until properly repaired. If necessary, it should be tested. The pattern of faults can help management decide what action to take, depending on whether the faults show:

- the wrong equipment is being selected for the job;
- further protection may be necessary in a harsh environment;
- the equipment is being misused.

Combined Inspections and tests.

The checks and inspections outlined in the previous paragraphs will, if carried out properly, reveal most (but not all) potentially dangerous faults. However, some deterioration of the cable, its terminals and the equipment itself can be expected after significant use. Additionally, the equipment itself may be misused or abused to the extent that it can give rise to danger. Some of these faults, such as loss of earth integrity (e.g. broken earth wire within a flexible cable), or deterioration of insulation integrity, or contamination of internal and external surfaces, cannot be detected by visual inspection alone. Periodic combined inspection and testing is the only reliable way of detecting such faults, and should be carried out to back up the checks and inspection regime.

Testing is likely to be justified:

- whenever there is reason to suppose the equipment may be defective (but this cannot be confirmed by visual inspection);
- after any repair, modification or similar work;
- at periods appropriate to the equipment, the manner and frequency of use and the environment.

The inspection carried out in conjunction with testing should usually include checking:

- the correct polarity of supply cables;
- correct fusing;
- effective termination of cables and cores;
- that the equipment is suitable for its environment.

Such combined inspection and testing requires a greater degree of competence than that required for inspection alone, because the results of the tests may require interpretation and appropriate electrical knowledge will be needed. However, it can often be carried out by a competent employee.

People carrying out testing of portable electrical equipment should be appropriately trained for this work. It is the employer's duty to ensure that they are competent for the work they are to carry out. Basically, there are two levels of competency.

The first level is where a person not skilled in electrical work routinely uses a simple 'pass/fail' type of portable appliance tester (PAT), where no interpretation of readings is necessary. The person would need to know how to use the PAT correctly. Providing the appropriate test procedures are rigorously followed and acceptance criteria are clearly defined, this routine can be straightforward.

The second level is where a person with appropriate electrical skills uses a more sophisticated instrument that gives actual readings requiring interpretation. Such a person would need to be competent through technical knowledge or experience related to the type of work.

Some combination of actions should provide the most cost effective way of ensuring, so far as is reasonably practicable, that equipment will be maintained in a safe condition wherever it is used.

Testing can be carried out at minimal cost where an employee has been trained to a suitable level of competence and provided with appropriate equipment.

Records of maintenance and tests.

Although there is no requirement in the Electricity at Work Regulations to keep maintenance logs for portable and transportable electrical equipment, the EAW Memorandum does refer to the benefits of recording maintenance, including test results. A suitable log is useful as a management tool for monitoring and reviewing the effectiveness of the maintenance scheme and also to demonstrate that a scheme exists. It can also be used as an inventory of equipment and a check on the use of unauthorised equipment (e.g. domestic kettles or electric heaters brought to work by employees).

The log can include faults found during inspection, which may be a useful indicator of places of use, or types of equipment, that are subject to a higher than average level of wear or damage. This will help monitor whether suitable equipment has been selected. Entries in a test log can also highlight any adverse trends in test readings that may affect the safety of the equipment, thus enabling remedial action to be taken. Be careful when interpreting trends where a subsequent test may be done with a different instrument from that used for an earlier test, as differences in the results may be due to difference in the instruments rather than deterioration in the equipment being tested.

Records do not necessarily have to be on a paper system. Test instruments are available that store the data electronically, which can then be downloaded directly onto a computer database. Duty holders with large amounts of equipment will find it useful to label equipment to indicate that the equipment has been tested satisfactorily i.e. has been passed as safe, and when the date for the next test is due. Otherwise, individual items may be missed on consecutive occasions.

Frequency of inspection and testing.

Deciding on the frequency of inspection and testing is a matter of judgement by the duty holder, and should be based on an assessment of risk. This can be undertaken as part of the assessment of risks under the Management of Health and Safety at Work Regulations 1999.

The Table below can help any duty holder decide how often to carry out a formal visual inspection as well as combined inspection and testing, particularly where a maintenance regime has not previously existed. Alternatively, seek advice from a competent person who has the knowledge and experience to make the necessary judgment, e.g. manufacturers or suppliers of equipment, or relevant trade associations.

Factors to consider when making the assessment include the following:

- Type of equipment and whether it is hand-held or not.
- Manufacturer's recommendations.
- Initial integrity and soundness of equipment.
- Age of the equipment.
- Working environment in which the equipment is used (e.g. wet or dusty) or likelihood of mechanical damage.
- Frequency of use and the duty cycle of the equipment.
- Foreseeable abuse of the equipment.
- Effects of any modifications or repairs to the equipment.
- Analysis of previous records of maintenance, including both formal inspection and combined inspection and testing.

The Table below sets out the suggested frequency of formal visual inspections and combined inspections and electrical tests for portable and transportable electrical equipment. It gives suggested starting intervals when implementing a maintenance programme. Where one figure is given, this is a guide for anticipated average use conditions; more demanding conditions of use will require more frequent formal visual inspections, and/or combined inspections and tests. Where a range is shown, the small interval is for more demanding conditions of use and the longer interval is for less demanding ones. It is up to the duty holder, with appropriate advice where necessary, to assess the conditions affecting equipment, which may lead to potential damage and/or deterioration and should determine the maintenance regime.

5.2.1.5 Use of safe systems of work (no live working unless no other option, isolation, locating buried services, protection against overhead cables)

Regulation 14 of the Electricity at Work Regs 1989 states:

No person shall be engaged in any work activity on or so near any live conductor (other than one suitably covered with insulating material so as to prevent danger) that danger may arise unless -

- it is unreasonable in all the circumstances for it to be dead; and
- it is reasonable in all the circumstances for him to be at work on or near it while it is live; and
- suitable precautions (including where necessary the provision of suitable protective equipment) are taken to prevent injury.

The need for the conductor to be live.

If danger may otherwise arise, it is always preferable from the point of view of safety that work on or near such electrical equipment should be carried out when that equipment is dead.

Regulation 14 recognises that there are circumstances, however, in which it is unreasonable, having regard to all relevant factors, for the equipment to be dead while work proceeds. An example of this might be where it was found necessary to undertake some maintenance, checking or repair on a busy section of electric railway track where it would be disproportionately disruptive and costly in many ways for the live conductors to be isolated for the period of the work. Other examples are to be found in the electrical supply industry, particularly live cable jointing, and in much of the work done on telephone network connections.

Equipment users should bear in mind at the time of ordering, purchase and installation of plant, the manner of operation, maintenance and repair of the electrical equipment which will be necessary during the life of the plant. It is recommended that the design of electrical equipment and of the installation should eliminate the need for live work which puts persons at risk of injury. This can often be done by careful thought at the design stage of installations, for example by the provision of alternative power in feeds, properly laid out distribution systems to allow parts to be isolated for work to proceed and by designing equipment housings etc to give segregation of parts to be worked on and protect persons from other parts which may be live.

Circuitry should be arranged so that the power circuits are physically separate and segregated from logic and control circuits or so placed, recessed or otherwise arranged that the risk of accidental contact is eliminated. Diagnostic work on the low power voltage circuits may then proceed with less risk to personnel. Where regular measurements of voltage, current etc are to be made, consideration should be given to appropriate test

and measuring equipment, e.g. voltmeters, ammeters, etc or test points being built into the equipment.

Live work includes live testing, for example the use of a potential indicator on mains power and control logic circuits.

Live working

High Voltage Glove Working

This type of work usually applies to voltages above 1,000 Volts. It is conducted on energised circuits and involves direct contact with the live parts. It therefore presents a high risk of serious injury if not conducted safely. Workers wear approved non-conducting gloves and gauntlets extending to the shoulder as a way of insulating themselves against the live circuit conductors. This is their primary method of protection.

Workers may also use insulated blankets and lengths of line hose to cover the lengths of exposed conductor that they are not working on. This helps to reduce the length of conductor to which they are exposed. Most linemen also work from an insulated platform to provide isolation from the earth/ground.

'Hot Stick' Working

This involves carrying out work on live lines by use of insulating poles. Typical tasks include replacing post insulators and transferring lines onto temporary supports. The sticks enable work to be carried out without infringing minimum clearance distances from live equipment.

Tools, such as hooks, socket wrenches and even pneumatic or hydraulic power tools can be mounted at the end of the pole, although dexterity is naturally reduced when operating tools at the end of a pole that is several metres long.

Safe working near overhead power lines underground cables – hazards and precautions

Contact with live overhead lines kills people and causes serious injuries every year. About 60% of electrical fatalities at work are caused by inadvertent contact with overhead power lines. This equates to about 10 to 15 deaths a year. The following link gives a good picture of what can happen in just such an occurrence.

<http://www.hse.gov.uk/press/2009/coisco11409.htm>

Contact with overhead electric lines can be lethal whether they are carrying a voltage as high as 400 000 V or as low as 230 V. Overhead lines consist usually of bare (uninsulated)

conductors (sometimes called cables) supported via insulators by wooden poles or metal towers and structures. Many people mistake overhead power lines carried on wooden poles for telephone wires.

If a crane jib, tipper lorry, excavator, scaffold pole, ladder, agricultural sprayer or similar object makes contact with, or approaches near to, these lines, an electric current can flow with a risk of fatal or severe shock and burns to any person in the immediate vicinity. This can also occur with objects made from materials such as wood or plastic, which are normally regarded as electrical insulators. If damp or dirty, these may also be capable of transmitting sufficient current to cause dangerous or fatal electric shocks.

For work at or near overhead power lines, application of this hierarchy suggests the following actions:

- find out if the work has to be carried out under or near overhead lines (can it be avoided altogether) or,
- if this cannot be done;
- divert all overhead lines clear of the work area or, if it is not reasonable for this to be done;
- make lines dead while the work is in progress or, if this cannot be done;
- work around the live overhead lines, using the precautions outlined in this guidance.

In some cases, it may be necessary to use suitable combinations of these measures, particularly where overhead lines pass over permanent work areas.

Work near overhead lines.

Pre-planning of safe working procedures is important. The first step in avoiding danger is to find out whether there is any overhead electric line;

(a) within or immediately adjoining the work area, or

(b) across any route to it.

Information may be available from the local electricity supplier about location of their lines. If any such lines are found, it should be assumed that they are live unless - or until - this has been proved otherwise by their owners.

If there are any electric lines over the work area, near the site boundaries, or over access roads to the work area, consult the owners of the lines so that the proposed plan of work can be discussed. Allow sufficient time for the line to be diverted or made dead, or for other precautions to be taken as described below. If the lines can only be made dead for short periods, then the passage of tall plant and, as far as is possible, other work around the lines

should be scheduled at these times. Liaison between the persons responsible for the work and the owner(s) of the lines should be continued until the work has been completed.

The precautions depend on the nature of the work at the site. It is strongly recommended they are taken even when work near the line is of short duration. There are three broad categories of this work.

(a) Work areas where there will be no scheduled work or passage of plant under the lines. Here, barriers can prevent close approach, particularly for construction or quarrying work.

(b) Work areas where plant will pass under the lines. Here, defined passageways should be made.

(c) Work areas where work will be carried out beneath the lines. Here, further precautions must be taken in addition to the erection of barriers with passageways.

Where passage is required under the overhead line either along an access road or from one part of the work area to another, it is recommended that the danger area should be made as small as possible. This should be achieved by restricting the width of the passageway to the minimum needed for the safe crossing of plant. It is safest if the passageway crosses the route of the line at right angles.

The following precautions are recommended:

(a) The number of such passageways should be kept to a minimum.

(b) The passageway should be fenced to define its route, and goal posts erected at each end to act as gateways in the barriers running parallel to the overhead line.

(c) The goal posts should be constructed from rigid, non-conducting material such as suitable timber or plastic pipe and distinctively marked, for example, in red and white stripes.

(d) At either side of the passageway, on or near the goal posts, there should be warning notices giving the cross-bar clearance height and instructing drivers to lower jibs, tipper bodies etc and keep below this height while crossing.

(e) On sites where work continues after dark, the notices and cross-bars should be lit. It has also been found that illuminating the conductors is useful. The light fittings used for this illumination should be sited at ground level, projecting the light upwards towards the conductors.

(f) Additional warning notices should be erected on the approaches to the crossing, about 30 metres away.

(g) The surface of the passageway should be levelled, firmed up and well-maintained to prevent undue tilting or bouncing of the equipment when under the overhead line.

Isolation

Using methods of isolation will help reduce the risk of electric shock, although you must keep in mind that other measure should be utilized as a first instance.

), where necessary to prevent danger, suitable means (including, where appropriate, methods of identifying circuits) shall be available for:

- (a) cutting off the supply of electrical energy to any electrical equipment; and
- (b) (b) the isolation of any electrical equipment.

"isolation" means the disconnection and separation of the electrical equipment from every source of electrical energy in such a way that this disconnection and separation is secure.

Shall not apply to electrical equipment which is itself a source of electrical energy but, in such a case as is necessary, precautions shall be taken to prevent, so far as is reasonably practicable, danger.

Use of locating devices (Locating buried services)

The degree of confidence with which buried services can be detected depends on a number of factors such as:

- the training, skill, hearing and experience of the operator;
- the characteristics of the device being used;
- the calibration and reliability of the locating device;
- the type, length and depth of the service;
- for cables, the magnitude of the current being carried; and
- the effects of other nearby services.

It is very important that anyone who uses a locator should have received thorough training in its use and limitations. Locating devices should always be used in accordance with the manufacturer's instructions and should be regularly checked and maintained in good working order.

A locator may not be able to distinguish between cables or pipes running close together and may represent them as a single signal. If, for example, two are sited one above the other, the lower one may not be detected. Exposing one cable or pipe does not mean that there is

not another close by. Frequent and repeated use should be made of locators during the course of the work. Service location is likely to become more accurate as cover is removed.

5.2.1.6 Emergency procedures following an electrical incident

Points to include in emergency procedures:

- Consider what might happen and how the alarm will be raised. Don't forget night and shift working, weekends and times when the premises are closed, eg holidays
- Plan what to do, including how to call the emergency services. Help them by clearly marking your premises from the road. Consider drawing up a simple plan showing the location of hazardous items
- If you have 25 tonnes or more of dangerous substances, you must notify the fire and rescue service and put up warning signs
- Decide where to go to reach a place of safety or to get rescue equipment. You must provide suitable forms of emergency lighting
- You must make sure there are enough emergency exits for everyone to escape quickly, and keep emergency doors and escape routes unobstructed and clearly marked
- Nominate competent people to take control (a competent person is someone with the necessary skills, knowledge and experience to manage health and safety)
- Decide which other key people you need, such as a nominated incident controller, someone who is able to provide technical and other site-specific information if necessary, or first-aiders
- Plan essential actions such as emergency plant shutdown, isolation or making processes safe. Clearly identify important items like shut-off valves and electrical isolators etc
- You must train everyone in emergency procedures. Don't forget the needs of people with disabilities and vulnerable workers
- Work should not resume after an emergency if a serious danger remains. If you have any doubts ask for assistance from the emergency services

Type of business/equipment	User checks	Formal visual inspection	Combined inspection and electrical tests
Equipment hire	Yes	Before issue and after return	Before issue
Construction	Yes	Before initial use and then every month	3 months
Industrial	Yes	Before initial use and then every 3 months	6-12 months
Hotels and offices, low-risk environments			
Battery operated (less than 20 V)	No	No	No
Extra low voltage (less than 50 V ac), for example telephone equipment, low-voltage desk lights	No	No	No
Computers/photocopiers/fax machines	No	Yes 2-4 years	No if double insulated, otherwise up to 5 years
Double-insulated equipment: not handheld. Moved occasionally, for example fans, table lamps, slide projectors	No	Yes 2-4 years	No
Double-insulated equipment: handheld, for example some floor cleaners, some kitchen equipment and irons	Yes	Yes 6 months-1 year	Yes 1-2 years
Earthed equipment (class 1): for example electric kettles, some floor cleaners, portable electric heaters	Yes	Yes 6 months-1 year	
Cables (leads) and plug connected to above. Extension leads (mains voltage)	Yes	Yes 6 months-4 years depending on the type of equipment it is connected to	Yes 1-5 years depending on the type of equipment it is connected to

Source: Derived from UKHSE. Note: Operational experience may demonstrate that the above intervals can be reviewed.

5.2.1.7 Inspection and maintenance strategies

User checks

Advice on user checks is that the person using the electrical equipment should complete the following checks:

- Damage (apart from light scuffing) to the cable sheath.
- Damage to the plug, for example the casing is cracking or the pins are bent.
- Inadequate joints, including taped joints in the cable; the outer sheath of the cable is not effectively secured where it enters the plug or the equipment. Obvious evidence would be if the coloured insulation of the internal cable cores were showing.
- The equipment has been subjected to conditions for which it is not suitable, e.g. it is wet or excessively contaminated.
- Damage to the external casing of the equipment or there are some loose parts or screws; evidence of overheating (burn marks or discolouration).

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To control the risks and to monitor the user checks, a competent person should carry out regular inspections that include visual checks similar to those listed above but undertaken in a more formal and systematic manner.

Additional checks could include:

- Removing the plug cover and ensuring that a fuse is being used (e.g. it is a fuse not a piece of wire or a nail etc).
- Checking that the cord grip is effective.
- Checking that the cable terminations are secure and correct, including an earth where appropriate, and there is no sign of internal damage, overheating or ingress of liquid or foreign matter.

The formal visual inspection should not include taking the equipment apart. This should be confined, where necessary, to the combined inspection and testing. The trained person can normally be a member of staff who has sufficient information and knowledge of what to look for, and what is acceptable, and who has been given the task of carrying out the inspection. To avoid danger, trained people should know when the limit of their knowledge

and experience has been reached. Simple, written guidance relating to the visual inspection can be produced that summarises what to look for and which procedures to follow when faults are found or when unauthorised equipment is found in use.

The formal visual inspections should be carried out at regular intervals. The period between inspections can vary considerably, depending on the type of equipment, the conditions of use and the environment. For example, equipment used on a construction site or in a heavy steel fabrication workshop will need much more frequent inspection than equipment such as floor cleaners in an office. In all cases, however, the period between inspections should be reviewed in the light of experience. Faulty equipment should be taken out of service and not used again until properly repaired. If necessary, it should be tested. The pattern of faults can help management decide what action to take, depending on whether the faults show:

- the wrong equipment is being selected for the job;
- further protection may be necessary in a harsh environment;
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Testing is likely to be justified:

- whenever there is reason to suppose the equipment may be defective (but this cannot be confirmed by visual inspection);
- after any repair, modification or similar work;
- at periods appropriate to the equipment, the manner and frequency of use and the environment.

The inspection carried out in conjunction with testing should usually include checking:

- the correct polarity of supply cables;

- correct fusing;
- effective termination of cables and cores;
- that the equipment is suitable for its environment.

Such combined inspection and testing requires a greater degree of competence than that required for inspection alone, because the results of the tests may require interpretation and appropriate electrical knowledge will be needed. However, it can often be carried out by a competent employee.

People carrying out testing of portable electrical equipment should be appropriately trained for this work. It is the employer's duty to ensure that they are competent for the work they are to carry out. Basically, there are two levels of competency.

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The second level is where a person with appropriate electrical skills uses a more sophisticated instrument that gives actual readings requiring interpretation. Such a person would need to be competent through technical knowledge or experience related to the type of work.

Some combination of actions should provide the most cost effective way of ensuring, so far as is reasonably practicable, that equipment will be maintained in a safe condition wherever it is used.

Testing can be carried out at minimal cost where an employee has been trained to a suitable level of competence and provided with appropriate equipment.

Records of maintenance and tests.

Although there is no requirement in the Electricity at Work Regulations to keep maintenance logs for portable and transportable electrical equipment, the EAW Memorandum does refer to the benefits of recording maintenance, including test results. A suitable log is useful as a management tool for monitoring and reviewing the effectiveness of the maintenance scheme and also to demonstrate that a scheme exists. It can also be used as an inventory of equipment and a check on the use of unauthorised equipment (e.g. domestic kettles or electric heaters brought to work by employees).

The log can include faults found during inspection, which may be a useful indicator of places of use, or types of equipment, that are subject to a higher than average level of wear or damage. This will help monitor whether suitable equipment has been selected. Entries in a test log can also highlight any adverse trends in test readings that may affect the safety of the equipment, thus enabling remedial action to be taken. Be careful when interpreting trends where a subsequent test may be done with a different instrument from that used for an earlier test, as differences in the results may be due to difference in the instruments rather than deterioration in the equipment being tested.

Records do not necessarily have to be on a paper system. Test instruments are available that store the data electronically, which can then be downloaded directly onto a computer database. Duty holders with large amounts of equipment will find it useful to label equipment to indicate that the equipment has been tested satisfactorily i.e. has been passed as safe, and when the date for the next test is due. Otherwise, individual items may be missed on consecutive occasions.

Frequency of inspection and testing.

Deciding on the frequency of inspection and testing is a matter of judgement by the duty holder, and should be based on an assessment of risk. This can be undertaken as part of the assessment of risks under the Management of Health and Safety at Work Regulations 1999.

The Table below can help any duty holder decide how often to carry out a formal visual inspection as well as combined inspection and testing, particularly where a maintenance regime has not previously existed. Alternatively, seek advice from a competent person who has the knowledge and experience to make the necessary judgment, e.g. manufacturers or suppliers of equipment, or relevant trade associations.

Factors to consider when making the assessment include the following:

- Type of equipment and whether it is hand-held or not.
- Manufacturer's recommendations.
- Initial integrity and soundness of equipment.
- Age of the equipment.
- Working environment in which the equipment is used (e.g. wet or dusty) or likelihood of mechanical damage.
- Frequency of use and the duty cycle of the equipment.
- Foreseeable abuse of the equipment.
- Effects of any modifications or repairs to the equipment.
- Analysis of previous records of maintenance, including both formal inspection and combined inspection and testing.

The Table below sets out the suggested frequency of formal visual inspections and combined inspections and electrical tests for portable and transportable electrical equipment. It gives suggested starting intervals when implementing a maintenance programme. Where one figure is given, this is a guide for anticipated average use conditions; more demanding conditions of use will require more frequent formal visual inspections, and/or combined inspections and tests. Where a range is shown, the small interval is for more demanding conditions of use and the longer interval is for less demanding ones. It is up to the duty holder, with appropriate advice where necessary, to assess the conditions affecting equipment, which may lead to potential damage and/or deterioration and should determine the maintenance regime.

The selection and suitability of equipment

Many factors which affect the selection of suitable electrical equipment, such as flammable, explosive and damp atmospheres and adverse weather conditions, have already been considered. Other issues include high or low temperatures, dirty or corrosive processes or problems associated with vegetation or animals (e.g. tree roots touching and displacing underground power cables, farm animals urinating near power supply lines and rats gnawing through cables). Temperature extremes will affect, for example, the lubrication of motor bearings and corrosive atmospheres can lead to the breakdown of insulating materials. The equipment selected must be suitable for the task demanded or either it will become overloaded or running costs will be too high.

The equipment should be installed to a recognized standard and be capable of being isolated in the event of an emergency. It is also important that the equipment is effectively and safely earthed. Electric supply failures may affect process plant and equipment. These are certain to happen at some time and the design of the installation should be such that a safe shutdown can be achieved in the event of a total mains failure. This may require the use of a battery-backed shutdown system or emergency standby electric generators (assuming that this is cost-effective).

Finally, it is important to stress that electrical equipment must only be used within the rating performance given by the manufacturer and any accompanying instructions from the manufacturer or supplier must be carefully followed.

Element 6 - Fire safety

Learning outcomes

- ✚ Describe the principles of fire initiation, classification and spread Outline the principles of fire risk assessment
- ✚ Describe the basic principles of fire prevention and the prevention of fire spread in buildings
- ✚ Outline the appropriate fire alarm system and fire-fighting arrangements for a simple workplace
- ✚ Outline the factors which should be considered when implementing a successful evacuation of a workplace in the event of a fire.

Introduction

On average across the 14 countries, the total 'cost' of fires was 0.65 per cent of GDP. Important components that are included in this calculation include monetary equivalents for human loss (deaths and injuries), monetary equivalents for volunteer fire fighters and other donated time, and the cost of achieving better fire performance in products, whether mandated by regulation or otherwise.

The financial costs associated with serious fires are very high including, in many cases (believed to be over 40 per cent), the failure to start up business again. Never underestimate the potential of any fire. What may appear to be a small fire in a waste bin, if not dealt with, can quickly spread through a building or a structure. The UK Bradford City Football ground in 1985 or King's Cross Underground station in 1987 are examples of where small fires quickly became raging infernos, resulting in many deaths and serious injuries.

6.1 Fire initiation, classification and spread - Principals of fire

6.1.1 Principals of fire

Fire is a spectacular example of a fast chemical reaction between a combustible substance and oxygen accompanied by the evolution of heat. An explosion is an even more spectacular example of the same reaction. The three requirements for fire are:

- A fuel or combustible substance;
- Oxygen, except in very special circumstances;
- A source of energy.

These three requirements are easily remembered in the form of the fire triangle. The triangle, however, says nothing about the relative importance of each of the requirements or their states of matter. These come from a full knowledge of the chemistry of combustion.

Fire triangle

Fire cannot take place unless three things are present.

The absence of any one of these elements will prevent a fire from starting. Prevention depends on avoiding these three coming together. Fire extinguishing depends on removing one of the elements from an existing fire, and is particularly difficult if an oxidising substance is present.

Once a fire starts, it can spread very quickly from fuel to fuel as the heat increases.

Source of ignition

Workplaces have numerous sources of ignition, some of which are obvious but others may be hidden inside machinery. Most of the sources may cause an accidental fire from sources inside but, in the case of arson (about 13 per cent of industrial fires), the source of ignition may be brought from outside the workplace and will be deliberately used. The following are potential sources of ignition in the typical workplace:

- **Naked flames**-from smoking materials, cooking appliances, heating appliances and process equipment.
- **External sparks** - from grinding metals, welding, impact tools, electrical switch gear.
- **Internal sparking** - from electrical equipment (faulty and normal), machinery, lighting.

- **Hot surfaces** - from lighting, cooking, heating appliances, process equipment, poorly ventilated equipment, faulty and/or badly lubricated equipment, hot bearings and drive belts.
- **Static electricity** - causing significant high-voltage sparks from the separation of materials such as unwinding plastic, pouring highly flammable liquids, walking across insulated floors or removing synthetic overalls



Figure – Fire triangle

Source of fuel

If something will burn, it can be fuel for a fire. The things which will burn easily are the most likely to be the initial fuel, which then burns quickly and spreads the fire to other fuels. The most common things that will burn in a typical workplace are below (note the pictograms given are those in the new UN Global Harmonized System being introduced worldwide. See the annex to the UN GHS for comparisons and allocation from existing signs.

Solids - these include, wood, paper, cardboard, wrapping materials, plastics, rubber, foam (e.g. polystyrene tiles and furniture upholstery), textiles (e.g. furnishings and clothing), wall paper, hardboard and chipboard used as building materials, waste materials (e.g. wood shavings, dust, paper), hair.

Liquids - these include, paint, varnish, thinners, adhesives, petrol, white spirit, methylated spirits, paraffin, toluene, acetone and other chemicals. Most flammable liquids give off vapours which are heavier than air so they will fall to the lowest levels. A flash flame or an explosion can occur if the vapour catches fire in the correct concentrations of vapour and air.

Gases - flammable gases include LPG (liquefied petroleum gas in cylinders, usually butane or propane), acetylene (used for welding) and hydrogen. An explosion can occur if the air/gas mixture is within the explosive range.

Oxygen

Oxygen is of course provided by the air all around but this can be enhanced by wind, or by natural or powered ventilation systems which will provide additional oxygen to continue burning.

Cylinders providing oxygen for medical purposes or welding can also provide an additional very rich source of oxygen. In addition, some chemicals such as nitrates, chlorates, chromates and peroxides can release oxygen as they burn and therefore need no external source of air.

Oxidising materials

The oxidizing materials do not necessarily present danger on their own, however, if an oxidizing material gets in touch with another chemical, it is very likely that it will catch on fire. Oxidizing materials come in forms of gas, liquids and solids. An examples of gas include oxygen and ozone, liquids include nitric acid, chromic acid and sodium, hypochlorite, and solids include chromate, potassium permanganate. These materials are likely to have great reactions and in turn cause explosions.

6.1.2 Classification of fire

Fires are classified in accordance with *EN2:1992 Classification of Fires and ISO 3941: Classification of Fires*. There are five main classes of fire - A, B, C, D and F - plus fires involving electrical equipment. The categories based on fuel and the means of extinguishing are as follows:

Class A - Fires which involve solid materials such as wood, paper, cardboard, textiles, furniture and plastics where there are normally glowing embers during combustion. Such fires are extinguished by cooling, which is achieved using water.

Class B - Fires which involve liquids or liquefied solids such as paints, oils or fats. These can be further subdivided into:

- *Class B1* - fires which involve liquids that are soluble in water such as methanol. They can be extinguished by carbon dioxide, dry powder, water spray, light water and vaporizing liquids;
- *Class B2* - fires which involve liquids not soluble in water, such as petrol and oil. They can be extinguished by using foam, carbon dioxide, dry powder, light water and vaporizing liquid.

Class C - Fires which involve gases such as natural gas, or liquefied gases such as butane or propane. They can be extinguished using foam or dry powder in conjunction with water to cool any containers involved or nearby.

Class D - Fires which involve metals such as aluminium or magnesium. Special dry powder extinguishers are required to extinguish these fires, which may contain powdered graphite or talc.

Class F - Fires which involve high-temperature cooking oils or fats in large catering establishments or restaurants.

Electrical fires - Fires involving electrical equipment or circuitry do not constitute a fire class on their own, as electricity is a source of ignition that will feed a fire until switched off or isolated. But there are some pieces of equipment that can store, within capacitors, lethal voltages even when isolated. Extinguishers specifically designed for electrical use like carbon dioxide or dry powder units should always be used for this type of fire hazard.

6.1.3 Principles of heat transmission and fire spread

Fire transmits heat in several ways, which needs to be understood in order to prevent, plan escape from, and fight, fires. Heat can be transmitted by convection, conduction, radiation and direct burning.

Convection

Hot air becomes less dense and rises, drawing in cold new air to fuel the fire with more oxygen. The heat is transmitted upwards at sufficient intensity to ignite combustible materials in the path of the very hot products of combustion and flames. This is particularly important inside buildings or other structures where the shape may effectively form a chimney for the fire.

Conduction

This is the transmission of heat through a material with sufficient intensity to melt or destroy the material and ignite combustible materials which come into contact or close to a hot section. Metals like copper, steel and aluminium are very effective or good conductors of heat. Other materials like concrete, brickwork and insulation materials are very ineffective or poor conductors of heat.

Poor conductors or good insulators are used in fire protection arrangements. When a poor conductor is also incombustible, it is ideal for fire protection. Care is necessary to ensure that there are no other issues, such as health risks, with these materials. Asbestos is a very poor conductor of heat and is incombustible. However, there are very severe health effects which now outweigh its value as a fire protection material and it is banned in the United Kingdom. Unfortunately, asbestos is still found in many buildings where it was used extensively for fire protection, it now has to be managed under legislation in many countries.

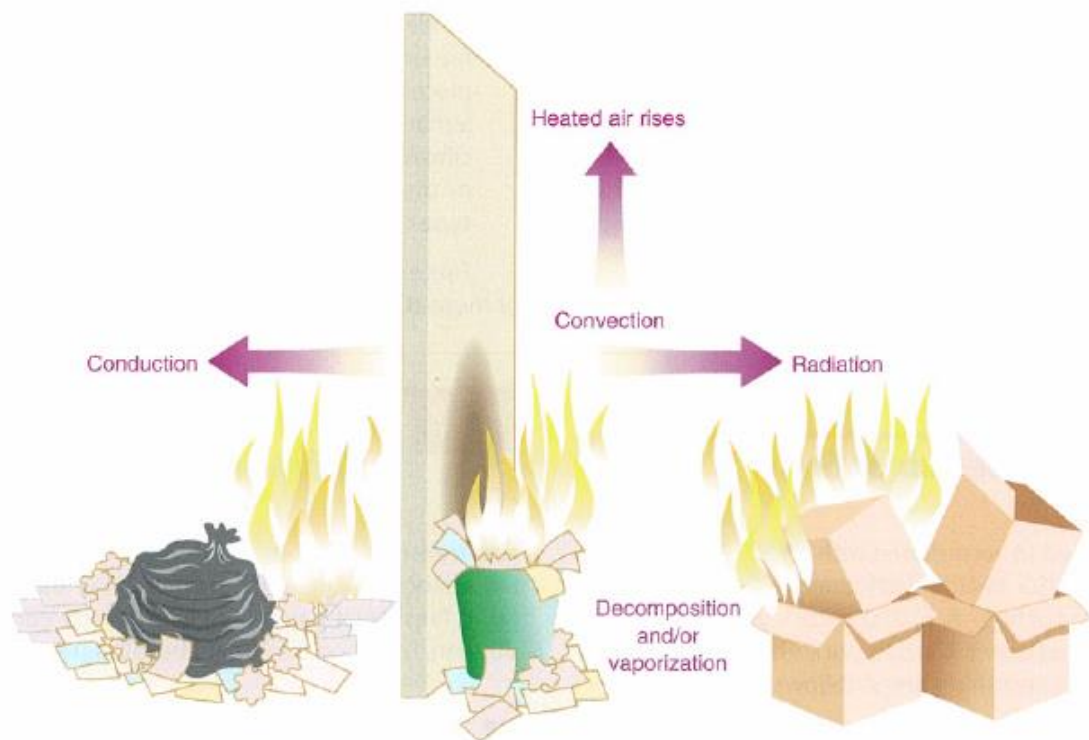


Figure – Principal of heat transmission

Radiation

Often in a fire, the direct transmission of heat through the emission of heat waves from a surface can be so intense that adjacent materials are heated sufficiently to ignite. A metal surface glowing red-hot would be typical of a severe radiation hazard in a fire.

Direct burning

This is the effect of combustible materials catching fire through direct contact with flames which causes fire to spread, in the same way that lighting an open fire, with a range of readily combustible fuels, results in its spread within a grate.

Fire and smoke spread in buildings

Where fire is not contained and people can move away to a safe location, there is little immediate risk to those people. However, where fire is confined inside buildings, the fire behaves differently.

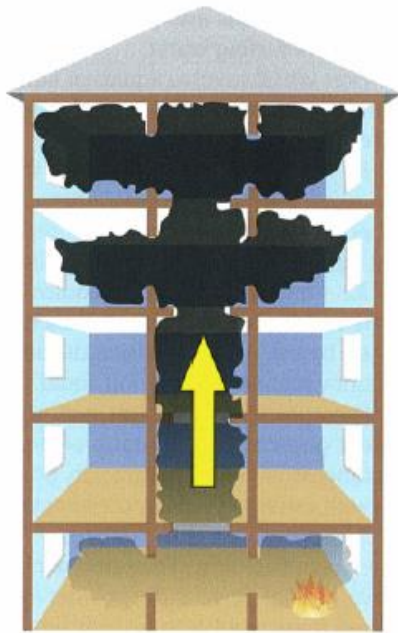


Figure - Fire and smoke spread in buildings

The smoke rising from the fire gets trapped inside the space by the immediate ceiling, then spreads horizontally across the space, deepening all the time until the entire space is filled. The smoke will also pass through any holes or gaps in the walls, ceiling or floor and get into other parts of the building. It moves rapidly up staircases or lift wells and into any areas that are left open, or rooms which have open doors connecting to the staircase corridors. The heat from the building gets trapped inside, raising the temperature very rapidly. The toxic smoke and gases are an added danger to people inside the building, who must be able to escape quickly to a safe location.

6.1.4 Common causes of fire and consequences

Causes

The UK Home Office statistics show that the causes of fires in buildings, excluding dwellings, was in 2005 as shown in Figure 13.7. The total was 35 300,6 per cent less than the previous year. This follows a 10 per cent fall between 2003 and 2004 and follows the general trend downwards since 1995.

The sources of ignition are shown in Figure. Out of the 21 200 accidental fires in 2005, it shows that cooking appliances and electrical equipment account for over 60 per cent of the total.

Smoking: It is a common cause of business or office fires because smokers inconsiderately dispose of their cigarette or match stick. Smoking is not only dangerous to health, but it can also cause a fire accident, which can result in injuries, property damage and even deaths. Therefore, there should be a designated smoking area in the office where smokers can extinguish their match or cigarettes after they are done.

Arson: One of the leading causes of deaths, injuries and damages of properties with offices, commercial building is Arson. This not only affects a company or business financially, but also results in death of workers, employees and firefighters. To protect against Arson, make sure that company is properly secured. Consider security cameras and good security system to defend against criminals, who are trying to burn down the business.

Electrical Fires: The most common causes of electrical fires are damaged electrical conductors, use of faulty electrical equipment, plug wires or extension cords, short or overloaded circuits and loose electrical connections. Therefore, use only that electrical equipment that is in good condition. However, if using heaters in the office, then keep them in a safe place.

In summary:

Careless actions and accidents

- 'Hot works' such as welding, cutting and grinding
- Discarded lighted cigarette end or match
- Smouldering waste

- Unattended burning of waste materials
- Poor electrical connections

Misusing equipment

- Overloading electrical circuits and/or using fuses of too high a rating
- Failure to follow servicing instructions
- Failure to repair faulty machinery/equipment promptly

Defective machinery or equipment

- Electrical short circuits
- Electrical earth fault can cause local overheating
- Electrical insulation failure may occur when affected by heat, damp or chemicals

Deliberate ignition (arson)

- Deliberate ignition is the crime of maliciously and intentionally, or recklessly, starting a fire or causing an explosion

For example, insurance fraud, aggrieved persons, concealment of another crime, political activists or vandalism.

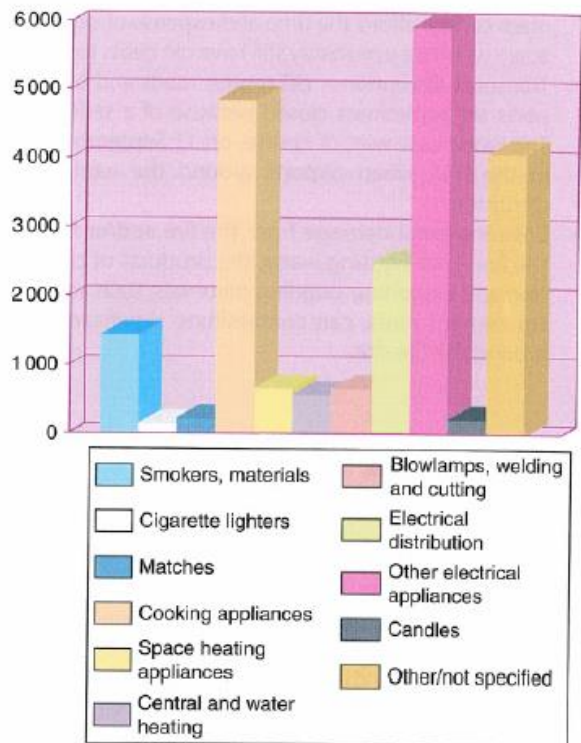
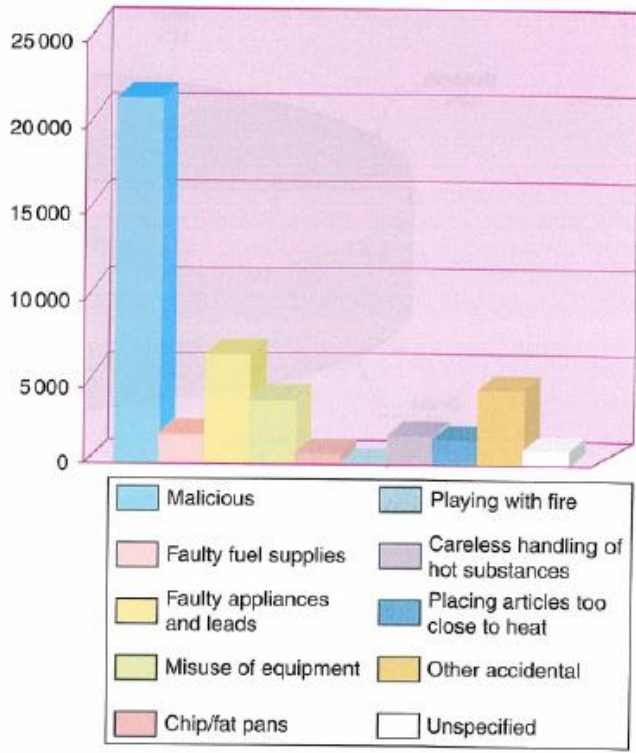


Figure – Causes of fire 2005
ignition, 2005

Figure – Accidental fires- source of

Consequences

The main consequence of fire is death. Although this is a very real risk, relatively few people die in building fires that are not in dwellings. In 2005, in the UK 21 (4%) people died out of a total of 485 in all fires.

The main causes of all deaths were:

- overcome by gas or smoke - 46%;
- burns-27%;
- burns and overcome by gas or smoke - 20%;
- other-7%.

Clearly gas and smoke are the main hazards. Other fire consequences are:

- Personal injury - some 1395 people were injured (12%) of total injuries in all fires.
- Building damage - can be very significant, particularly if the building materials have poor resistance to fire and there is little or no built-in fire protection.
- Flora and fauna damage - can be significant, particularly in a hot drought or forest fire.
- Loss of business and jobs - it is estimated that about 40% of businesses do not start up again after a significant fire. Many are under- or not insured and small companies often cannot afford the time and expense of setting up again when they probably still have old debts to service.
- Transport disruption - rail routes, roads and even airports are sometimes closed because of a serious fire. The worst case was, of course, on 11 September 2001 in the USA when airports around the world were disrupted.
- Environmental damage from the fire and/or fighting the fire - fire-fighting water, the products of combustion and exploding building materials, such as asbestos cement roofs, can contaminate significant areas around the fire site.

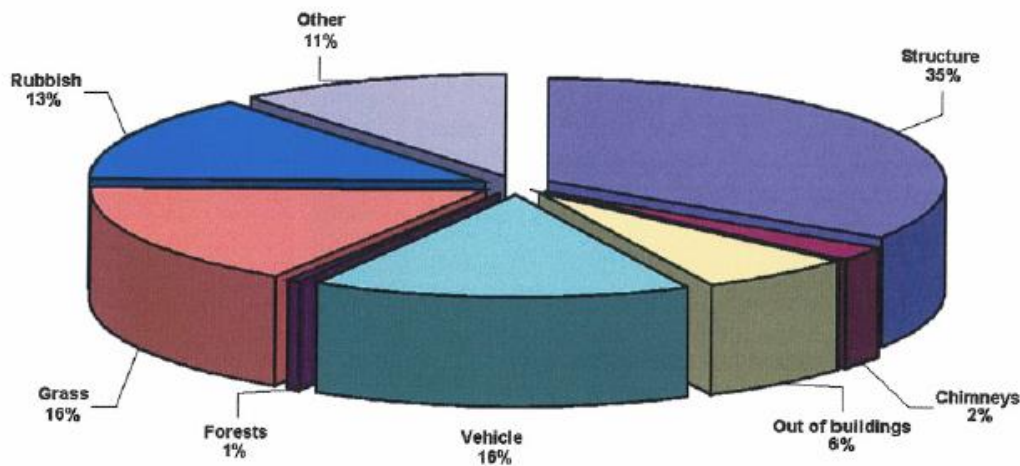


Figure - Distribution of Fires by fire origin. Source: CTIF World Fire Statistics 2006

6.2 Fire risk assessment

A fire risk assessment will indicate what fire precautions are needed. There are numerous ways of carrying out a fire risk assessment: the one described below is based on the method contained within Fire Safety Guides published by the UK Department of Communities and Local Government. A systematic approach, considered in five simple stages, is generally the best practical method.

6.2.1 The reasons for carrying out a fire risk assessment

The purpose of a fire risk assessment (FRA) is to identify where fire may start in the workplace, the people who would be put at risk, and to reduce the risk where possible.

The ILO has established a number of health and safety conventions, recommendations and guidance for conducting health and safety risk assessments which is part of the principles and practices established by these requirements.

Most of the countries around the world have established specific legal requirements relating to risk assessments, including fire risks.

Hence, it is important to carry out a Risk Assessment for:

- 1. Financial reasons:** There is considerable evidence, borne out by companies' practical experiences that effective safety and health management in the workplace contributes to business success. Accidents and ill-health inflict significant costs, often hidden and underestimated.
- 2. Legal reasons:** Carrying out a Risk Assessment and implementing what employer has

written down are not only central to any safety and health management system, they are required by law. Health and Safety Authority inspectors visiting workplaces will want to know how employers are managing safety and health. If they investigate an accident, they will scrutinise the Risk Assessment and the procedures and work practices in use. It should be ensured that these stand up to examination. If the inspector finds that one of these is inadequate, he or she can ask the employer to revise it. Employers can be prosecuted if they do not have a Risk Assessment.

3. Moral and ethical reasons: The process of carrying out a Risk Assessment and implementing what employer has written down will help employees prevent injuries and ill-health at work. Employers are ethically bound to do all they can to ensure that their employees do not suffer illness, a serious accident or death.

6.2.2 Factors to be considered in carrying out the assessment

Stage1 - Factors to be considered in carrying out the assessment

There are five main hazards produced by fire that should be considered when assessing the level of risk:

- oxygen depletion;
- flames and heat;
- smoke;
- gaseous combustion products;
- structural failure of buildings.

Of these, smoke and other gaseous combustion products are the most common cause of death in fires.

For a fire to occur, it needs sources of heat and fuel. If these hazards can be kept apart, removed or reduced, then the risks to people and businesses are minimized. *Identifying fire hazards* in the workplace is the first stage as follows.

Identify any combustibles

Most workplaces contain combustible materials. Usually, the presence of normal stock in trade should not cause concern, provided the materials are used safely and stored away from sources of ignition. Good standards of housekeeping are essential to minimize the risk of a fire starting or spreading quickly.

The amount of combustible material in a workplace should be kept as low as is reasonably practicable. Materials should not be stored in gangways, corridors or stairways or where they may obstruct exit doors and routes. Fires often start and are assisted to spread by

combustible waste in the workplace. Such waste should be collected frequently and removed from the workplace, particularly where processes create large quantities of it.

Some combustible materials, such as flammable liquids, gases or plastic foams, ignite more readily than others and quickly produce large quantities of heat and/or dense toxic smoke. Ideally, such materials should be stored away from the workplace or in fire-resisting stores. The quantity of these materials kept or used in the workplace should be as small as possible, normally no more than half a day's **supply**.

Identify any sources of heat

All workplaces will contain heat/ignition sources; some will be obvious such as cooking sources, heaters, boilers, engines, smoking materials or heat from processes, whether in normal use or through carelessness or accidental failure. Others may be less obvious such as heat from chemical processes or electrical circuits and equipment.

Where possible, sources of ignition should be removed from the workplace or replaced with safer forms. Where this cannot be done, the ignition source should be kept well away from combustible materials or made the subject of management controls.

Particular care should be taken in areas where portable heaters are used or where smoking is permitted (now banned inside UK premises). Where heat is used as part of a process, it should be used carefully to reduce the chance of a fire as much as possible. Good security both inside and outside the workplace will help to combat the risk of arson.

Under smoke-free legislation in Europe, smoking is not permitted in enclosed or significantly enclosed areas. Outside designated safe areas should be provided for those who still require to smoke. The smoking rules should be rigorously enforced.

Demolition work can involve a high risk of fire and explosion. In particular:

- Dismantling tank structures can cause the ignition of flammable residues. This is especially dangerous if hot methods are used to dismantle tanks before residues are thoroughly cleaned out. The work should only be done by specialists.
- Disruption and ignition of buried gas and electrical services is a common problem. It should always be assumed that buried services are present unless it is positively confirmed that the area is clear. A survey using service detection equipment must be carried out by a competent person to identify any services. The services should then be marked, competently purged or made dead, before any further work is done. A permit to excavate or dig is the normal formal procedure to cover buried services.

Identify any unsafe acts

Persons undertaking unsafe acts such as smoking next to combustible materials, etc.

Identify any unsafe conditions

These are hazards that may assist a fire to spread in the workplace, for example if there are large areas of hardboard or polystyrene tiles etc., or open stairs that can enable a fire to spread quickly, trapping people and engulfing the whole building.

An ideal method of identifying and recording these hazards is by means of a simple single-line plan.. Checklists may also be used.

Stage 2 - identify persons who are at significant risk

Consider the risk to any people who may be present. In many instances, and particularly for most small workplaces, the risk(s) identified will not be significant, and specific measures for persons in this category will not be required. There will, however, be some occasions when certain people may be especially at risk from fire, because of their specific role, disability, sleeping, location or the workplace activity. Special consideration is needed if:

- sleeping accommodation is provided;
- persons are physically, visually or mentally challenged;
- people are unable to react quickly;
- persons are isolated.

People, such as visitors, the public or other workers, may come into the workplace from outside. The assessor must decide whether the current arrangements are satisfactory or if changes are needed.

Because fire is a dynamic event, which, if unchecked, will spread throughout the workplace, all people present will eventually be at risk if fire occurs. Where people are at risk, adequate means of escape from fire should be provided together with arrangements for detecting and giving warning of fire. Fire fighting equipment suitable for the hazards in the workplace should be provided.

Some people may be at significant risk because they work in areas where fire is more likely or where rapid fire growth can be anticipated. Where possible, the hazards creating the high level of risk should be reduced. Specific steps should be taken to ensure that people affected are made aware of the danger and the action they should take to ensure their safety and the safety of others.

Stage 3 - evaluate and reduce the risks

If the building has been built and maintained in accordance with Building Regulations and is being put to its designed use, it is likely that the means of escape provisions will either be adequate, or it will be easy to decide what is required in relation to the risk. Having identified the hazards and the persons at risk, the next stage is to reduce the chance of a fire occurring and spreading, thereby minimising the chance of harm to persons in the workplace. The principles of prevention are based on EC Directive requirements (see Chapter 6 for further details).

Evaluate the risks

Attempt to classify each area as 'high', 'normal' or 'low risk'. If 'high risk', it may be necessary to reconsider the principles of prevention, otherwise additional compensatory measures will be required.

Low risk - Areas where there is minimal risk to persons' lives; where the risk of fire occurring is low; or the potential for fire, heat and smoke spreading is negligible and people would have plenty of time to react to an alert of fire.

Normal risk - Such areas will account for nearly all parts of most workplaces; where an outbreak of fire is likely to remain confined or spread slowly, with an effective fire warning allowing persons to escape to a place of safety.

High risk - Areas where the available time needed to evacuate the area is reduced by the speed of development of a fire, for example highly flammable or explosive materials stored or used (other than small quantities under controlled conditions); also where the reaction time to the fire alarm is slower because of the type of person present or the activity in the workplace, for example the infirm and elderly or persons sleeping on the premises.

Stage 4 - the findings (always recommended, see Stage 5 - review)

The findings of the assessment and the actions (including maintenance) arising from it should be recorded. If five or more people are employed, or an Alterations Notice (UK) is required, a formal record of the significant findings and any measures proposed to deal with them must be recorded (see Appendix 13.2). The record should indicate:

- the date the assessment was made;
- the hazards identified;
- any staff and other people especially at risk;

- what action needs to be taken, and by when (the *action plan*);
- the conclusions arising.

The above guidelines are to be used with caution. Each part of the workplace must be looked at and a decision made on how quickly persons would react to an alert of fire in each area. Adequate safety measures will be required if persons are identified as being at risk. Where maximum travel distances cannot be achieved, extra fire safety precautions will be needed.

Where persons are at risk or an unacceptable hazard still exists, additional fire safety precautions will be required to compensate for this, or alternatively repeat previous stages to manage risk to an acceptable level.

Stage 5 - monitor and review on a regular basis

The fire risk assessment is not a one-off procedure. It should be continually monitored to ensure that the existing fire safety arrangements and fire risk assessment remain realistic. The assessment should be reviewed if there is a significant change in the occupancy; work activity; the materials used or stored when building works are proposed, or when it is no longer thought to be valid. Use Appendix 13.3 for checking on fire safety standards.

6.3.3 Consideration of temporary workplaces and changes to workplaces

It is essential to ensure that people can escape quickly from a workplace if there is a fire. Normally the entrances and exits to the workplace will provide escape routes, particularly if staff have been trained in what to do in case of fire and if it is certain that an early warning will be given.

It is likely that the means of escape will be adequate in modern buildings which have had local Building Regulation approval or have been built to acceptable building construction standards. Where there have not been significant changes to the building or where the workplace has recently been inspected by the fire authorities or other fire expert and found to be satisfactory, no change is likely to be needed. It may occasionally be necessary to improve the fire protection on existing escape routes, or to provide additional exits. In making a decision about the adequacy of means of escape, the following points should be considered:

- people need to be able to turn away from a fire as they escape or be able to pass a fire when it is very small;
- if a single-direction escape route is in a corridor, the corridor may need to be protected from fire by fire-resisting partitions and self-closing fire doors;
- stair openings can act as natural chimneys in fires. This makes escape from the upper parts of some work places difficult. Most stairways, therefore, need to be separated from the workplace by fire-resistant partitions and self-closing fire doors. Where stairways serve no more than two open areas, in shops for example, which people may need to use as escape routes, there may be no need to use this type of protection.

Legislation covering Fire Safety in the U.K. has gone through a dramatic change. The Fire Precautions Act 1971 and the Fire Precautions (Workplace) Regulations 1997 have been repealed, along with many other fire safety regulations embedded in other statutes, Fire certificates have ceased to exist, and employers have become solely responsible for fire safety within their workplaces, this includes outdoor event sites as well building and temporary structures.

The following signs are typical of some of the ones most likely to be needed in these premises. Others may be necessary, depending on the hazards and risks present. The wording will of course be in the relevant local language.

- Overhead obstacles, construction site and Prohibition notices (Figure 6.5).
- Wet floors - These need to be used wherever a slippery area is not cordoned off. Lightweight stands holding double-sided signs are readily available.
- (Hi) Chemical storage - Where hazardous cleaning chemicals are stored, apart from keeping the store locked, a suitable warning notice should be posted if it is considered this would help to reduce the risk of injury.
- Fire safety signs - These are needed to indicate emergency routes and emergency exits.
- Fire action signs -These are needed to show actions necessary in an emergency such as sounding a fire alarm, location of fire extinguishers or hose reels.
- First-aid - Signs showing the location of first-aid facilities will be needed. Advice on the action to take in the case of electric shock is no longer a legal requirement but is recommended.
- Gas pipes and LPG cylinder stores - LPG cylinder stores should have the sign No smoking - Where smoking is not permitted the no-smoking sign is required. In many EU member states areas substantially enclosed areas should have the sign shown in under smoke-free legislation.
- Fragile roofs - Signs should be erected at roof access points and at the top of outside walls where ladders may be.

- Obstacles or dangerous locations - For example low head height, tripping hazard, etc. - alternating yellow and black stripes.

Basic requirements

Exit routes must meet the following

- An exit route must be permanent.
- An exit must be separated by fire resistant materials
- Openings into an exit must be limited.
- An opening into an exit must be protected by a self-closing fire door that remains closed or automatically closes

The number of exit routes must be adequate.

- Two exit routes. At least two exit routes must be available in a workplace
- More than two exit routes. More than two exit routes must be available in a workplace if the number of employees, the size of the building, its occupancy, or the arrangement of the workplace is such that all employees would not be able to evacuate safely during an emergency.

Exit discharge.

- Each exit discharge must lead directly outside or to a street, walkway, refuge area, public way, or open space with access to the outside.
- The street, must be large enough to accommodate the building occupants
- Exit stairs that continue beyond the level on which the exit discharge is located must be interrupted at that level by doors.

An exit door must be unlocked

- Employees must be able to open an exit door from the inside without keys, tools, or special knowledge. A device such as a panic bar that locks only from the outside is permitted on exit discharge doors.
- Exit route doors must be free of any device or alarm that could restrict emergency use of the exit route if the device or alarm fails.

- The width of an exit route must be sufficient
- Objects that project into the exit route must not reduce the width of the exit route

Exit routes must be free and unobstructed. No materials or equipment may be placed, either permanently or temporarily, within the exit route. The exit access must not go through a room that can be locked, such as a bathroom, to reach an exit or exit discharge, nor may it lead into a dead-end corridor. Stairs or a ramp must be provided where the exit route is not substantially level.

6.3 Fire prevention and prevention of fire spread

6.3.1 Control measures to minimise the risk of fire in a workplace

Choose control measures which are consistent with the risk assessment and appropriate to the nature of the activity or operation. These can include:

- preventing fires and explosions from spreading to other
- plant and equipment or to other parts of the workplace;
- making sure that a minimum number of employees is exposed;
- in the case of a process plant, providing plant and
- equipment that can safely contain or suppress an
- explosion, or vent it to a safe place.

In workplaces where explosive atmospheres may occur, ensure that:

- areas where hazardous explosive atmospheres may occur are classified into zones based on their likelihood and persistence;
- areas classified into zones are protected from sources of ignition by selecting suitable special equipment and protective systems;
- where necessary, areas classified into zones are marked with a specified 'EX' sign at their points of entry;
- employees working in zoned areas must be provided with appropriate clothing that does not create a risk of an electrostatic discharge igniting the explosive atmosphere;
- before coming into operation for the first time, areas where hazardous explosive atmosphere may be present are confirmed as being safe (verified) by a person (or organization) competent in the field of explosion protection. The person carrying

out the verification must be competent to consider the particular risks at the workplace and the adequacy of control and other measures put in place.

Storage

Dangerous substances should be kept in a safe place in a separate building or the open air. Only small quantities of dangerous substances should be kept in a workroom or area as follows:

- For flammable liquids that have a flashpoint above the maximum ambient temperature (normally taken as 32°C), the small quantity that may be stored in the workroom is considered to be an amount up to 250 litres.
- For extremely and highly flammable liquids and those flammable liquids with a flashpoint below the maximum ambient temperature, the small quantity is considered to be up to 50 litres and this should be held in a special metal cupboard or container.
- Any larger amounts should be kept in a special fire-resisting store, which should be:
 - properly ventilated;
 - provided with spillage retaining arrangements such as sill;
 - free of sources of ignition, such as unprotected electrical equipment, sources of static electrical sparks, naked flames or smoking materials;
 - arranged so that incompatible chemicals do not become mixed together either in normal use or in a fire situation;
 - of fire-resisting construction;
- used for empty as well as full containers - all containers must be kept closed;
- kept clear of combustible materials such as cardboard or foam plastic packaging materials.

Flammable gases

Flammable gas cylinders also need to be stored and used safely. The following guidance should be adopted:

- both full and empty cylinders should be stored outside. They should be kept in a separate secure compound at ground level with sufficient ventilation. Open mesh is preferable;
- valves should be uppermost during storage to retain them in the vapour phase of the LPG;

- cylinders must be protected from mechanical damage. Unstable cylinders should be chained together, for example, and cylinders must be protected from the heat of the summer sun;
- the correct fittings must be used. These include hoses couplers, clamps and regulators;
- gas valves must be turned off after use at the end of the shift;
- precautions must be taken to avoid welding flame 'flash back' into the hoses or cylinders. People need training in the proper lighting up and safe systems of work procedures; non-return valves and flame arrestors also need to be fitted;
- cylinders must be changed in a well-ventilated area remote from any sources of ignition;
- joints should be tested for gas leaks using soapy/detergent water - never use a flame;
- flammable material must be removed or protected before welding or similar work;
- cylinders should be positioned outside buildings with gas piped through in fixed metal piping;
- both high and low ventilation must be maintained where LPG applications are being used;
- Flame failure devices are necessary to shut off the gas supply in the event of flame failure.

Control of ignition sources

Where electrical installations or equipment are required to be located or used in a hazardous area e.g. lighting, mixers and stirrers, pumps, control systems, forklift trucks, detectors, torches etc, these items must be designed and constructed so that they cannot release energy within the hazardous area that is sufficient to cause an ignition.

There are many possible ignition sources:

- Sparks from electrical tools and equipment.
- Sparks, arcs and hot metal surfaces from welding and cutting.
- Tobacco smoking.
- Open flames from portable torches and heating units, boilers, pilot lights, ovens, and driers.
- Hot surfaces such as boilers, furnaces, steam pipes, electric lamps, hot plates, irons, hot ducts and flues, electric coils and hot bearings.
- Embers and sparks from incinerators, foundry cupolas, fireboxes and furnaces.
- Sparks from grinding and crushing operations.

- Sparks caused by static electricity from rotating belts, mixing operations or improper transfer of flammable or hot combustible liquids.

Eliminate many of these ignition sources by:

Removing open flames and spark-producing equipment.

Not smoking around these liquids.

Using approved explosion-proof equipment in hazardous areas.

Use of suitably-rated electrical equipment (e.g. Intrinsically safe or flame-proof)

Ensuring electrical equipment is effectively maintained where poorly maintained electrical equipment can present a significant risk for example through worn brushes

Ensuring electrical equipment is properly earthed

Ensuring the auto-ignition temperature of the hazardous chemical is considered as some hazardous chemicals may ignite spontaneously above certain temperatures

Implementing administrative controls such as permit systems preventing hot work (for example, welding) in these areas.

Systems of work

Hot work is any process involving grinding, welding, brazing, oxy cutting, heat treatment or any other similar process that generates heat or continuous streams of sparks. Undertaking hot work in areas where flammable or combustible chemicals or other materials are present creates a significant risk of fire or explosion. Conducting hot work on containers such as drums, tanks and pipes that have not been properly decontaminated is a common cause of serious incidents. A hot work permit system is a system designed to eliminate or minimise risks from these activities by controlling when and how hot work is undertaken in these areas. A permit to work is appropriate in situations of high hazard/risk and, for example, where there is a need to:

- Ensure that there is a formal check confirming that a safe system of work is being followed;
- Co-ordinate with other people or activities;
- Provide time-limits when it is safe to carry out the work; and
- Ensure that specialised personal protective equipment (such as breathing apparatus) has been provided and/or that adequate methods of communication are available.

Permit to work procedure

A permit to work is an official, documented safe system of work that is used for controlling high risk activities. implementation is required prior to work beginning to ensure that all precautions are taken and securely in place to prevent danger to the workforce.

When managed correctly, a permit to work prevents any mistakes or deviations through poor verbal communication by stating the specific health and safety requirements of the work activity. For fire control, a permit to work is typically used where there is a requirement to use flammable materials or when hot work or processes are being carried out.

Hot work permits

Hot work permits control and implement a safe system of work whenever work activities utilise heat or flame. If the risk of fire is low, it may not be necessary to implement a hot work permit; however, they should always be considered. The authorised person issues the hot work permit to work and will sign the document to declare that all isolations are made and remain in place throughout the duration of the work activity. Hot work permits should be issued for a specific time, for a specific place, for a specific task, and are issued to a designated competent person. In addition to this, the authorised person will make checks to ensure that all controls to be implemented by the acceptor are in place before work begins. The acceptor of the permit to work assumes responsibility for carrying out the work. The acceptor signs the document to declare that the terms and conditions of the permit to work are understood and will be complied with fully at all times by the entire work team. Compliance with a permit to work system includes ensuring the required safeguards are implemented and that the work will be restricted to that stated within the permit to work document. Items included in a permit to work document are:

Permit issue number	Signature of authoriser
Authorised person identification	Signature of acceptor
Location of fire-fighting equipment	Signature for work clearance. extension/handover
Location of flammable materials	Signature for cancellation
Emergency muster point	Other precautions (risk assessment, method statement, PPF)
Details of the work to be carried out.	

Good housekeeping

Most workplaces contain combustible materials. Usually, the presence of normal stock in trade should not cause concern, provided the materials are used safely and stored away from sources of ignition. Good standards of housekeeping are essential to minimize the risk of a fire starting or spreading quickly.

The amount of combustible material in a workplace should be kept as low as is reasonably practicable. Materials should not be stored in gangways, corridors or stairways or where they may obstruct exit doors and routes. Fires often start and are assisted to spread by combustible waste in the workplace. Such waste should be collected frequently and removed from the workplace, particularly where processes create large quantities of it.

Some combustible materials, such as flammable liquids, gases or plastic foams, ignite more readily than others and quickly produce large quantities of heat and/or dense toxic smoke. Ideally, such materials should be stored away from the workplace or in fire-resisting stores. The quantity of these materials kept or used in the workplace should be as small as possible, normally no more than half a day's **supply**.

6.3.2 Storage of flammable liquids in work rooms and other locations

The Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) require risks from the indoor storage of Dangerous Substances to be controlled by elimination or by reducing the quantities of such substances in the workplace to a minimum and providing mitigation to protect against foreseeable incidents.

It is recognised that for practical purposes where flammable liquids are used, there is likely to be a need for a limited quantity to be stored in the workroom/working area. It is the responsibility of the employer / dutyholder when carrying out their risk assessment required under DSEAR Regulation 5, to justify the need to store any particular quantity of flammable liquid within a workroom/working area. However, the guiding principle is that only the minimum quantity needed for frequently occurring activities or that required for use during ½ day or one shift should be present in the workroom/working area (DSEAR ACOP L135, par.39 refers). Clearly actual quantities will depend on the work activity and also the organisational arrangements for controlling the fire risks in the workroom / working area.

When not in use, containers of flammable liquids needed for current work activities should be kept closed and stored in suitable cabinets or bins of fire-resisting construction and which are designed to retain spills (110% volume of the largest vessel normally stored in it). These should be located in designated areas that are where possible away from the immediate processing area and do not jeopardise the means of escape from the

workroom/working area. The flammable liquids should be stored separately from other dangerous substances that may enhance the risk of fire or compromise the integrity of the container or cabinet/bin; for example energetic substances, oxidizers and corrosive materials. It is recognised that these other dangerous substances may be flammable liquids in their own right or held in a flammable liquid. However, it is still inappropriate to store these in the same cabinets or bins with other flammable liquids. [Further guidance on Energetic and spontaneously combustible substances is contained in HS(G)131 published by HSE]

It is recommended that the maximum quantities that may be stored in cabinets and bins are no more than 50 litres for extremely, highly flammable and those flammable liquids with a flashpoint below the maximum ambient temperature of the workroom/working area; and no more than 250 litres for other flammable liquids with a higher flashpoint of up to 55°C (DSEAR ACOP L135, par.40 refers).

These quantities are intended to be viewed as recommended maxima representing good industry safe practice, rather than be taken as absolute limits. There is intended to be some flexibility with these limits, where it is recognised that the design of modern day buildings and the pattern of work can sometimes make adherence to these quantities difficult to achieve; for example, in large or open-plan workrooms / working areas. However, where the employer/dutyholder does identify a need to store quantities in excess of the recommended maxima, a robust demonstration of this requirement would need to be made and in particular the risk assessment should take into account:

- The properties of the materials to be stored or handled in the workroom / working area. For mixed storage the worst case situation should be applied, i.e. all materials in the storage cupboard or bin should be considered as being the same material as the one that has the lowest flashpoint;
- The size of the workroom / working area and the number of people working in it;
- The amount of flammable liquids being handled in the workroom / working area and the quantities of liquid that may be accidentally released or spilled;
- Ignition sources in the workroom / working area and potential fire spread in the event of an ignition:
- Exhaust ventilation provision to the workroom / working area and / or the storage cupboard or bin;
- The fire performance of the storage cupboard or bin;
- The arrangements for closing the cupboard or bin doors/lid in the event of a fire;
- Means of escape from the workroom / working area.

The particular objective, in the event of an incident, is to ensure that people can safely escape from the workroom / working area. In this context, the purpose of storing Dangerous Substances in cupboards and bins of appropriate construction and design is to provide a

physical barrier to delay the involvement of these materials in a fire and limit the passage of flame and hot gases should the Dangerous Substances subsequently become involved, for sufficient time for people's safe evacuation and the dutyholder's immediate emergency procedures supporting this to be implemented (DSEAR ACOP L136 par. 68 refers).

Paragraphs 94 –96, along with Appendices A & B and paragraph 104 in the DSEAR ACOP L136 detail the performance requirements for fire resisting cupboards and bins. It is important to recognise that these do not specify an absolute test or standard for the cupboard or bin itself, rather they relate to nominal construction principles. Namely:

1. that the materials used to form the sides, top, bottom, door(s) and lid are capable of providing the required fire resistance (i.e. 30 minutes integrity) and reaction to fire (i.e. minimal risk);
2. that the joints between the sides, top and bottom of cupboards and bins should be free from openings or gaps;
3. that the lid / doors should be close fitting against the frame of the bin/cupboard, such that there is a nominal overlap between the frame and lid/doors in their closed position;
4. that the supports and fastenings should be of a material with a melting point greater than 750°C.

These criteria represent the minimum performance requirements for compliance with the current legislation. However, it is to be noted that there are a number of more demanding standards and design specifications, which refer to the fire performance of the complete cabinet structure, including: BS EN 14470-1:2004 'Fire safety storage cabinets – Part 1: Safety storage cabinets for flammable liquids'; Factory Mutual, Underwriters Laboratories and ANSI/NFPA 30 standards. Where standards go beyond the minimum requirements of UK health and safety legislation, it is to be emphasized that their implementation in the UK is not a legal requirement. However, for quantities in excess of the recommended maxima employers/dutyholders may find cabinets with enhanced fire performance help in making their risk assessment demonstration.

It is of course the responsibility of the employer/dutyholder to ensure that cabinets to any particular standard or design specification do meet the minimum legal requirements. Equally, the use of cabinets with enhanced fire performance should not be seen as a substitute for the provision of dedicated store rooms and outdoor storage areas for the safe keeping of containers which are nominally empty or are not needed for current work.

6.3.3 Awareness of structural measures to prevent the spread of fire and smoke: properties of common building materials; protection of openings and voids

Building material

If structural elements such as walls, floors, beams, columns and doors are to provide effective barriers to fire spread and to contribute to the stability of a building, they should be of a required standard of fire resistance.

In the UK, tests for fire resistance are made on elements of structure, full size if possible, or on a representative portion having minimum dimensions of 3 m long for columns and beams and 1 m² for walls and floors. All elements are exposed to the same standard fire provided by furnaces in which the temperature increases with time at a set rate. The conditions of exposure are appropriate to the element tested. Freestanding columns are subjected to heat all round, and walls and floors are exposed to heat on one side only. Elements of structure are graded by the length of time they continue to meet three criteria:

- the element must not collapse;
- the element must not develop cracks through which flames or hot gases can pass;
- the element must have enough resistance to the passage of heat so the temperature of the unexposed face does not rise by more than a prescribed amount.

The term fire resistance has a precise meaning. It should not be applied to such properties of materials as resistance to ignition or resistance to flame propagation. For example steel has a high resistance to ignition and flame propagation but will distort quickly in a fire and allow the structure to collapse - it therefore has poor 'fire resistance'. It must be insulated to provide good fire protection. This is normally done by encasing steel frames in concrete.

In the past, asbestos has been made into a paste and plastered onto steel frames, giving excellent fire protection, but it has caused major health problems and its use in new work is banned.

Building materials with high fire resistance are, for example, brick, stone, concrete, very heavy timbers (the outside chars and insulates the inside of the timber), and some specially made composite materials used for fire doors.

Building materials used for thermal or sound insulation could contribute to the spread of fire. Only suitable fire-resisting materials should be used.

Protection of openings and voids

It is essential to ensure that people can escape quickly from a workplace if there is a fire. Normally the entrances and exits to the workplace will provide escape routes, particularly if staff have been trained in what to do in case of fire and if it is certain that an early warning will be given.

It is likely that the means of escape will be adequate in modern buildings which have had local Building Regulation approval or have been built to acceptable building construction standards. Where there have not been significant changes to the building or where the workplace has recently been inspected by the fire authorities or other fire expert and found to be satisfactory, no change is likely to be needed. It may occasionally be necessary to improve the fire protection on existing escape routes, or to provide additional exits. In making a decision about the adequacy of means of escape, the following points should be considered:

- people need to be able to turn away from a fire as they escape or be able to pass a fire when it is very small;
- if a single-direction escape route is in a corridor, the corridor may need to be protected from fire by fire-resisting partitions and self-closing fire doors;
- stair openings can act as natural chimneys in fires. This makes escape from the upper parts of some work places difficult. Most stairways, therefore, need to be separated from the workplace by fire-resistant partitions and self-closing fire doors. Where stairways serve no more than two open areas, in shops for example, which people may need to use as escape routes, there may be no need to use this type of protection.

Protection of voids

Voids are often used for the passing of services which in turn creates a source of inception, for example electrical cabling providing power to lighting units. Even with no obvious inception hazard, in a fire situation a void can act as a flue drawing heat and smoke across a wide area causing unnecessary fire spread.

Because such voids are often hidden or difficult to access, a fire can develop undiscovered and fire fighting in such an area may be problematical because of the confined space or difficulties with access.

Physical Protection

The most common way of reducing the size of a large void or reducing the spread potential, where the void bypasses lines of compartmentation that do not separate different occupancies or occupancy types, is by cavity barriers. Cavity barriers should not be used as an extension of compartment walls separating differing occupancies. An example of this would be where there are ceilings with a void above bridging two rooms. In this scenario it is more preferable to extend the room walls above the ceiling level to the underside of the roof or floor level above, in effect considering the void as part of the room compartment, rather than install cavity barriers and the like between the ceilings and the floors above.

To emphasize the point that cavity barriers are not a substitute for compartmentation walls or floors, sub-division in roof/floor voids should be spaced at not more than 20m apart or in line with walls above or below. Sub-division of wall voids must be in line with all fire separating walls and floors. For narrow gaps (less than 100mm) cavity barriers may not be appropriate and alternative fire stopping or seals may be a preferred alternative. Further guidance on cavity barriers can be found in the LPC Design Guide: Fire Protection of Buildings – Core document - Protection of Openings and Service penetrations from Fire.

Where a void is used for the passing of services or ductwork, appropriate fire stopping must be installed where the services or ductwork pass through any compartmentation including cavity barriers, to ensure the intended fire performance of the fire stopping barrier is upheld. As such work is often carried out by a number of differing contractors, it is important that there are regular inspections to ensure the integrity of any fire stopping is maintained.

Housekeeping in the voids should also be monitored as part of the inspections so that no combustible

packaging or redundant materials are abandoned in the void creating an unnecessary fire load.

6.3.4 Use of suitable electrical equipment in flammable atmospheres

The use of electricity can generate hot surfaces or sparks which can ignite an explosive atmosphere. An explosive atmosphere could be present in a variety of different places including paint spray booths, near fuel tanks, in sumps, or many places where aerosols, vapours, mists, gases, or dusts exist.

Areas where it is possible that an explosive atmosphere may exist must be treated differently from other areas. The Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) requires that such areas be risk assessed before any new work is carried out in them and that measures be taken to control the risks. HSE has produced guidance on DSEAR that explains how the Dangerous Substances and Explosive Atmospheres Regulations 2002 can be complied with.

Care should be taken to prevent static discharges in potentially explosive atmospheres. Measures such as earth bonding and the selection of antistatic work clothing and footwear can help to reduce the risk of static discharges.

Equipment and explosive atmospheres

Electrical and non-electrical equipment and installations in potentially explosive atmospheres must be specially designed and constructed so that the risks of ignition are eliminated or reduced. Techniques to do this include sealing electrical equipment so that the explosive atmosphere cannot come into contact with electrical components, reducing the power of electrical equipment, and de-energising electrical equipment where a fault or an explosive atmosphere is detected.

Recently installed equipment should be marked with an 'Ex' to show it is suitable for use in potentially explosive atmospheres. All new equipment must comply with The Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations 1996 that implements the European ATEX Directive. This requires it to be assessed as suitable for a particular explosive atmosphere type and for this to be marked on the

equipment along with CE and ATEX markings. Most new equipment being sold in the UK for use in potentially explosive atmospheres must have an ATEX certificate.

Equipment for use in explosive atmospheres should be regularly inspected and maintained to ensure it does not pose an increased risk of causing a fire or explosion. Maintenance of the equipment should only be carried out by people who are competent to do so. BS EN 60079 part 17: Explosive atmospheres. Electrical installations inspection and maintenance offers guidance as to the frequency and scope of maintenance required.

6.4 Fire alarm system and fire-fighting arrangements

6.4.1 Fire detection, fire warning and fire-fighting equipment

6.4.1.1 Common fire detection and alarm systems

In the event of fire, it is vital that everyone in the workplace is alerted as soon as possible. The earlier the fire is discovered, the more likely it is that people will be able to escape before the fire takes hold and before it blocks escape routes or makes escape difficult.

Every workplace should have detection and warning arrangements. Usually the people who work there will detect the fire and in many workplaces nothing further will be needed.

It is important to consider how long a fire is likely to burn before it is discovered. Fires are likely to be discovered quickly if they occur in places that are frequently visited by employees, or in occupied areas of a building. For example, employees are likely to smell burning or see smoke if a fire breaks out in an office.

Where there is concern that fire may break out in an unoccupied part of the premises, for example in a basement, some form of automatic fire detection should be fitted. Commercially available heat or smoke detection systems can be used. In small premises, a series of interlinked domestic smoke alarms that can be heard by everyone present will be sufficient. In most cases, staff can be relied upon to detect a fire.

In small workplaces where occupancy is low, a shouted warning should be all that is needed, as long as the warning can be heard and understood everywhere on the premises.

If the size or occupancy of a workplace means that a shouted warning is insufficient, hand-operated devices such as bells, gongs or sirens can be used. They should be installed on exit routes and should be clearly audible throughout the workplace. In all other places an electrically operated fire alarm system should be fitted. This will have call points adjacent to exit doors and enough bells or sounders to be clearly audible throughout the premises.

If it is thought that there might be some delay in fire being detected, automatic fire detection should be considered, linked into an electrical fire alarm system. Where a workplace provides sleeping accommodation or where fires may develop undetected, automatic detection must be provided. If a workplace provides sleeping accommodation for fewer than six people, interlinked domestic smoke alarms (wired to the mains electricity supply) can be used provided that they are audible throughout the workplace while people are present.

6.4.1.2 Portable fire-fighting equipment: siting, maintenance and training requirements

The 46 countries that comprise Europe have each developed specific regulations for their own territories. The 27 countries of the European Union (EU) have consolidated much of their individual legislation and codes, often sacrificing particular national interests to a pan-European effort toward standardization, for example, making a particular standard on portable fire extinguisher classifications or fire detection system and component specifications commonly applicable throughout all the member countries.

Employers or those who have control of non-domestic premises usually have a statutory duty under fire safety and/or health and safety legislation to ensure that there are appropriate means of fighting fires. The employer or controller of non-domestic premises may be known as the 'responsible person'. The responsible person also has to provide suitably trained people to operate non-automatic firefighting equipment.

If fire breaks out in the workplace and trained staff can safely extinguish it using suitable firefighting equipment, the risk to others will be removed. Therefore, all workplaces where people are at risk from fire should be provided with suitable firefighting equipment.

The most useful form of firefighting equipment for general fire risks is the water-type extinguisher or suitable alternative. One such extinguisher should be provided for around each 200 m² of floor space with a minimum of one per floor. If each floor has a hose reel, which is known to be in working order and of sufficient length for the floor it serves, there may be no need for water-type extinguishers to be provided.

Areas of special risks involving the use of oil, fats or electrical equipment may need carbon dioxide, dry powder or other types of extinguisher.

Fire extinguishers should be sited on exit routes, preferably near to exit doors or where they are provided for specific risks, near to the hazards they protect. Notices indicating the location of FFE should be displayed where the location of the equipment is not obvious or in areas of high fire risk where the notice will assist in reducing the risk to people in the workplace.

All halon fire extinguishers should have been decommissioned and disposed of safely as halon affects the ozone layer in the Earth's atmosphere.

Employees carrying out hot work should have appropriate fire extinguishers with them and know how to use them.

The primary purpose of fire extinguishers is to tackle fires at a very early stage to enable people to make their escape. Putting out larger fires is the role of the fire and rescue services.

Extinguishers should conform to a recognised standard such as ISO 7165:2009 *Firefighting-Portable fire extinguishers -Performance and construction*, or in Europe, EN 3:7 *Portable Fire Extinguishers. Characteristics, performance requirements and test methods*.

Under ISO7165 the recommended colour for extinguisher bodies is red with no secondary colour coding noted. Under EN3:7 fire extinguishers are all red with 5% of the cylindrical area taken up with a secondary colour code. The colour code (band) denotes on which class of fire the extinguisher can be used. There is no single universal colour coding used, Table 13.2 shows the Australian code, Table 13.3 shows the UK code which is also followed in the EU, Table 13.4 shows the USA code.

6.4.1.3 Extinguishing media: water, foam, dry powder, carbon dioxide; advantages and limitations

Advantages and limitations of the main extinguishing media

In these standards fire extinguishers are classified by the type of extinguishing medium they contain. The following gives the advantages and disadvantages of the various types of extinguishing medium. Banding colours follow EN3:7.

Water extinguishers (red band)

This type of extinguisher can only be used on Class A fires. They allow the user to direct water onto a fire from a considerable distance.

A nine-litre water extinguisher can be quite heavy and some water extinguishers with additives can achieve the same rating, although they are smaller and therefore considerably lighter. This type of extinguisher is not suitable for use on live electrical equipment, liquid or metal fires (Figure 13.18).

Water extinguishers with additives (red band)

This type of extinguisher is suitable for Class A fires. They can also be suitable for use on Class B fires and, where appropriate, this will be indicated on the extinguisher. They are generally more efficient than conventional water extinguishers.

Foam extinguishers (cream band)

This type of extinguisher can be used on Class A or B fires and is particularly suited to extinguishing liquid fires such as petrol and diesel. They should not be used on free-flowing liquid fires unless the operator has been specially trained, as these have the potential to rapidly spread the fire to adjacent material. This type of extinguisher is not suitable for deep-fat fryers or chip pans. They should not be used on electrical or metal fires.

Table 13.2 Classification for fire extinguishers used in Australia								
Type	Pre-1997		Current	SUITABLE FOR USE ON FIRE CLASSES (BRACKETS DENOTE SOMETIMES APPLICABLE)				
Water	Solid red	Red	Solid red	A				
Foam	Solid blue	Blue	Red with a blue band	A	B			
Dry chemical (powder)	Red with a white band	White	Red with a white band	A	B	C	E	
Carbon dioxide	Red with a black band	Black	Red with a black band	(A)	B	C	E	F
Vaporizing liquid (not halon)	Red with a yellow band	Yellow	Red with a yellow band	A	B	C	E	
Halon	Solid green	Green	No longer produced	A	B		E	
Wet chemical	Solid oatmeal	Oatmeal	Red with an oatmeal band	A				F

2 kg CARBON-DIOXIDE FIRE EXTINGUISHER

INSPECTION: INSPECT MONTHLY. CHECK THAT EXTINGUISHER IS CHARGED, UNDAMAGED AND SEAL IS INTACT. MAKE SURE HORN IS UNOBSTRUCTED.

MAINTENANCE: EXAMINE CAREFULLY EVERY 12 MONTHS TO ENSURE EXTINGUISHER IS OPERABLE. RECHARGE IF MASS LOSS EXCEEDS 0.2 kg. REPLACE ANY DAMAGED PARTS. CHECK HORN FOR OBSTRUCTIONS. HYDROSTATIC RETEST TO DOT/TC REQUIREMENTS EVERY 5 YEARS.

USE: AFTER ANY USE RECHARGE IMMEDIATELY.


RECHARGE: CO₂ CHARGE IS 2 kg. FULL MASS STAMPED ON VALVE BODY INCLUDES HORN ASSEMBLY.

RECORD: RECORD MAINTENANCE AND RECHARGE DATES ON ATTACHED TAG, FOR INDUSTRIAL USE.

INSTRUCTIONS

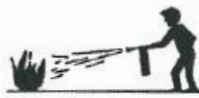
①

HOLD UPRIGHT
PULL RING PIN




②



START BACK 3 m
AIM AT BASE OF FIRE



③

SQUEEZE LEVER
SWEEP SIDE TO SIDE



APPROVAL MARK

CARBON-DIOXIDE FIRE EXTINGUISHER
CLASSIFICATION 21-B
SERIAL NO. XX-XXXXX

MEETS ISO XXXXX STANDARD
2 kg CARBON DIOXIDE FIRE EXTINGUISHER
SUITABLE FOR USE AT TEMPERATURES FROM -40 °C TO 49 °C (-40 °F TO 120 °F)
PRESSURE TESTED TO 20 MPa

MODEL
322

1999

MFG. NAME
MFG. ADDRESS

Figure - Marking layout for an extinguisher under ISO 7165:2009

Table 13.3 Classification for fire extinguishers used in the UK under EN3:7							
Type	Old Code		BS EN 3 Colour Code	SUITABLE FOR USE ON FIRE CLASSES (BRACKETS DENOTE SOMETIMES APPLICABLE)			
Water	Signal Red		Signal Red	A			
Foam	Cream		Red with a Cream panel above the operating instructions	A	B		
Dry powder	Blue		Red with a Blue panel above the operating instructions	(A)	B	C	E
Carbon dioxide	Black		Red with a Black panel above the operating instructions		B		E
Wet chemical	N/A		Red with a Canary Yellow panel above the operating instructions	A	(B)		F
Class D powder	Blue		Red with a Blue panel above the operating instructions				D
Halon gas	Green		Now prohibited except under certain situations.				

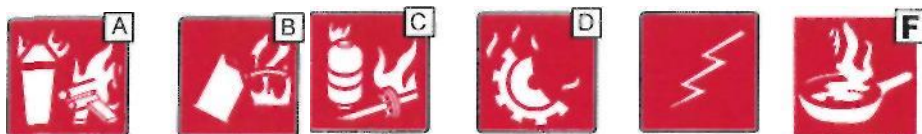


Figure 13.17 Use-Code symbols for extinguishers under ISO 7165:2009. Class A: Ordinary solid material fires. Class B: Flammable liquid fires. Class C: Gas and vapour fires. Class D: Combustible metal fires. Fires involving energized electrical conductors. Class F: Cooking oil fires.

Powder extinguishers (blue band)

This type of extinguisher can be used on most classes of fire and achieve a good 'knock down' of the fire. They can be used on fires involving electrical equipment but will almost certainly render that equipment useless.

Because they do not cool the fire appreciably, it can re-ignite. Powder extinguishers can create a loss of visibility and may affect people who have breathing problems and are not generally suitable for confined spaces. They should not be used on metal fires.

Carbon dioxide extinguishers (black band)

This type of extinguisher is particularly suitable for fires involving electrical equipment as they will extinguish a fire without causing any further damage (except in the case of some electronic equipment, for example computers). As with all fires involving electrical equipment, the power should be disconnected if possible. These extinguishers should not be used on metal fires.

Wet chemical – class 'F' extinguishers

This type of extinguisher is particularly suitable for commercial catering establishments with deep-fat fryers. The intense heat in the fluid generated by fat fires means that when standard foam or carbon dioxide extinguishers stop discharging, re-ignition tends to occur.

Wet chemical extinguishers starve the fire of oxygen by sealing the burning fluid, which prevents flammable vapour reaching the atmosphere.

6.4.1.4 Access for fire and rescue services and vehicles

Vehicle access to the exterior of a building is needed to enable high reach appliances, such as turntable ladders and hydraulic platforms, to be used, and to enable pumping appliances to supply water and equipment for fire-fighting and rescue activities. The access arrangements increase with building size and height.

Conversions - in the case of conversions, as specified in regulation 4, the building as converted shall meet the requirements of this standard in so far as is reasonably practicable, and in no case be worse than before the conversion

Vehicle access provision

Access from a public road should be provided to assist fire and rescue personnel in their rescue and fire-fighting operations. Whilst the access will depend to some extent on the vehicles and equipment used, assistance may be provided from adjoining fire and rescue services when the need arises. For this reason, the more demanding guidance for high reach appliances may be recommended by the fire and rescue service. This may have a significant impact on planning and a feasibility study may be appropriate. Consultation with the fire and rescue service at the earliest opportunity is strongly recommended.

Vehicle access should be provided to at least one elevation of all domestic building to assist in fire-fighting and rescue operations.

Flats or maisonettes with a common entrance, a vehicle access route for fire-fighting vehicles from a public road should be provided not more than 45m from the common entrance.

In addition, where dry or wet fire mains are installed in a building, parking spaces should be provided for fire and rescue service vehicles a distance not more than 18m from riser inlets. The intention is to assist fire and rescue service personnel connect a short length of hose between the pumping appliance and the inlets to the fire mains quickly and efficiently therefore saving operational time.

However vehicle access routes to more than one elevation may not always be possible due to the constraints of the site, and pedestrian access for fire and rescue service personnel. In such cases, advice from the fire and rescue service should be sought.

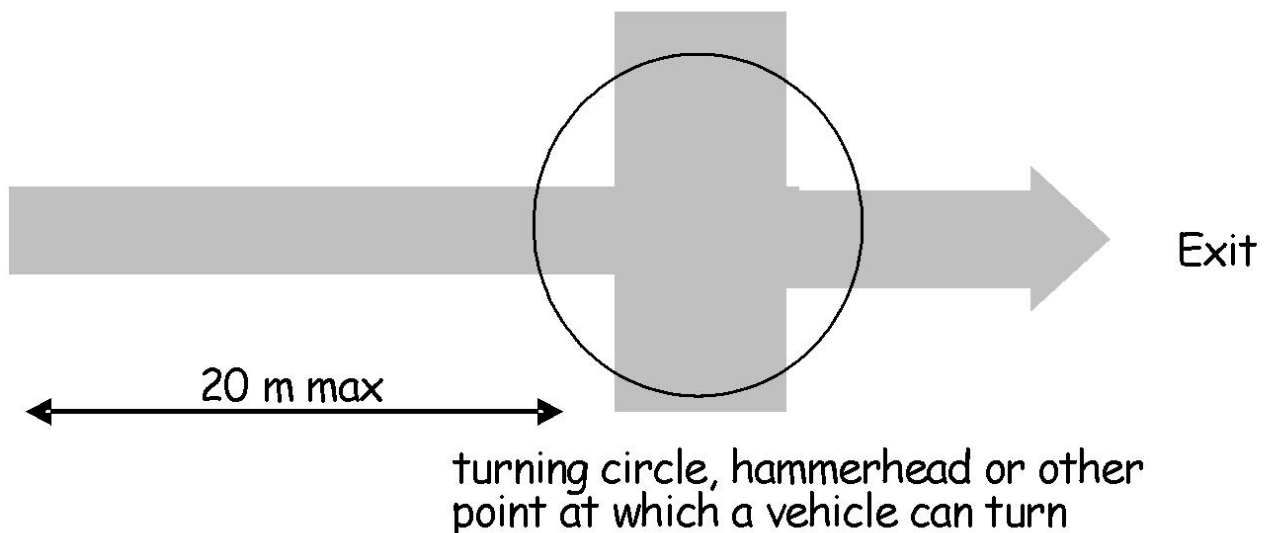
Every house should be provided with a vehicle access route for fire-fighting vehicles from a public road to not more than 45m from any door giving direct access to the interior of the dwelling.

Vehicle access routes

Access routes to buildings for fire and rescue service vehicles or personnel should not be assessed in isolation and the proposed vehicle access routes will in effect, will be dictated by need for water hydrants and other fire-fighting facilities such as fire mains.

Dead end route - fire and rescue service vehicles should not have to reverse more than 20m from the end of an access road. Where any dead-end route is more than 20m long, turning facilities should be provided. This can be a turning circle or a hammerhead designed on the basis of the diagram and table below.

In rural areas, access from a public road may not be possible to within 45m of an entrance to the building, and access from a private road will suffice provided the guidance in the table below has been followed. The vehicle access route assumes that access for pumping appliances will be sufficient for houses, but that provision for high reach appliances should be made to buildings containing flats or maisonettes. Where, in consultation with the fire and rescue service access is only needed for pumping appliances, the smaller dimensions for a house may be used.



Operating spaces for high reach appliances

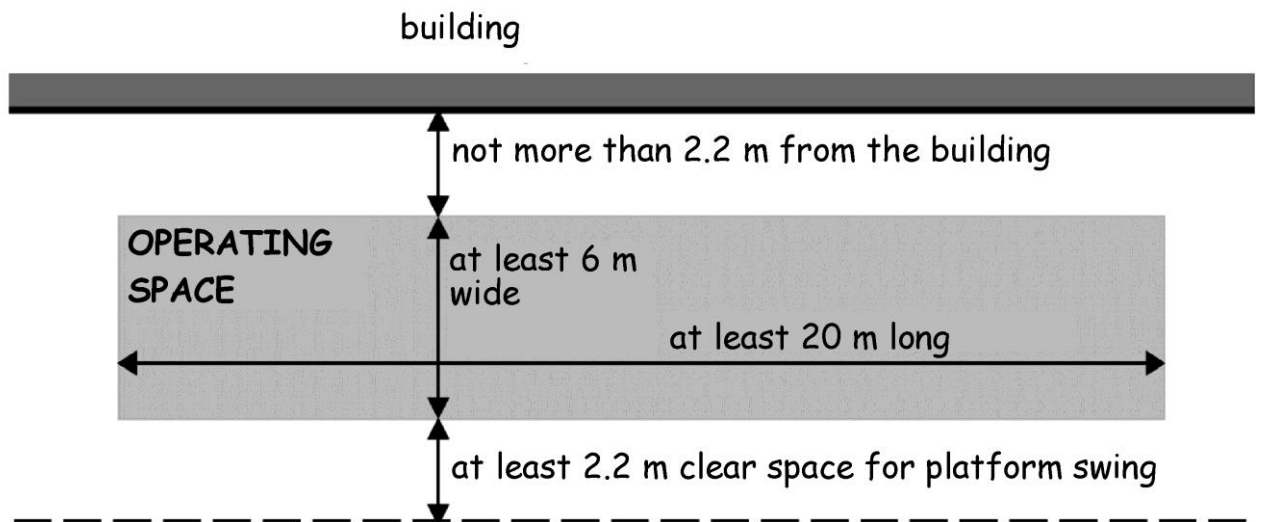
Following consultation with the fire and rescue service, if it is recommended that an operating space, or spaces, for a high reach appliance should be provided, the operating space(s) should:

- have a ground loading capacity of not less than $8.3\text{kg}/\text{cm}^2$ and
- be level or not have a gradient more than 1 in 12.

The operating space shown in the diagram below is suitable for either a hydraulic platform or turntable ladder. Where the building has obstructions such as balconies or other

projections, the building line should be taken to be the outer edge of the balconies or other projections.

Figure - Minimum dimensions for operating space for high reach appliances



Access for fire and rescue service personnel

It is common practice for fire and rescue service personnel to enter a domestic building through the normal entrances and fight the fire head on. This is termed 'offensive fire-fighting'.

In order to allow unobstructed access to a domestic building for fire and rescue service personnel, a paved (or equivalent) footpath at least 900mm wide (see also Section 4 Safety) should be provided to the normal entrances, of a building.

In addition, where vehicle access is not possible to within 18m of the dry riser inlets (see clause 2.12.1), a footpath should also be provided to the riser inlets. This will allow the fire and rescue service to deploy portable pumps to relay water supplies to where the water is needed. Whilst this method of water distribution is quite common, it should be avoided for new developments because of the time delay in supplying water to the fire-fighters.

Every elevation which is provided with vehicle or pedestrian access for fire and rescue service personnel should have a door giving access to the interior of the building. Inward opening doors are preferable because this allows easier forced entry by fire and rescue

service personnel should the need arise. However an outward opening final exit door or emergency door should also be considered as providing suitable access.

6.5 Evacuation of a workplace

6.5.1 Means of escape: travel distances, stairs, passageways, doors, emergency lighting, exit and directional signs, assembly points

It is essential to ensure that people can escape quickly from a workplace if there is a fire. Normally the entrances and exits to the workplace will provide escape routes, particularly if staff have been trained in what to do in case of fire and if it is certain that an early warning will be given.

It is likely that the means of escape will be adequate in modern buildings which have had local Building Regulation approval or have been built to acceptable building construction standards. Where there have not been significant changes to the building or where the workplace has recently been inspected by the fire authorities or other fire expert and found to be satisfactory, no change is likely to be needed. It may occasionally be necessary to improve the fire protection on existing escape routes, or to provide additional exits. In making a decision about the adequacy of means of escape, the following points should be considered:

- people need to be able to turn away from a fire as they escape or be able to pass a fire when it is very small;
- if a single-direction escape route is in a corridor, the corridor may need to be protected from fire by fire-resisting partitions and self-closing fire doors;
- stair openings can act as natural chimneys in fires. This makes escape from the upper parts of some work places difficult. Most stairways, therefore, need to be separated from the workplace by fire-resistant partitions and self-closing fire doors. Where stairways serve no more than two open areas, in shops for example, which people may need to use as escape routes, there may be no need to use this type of protection.

Doors

Some doors may need to open in the direction of travel, such as:

- doors from a high-risk area, such as a paint spraying room or large kitchen;
- doors that may be used by more than 50 persons;

- doors at the foot of stairways where there may be a danger of people being crushed;
- some sliding doors may be suitable for escape purposes provided that they do not put people using them at additional risk, slide easily and are marked with the direction of opening;
- doors which only revolve and do not have hinged segments are not suitable as escape doors.

Escape routes

Escape routes should meet the following criteria:

- where two or more escape routes are needed they should lead in different directions to places of safety;
- escape routes need to be short and to lead people directly to a place of safety, such as the open air or an area of the workplace where there is no immediate danger;
- it should be possible for people to reach the open air without returning to the area of the fire. They should then be able to move well away from the building;
- escape routes should be wide enough for the volume of people using them. A 750 mm door will allow up to 40 people to escape in 1 minute, so most doors and corridors will be wide enough. If the routes are likely to be used by people in wheelchairs, the minimum width will need to be 800 mm.

While the workplace is in use, it must be possible to open all doors easily and immediately from the inside, without using a key or similar device. Doors must be readily opened in the direction of escape. Fire doors should be self-closing (fire doors to cupboards or lockers can be simply latched or locked).

Make sure that there are no obstructions on escape routes, especially on corridors and stairways where people who are escaping could dislodge stored items or be caused to trip. Any fire hazards must be removed from exit routes as a fire on an exit route could have very serious consequences.

Escape routes need regular checks to make sure that they are not obstructed and that exit doors are not locked. Self-closing fire-resisting doors should be checked to ensure doors close fully, including those fitted with automatic release mechanisms.

Lighting

Escape routes must be well lit. If the route has only artificial lighting or if it is used during the hours of darkness, alternative sources of lighting should be considered in case the power fails during a fire. Check the routes when it is dark as, for example, there may be

street lighting outside that provides sufficient illumination. In small workplaces it may be enough to provide the staff with torches that they can use if the power fails. However, it may be necessary to provide battery-operated emergency lights so that if the mains lighting fails the lights will operate automatically. Candles, matches and cigarette lighters are not adequate forms of emergency lighting.

Signs

Exit signs on doors or indicating exit routes (Figure 13.14) should be provided where they will help people to find a safe escape route. Signs on exit routes should have directional arrows, 'up' for straight on and 'left', 'right' or 'down' according to the route to be taken. Signs should be in accordance with ISO 7010:2003 Graphical symbols - safety colours and safety signs -Safety signs used in workplaces and public areas. Advice on the use of all signs including exit signs can be found in Chapters 6.

Escape times

Everyone in the building should be able to get to the nearest place of safety in between 2 and 3 minutes. This means that escape routes should be kept short. Where there is only one means of escape, or where the risk of fire is high, people should be able to reach a place of safety, or a place where there is more than one route available, in 1 minute.

The way to check this is to pace out the routes, walking slowly and noting the time. Start from where people work and walk to the nearest place of safety. Remember that the more people there are using the route, the longer they will take. People take longer to negotiate stairs and they are also likely to take longer if they have a disability.

Where fire drills are held, check how long it takes to evacuate each floor in the workplace. This can be used as a basis for assessment. If escape times are too long, it may be worth re-arranging the workplace so that people are closer to the nearest place of safety, rather than undertake expensive alterations to provide additional escape routes.

6.5.2 Emergency evacuation procedures

A major factor in fatalities caused by fire, in particular in non-domestic premises is the situation that the occupants did not know what to do (or where to go) during the incident.

By developing and implementing planned and rehearsed evacuation procedures, this factor will be greatly reduced.

There is no single generic fire procedure, and procedures need to be developed for each building, taking into account all aspects such as the purpose and use of the building, number of occupants, disabled occupants, materials, environment. These points will be recapped and others developed as you work through the element.

A requirement of the Regulatory Reform (Fire Safety) Order 2005 is that risk assessments of the workplace are undertaken and the results of the risk assessment should be used to equip that building with appropriate safety devices, in particular fire detectors, fire alarms and fire-fighting equipment.

Procedures should then be developed that take into account the use of such provisions along with any precautions and methods to be followed in the event of a fire.

The procedures aim typically at three principal groups:

- The person(s) discovering a fire.
- Persons who are to evacuate the premises only, meaning this group has no duties in the event of evacuation.
- Employees who have special duties to undertake when a fire warning is given.

Procedures must cater for the evacuation of able-bodied and disabled persons. (Procedures for disabled persons are covered in more detail in a later section).

The fire procedure should be a formal document and be given to all employees; in addition, the procedure should also be displayed at key points throughout the premises.

Copies could be placed at the pedestrian entry to the premises and a clearly defined area in the works canteen.

Along with the written text, a copy of a simplified floor plan should be included which as well as showing exits routes also shows no-go areas in case of evacuation; symbols such as the no entry sign can be used to cater for people with reading difficulties and employees whose first language is not English.

The text and the floor plan can be included in the employees' handbook; the employee's signature of receipt for this serves as written confirmation that they have seen it.

In addition to the specific requirements of the procedures, it can also be an advantage to include a 'general statement' which may help to engage employees with the need for such procedure.

6.5.3 Role and appointment of fire marshals

The main duties of the fire marshal depend on your fire risk assessment but generally include:

- * identify fire hazards at their workplace,
- * Note and report hazards to the appropriate person,
- * take the correct action in the event of a fire,
- * ensure that escape routes are kept clear and can be used effectively at all times,

If a fire is discovered, the fire marshal is expected to:

- * Check that the alarm has been raised by somebody,
- * check that machinery has been made safe,
- * evacuate people from the area involved or designated zone
- * ensure that anyone with disabilities are assisted in line with their PEEP,
- * call the reporting company and give details of the location of the alarm and the cause of the fire, if possible,
- * fight the fire with appropriate extinguishers if it is safe to do so and company policy allows

When the alarm is heard, fire marshals should ensure that everyone leaves the building as quickly and as orderly as feasible, ensuring that security measures, such as closing fire-resistant safes, are carried out in accordance with company policy (but not to delay the evacuation procedure) Electrical equipment should be closed down and windows closed if possible.

Fire Marshals should search toilets and storerooms in their zone/s in a methodical way to ensure no one remains.

The Marshal should then go to the relevant assembly point and become involved in the roll call procedure. If specified, the Fire Marshal may be appointed to ensure no one re-enters the building until the Fire Brigade say it is safe.

Fire Marshals play an important role in reporting any changes to ignition sources and combustibles. This fire prevention role supports the fire risk assessment process. The fire safety manager should liaise with fire marshals and any changes to policy or procedure must be shared quickly.

Fire and Bomb Drills

On some sites where there is a risk of terrorist action aimed at the company or others in the area, it is also useful to carry out a bomb drill occasionally, with the aim of reminding staff of the actions that should be taken. Records of this exercise should be kept and procedures modified as required.

It is important to consider the possibility of a device outside in the street and to have assembly points further away than for fires.

6.5.4 Fire drills; roll call; provisions for people with disabilities

Fire drills

Once a fire routine has been established, it must be test at regular intervals in order to ensure that all staff are familiar with the action to be taken in an emergency.

The most effective way of achieving this is by carrying out fire drills at prescribed intervals. Drills should be held at least twice a year other than in areas dealing with hazardous processes, where they should be more frequent. A programme of fire drills should be planned to ensure that all employees, including shift workers and part-time employees, are covered.

Assembly and roll call

Assembly points should be established for use in the event of evacuation. They should be in positions, preferably under cover, which are unlikely to be affected at the time of fire. In some cases, it may be necessary to make mutual arrangements with the occupiers of nearby premises.

In the case of small premises, a complete list of the names of all staff should be maintained so that a roll call can be made if evacuation becomes necessary.

In those premises where the number of staff would make a single roll call difficult, each departmental fire warden should maintain a list of the names of staff in their area. Roll call lists must be updated regularly.

People with special needs

Of all the people who may be especially at risk, employers will need to pay particular attention to people who have special needs, including those with a disability.

In the UK, the Disability Rights Commission estimates that 11 million people have some form of disability, which may mean that they find it more difficult to leave a building if there is a fire. Under the UK Disability Discrimination Act (DDA), if disabled people could realistically expect to use premises, then employers or those in charge of premises must

anticipate any reasonable adjustments that would make it easier for that right to be exercised. Similar legislation may well be in place in most EU countries and a number of countries elsewhere.

The DDA includes the concept of 'reasonable adjustments' and this can be carried over into fire safety law. It can mean different things in different circumstances. For a small business, it may be considered reasonable to provide contrasting colours on a handrail to help people with vision impairment to follow an escape route more easily. However, it might be unreasonable to expect that same business to install an expensive voice alarm system. Appropriate reasonable adjustments for a large business or organisation may be much more significant.

Where people with special needs use or work on the premises, their needs should, so far as is practicable, be discussed with them. These will often be modest and may require only changes or modifications to existing procedures. There may be a need to develop individual 'personal emergency evacuation plans' (PEEPs) for disabled persons who frequently use a building. They will need to be confident of any plan/PEEP that is put in place after consultation with them. As part of an employer's consultation exercise they will need to consider the matter of personal dignity.

People with special needs (including members of the public) need extra consideration when planning for emergencies. But the problems this raises are seldom great. Employers should:

- identify everyone who may need special help to get out;
- allocate responsibility to specific staff to help people with a disability in emergency situations;
- consider possible escape routes;
- enable the safe use of lifts;
- enable people with a disability to summon help in emergencies;
- train staff to be able to help their colleagues;
- consider safe havens.

People with impaired vision must be encouraged to familiarize themselves with escape routes, particularly those not in regular use. A 'buddy' system would be helpful. But, to take account of absences, more than one employee working near anyone with impaired vision should be taught how to help them.

If disabled people are going to be in premises, then employers must also provide a safe means for them to leave if there is a fire. Staff should be aware that disabled people may not react, or can react differently, to a fire warning or a fire incident. Employers should give similar consideration to others with special needs such as parents with young children or the elderly.

In premises with a simple layout, a common-sense approach, such as offering to help lead a blind person or helping an elderly person down steps may be enough. In more complex premises, more elaborate plans and procedures will be needed, with trained staff assigned to specified duties.

Consider the needs of people with mental disabilities or spatial recognition problems. The range of disabilities encountered can be considerable, extending from mild epilepsy to complete disorientation in an emergency situation. Many of these can be addressed by properly trained staff, discreet and empathetic use of the 'buddy system' or by careful planning of colour and texture to identify escape routes.

6.5.5 Building plans to include record of emergency escape

The FSO requires that a 'responsible person' must carry out, and keep up to date, a risk assessment and implement appropriate measures to minimise the risk to life and property from fire.

The responsible person will usually be the main or principal contractor in control of the site.

You should identify sources of fuel and ignition and establish general fire precautions including, means of escape, warning and fighting fire, based on your fire risk assessment.

In occupied buildings such as offices, make sure the work does not interfere with existing escape routes from the building, or any fire separation, alarms, dry risers, or sprinkler systems.

Key issues are:

- Risk assessment
- Means of escape
- Means of giving warning
- Means of fighting fire

Construction of timber frame buildings will require significant additional measures – please refer to the specific guidance listed.

What you need to know

Each year there a number of serious fires on construction sites and buildings undergoing refurbishment.

Risk assessment

In most cases, conducting a risk assessment will be a relatively straightforward and simple task that may be carried out by the responsible person, or a person they nominate, such as a consultant.

There are five steps in carrying out a fire risk assessment:

1. **Identify hazards:** consider how a fire could start and what could burn;
2. **People at risk:** employees, contractors, visitors and anyone who is vulnerable, e.g. disabled;
3. **Evaluation and action:** consider the hazards and people identified in 1 and 2 and act to remove and reduce risk to protect people and premises;
4. **Record, plan and train:** keep a record of the risks and action taken. Make a clear plan for fire safety and ensure that people understand what they need to do in the event of a fire; and
5. **Review:** your assessment regularly and check it takes account of any changes on site.

Means of escape

Key aspects to providing safe means of escape on construction sites include:

- **Routes:** your risk assessment should determine the escape routes required, which must be kept available and unobstructed;
- **Alternatives:** well-separated alternative ways to ground level should be provided where possible;
- **Protection:** routes can be protected by installing permanent fire separation and fire doors as soon as possible;
- **Assembly:** make sure escape routes give access to a safe place where people can assemble and be accounted for. On a small site the pavement outside may be adequate; and
- **Signs:** will be needed if people are not familiar with the escape routes. Lighting should be provided for enclosed escape routes and emergency lighting may be required.

Means of giving warning

Set up a system to alert people on site. This may be temporary or permanent mains operated fire alarm (tested regularly), a klaxon, an air horn or a whistle, depending on the size and complexity of the site.

The warning needs to be distinctive, audible above other noise and recognisable by everyone.

Means of fighting fire

Fire extinguishers should be located at identified fire points around the site. The extinguishers should be appropriate to the nature of the potential fire:

- wood, paper and cloth – water extinguisher;
- flammable liquids – dry powder or foam extinguisher;
- electrical – carbon dioxide (CO₂) extinguisher.

Nominated people should be trained in how to use extinguishers.

Element 7 - Chemical and biological health hazards and risk control

Learning outcomes

- ✚ Outline the forms of, the classification of, and the health risks from exposure to, hazardous substances
- ✚ Explain the factors to be considered when undertaking an assessment of the health risks from substances commonly encountered in the workplace
- ✚ Explain the use and limitations of occupational exposure limits including the purpose of long term and short term exposure limits
- ✚ Outline control measures that should be used to reduce the risk of ill-health from exposure to hazardous substances
- ✚ Outline the hazards, risks and controls associated with specific agents
- ✚ Outline the basic requirements related to the safe handling and storage of waste

Introduction

Work in the field of occupational health has been taking place for the last four centuries and possibly longer. The main reason for the relatively low profile for occupational health over the years has been the difficulty in linking the ill-health effect with the workplace cause. Many illnesses, such as asthma or back pain, can have a workplace cause but can also have other causes. Many of the advances in occupational health have been as a result of statistical and epidemiological studies (one well-known such study linked the incidence of lung cancer to cigarette smoking). While such studies are invaluable in the assessment of health risk, there is always an element of doubt when trying to link cause and effect. The measurement of gas and dust concentrations is also subject to doubt when a correlation is made between a measured sample and the workplace environment from which it was taken. Occupational health, unlike occupational safety, is generally more concerned with probabilities than certainties.

The hazards of working in unfamiliar countries and/ or climates are important health and safety issues - think of snake bites, diseases (such as malaria and yellow fever) and sunstroke. The course provider will relate these and any other particular hazards to the country for which the course is being provided.

7.1 Forms of, classification of, and health risks from hazardous substances

7.1.1 Forms of chemical agent:

Chemicals can be transported by a variety of agents and in a variety of forms. They are normally defined in the following ways.

The common forms of chemical agents are:

- dusts,
- fibers,
- fumes,
- gases,
- mists,
- vapours and
- liquids

Dusts are solid particles slightly heavier than air but often suspended in it for a period of time. The size of the particles ranges from about 0.4 µm (fine) to 10 µm (coarse). Dusts are created either by mechanical processes (e.g. grinding or pulverizing) or construction processes (e.g. concrete laying, demolition or sanding), or by specific tasks (e.g. furnace ash removal). The fine dust is much more hazardous because it penetrates deep into the lungs and remains there -known as *respirable dust*. In rare cases, respirable dust enters the bloodstream, directly causing damage to other organs. Examples of such fine dust are cement, granulated plastic materials and silica dust produced from stone or concrete dust. Repeated exposure may lead to permanent lung disease. Any dusts which are capable of entering the nose and mouth during breathing, are known as *inhalable dusts*. **Gases** are any substances at a temperature above their boiling point. Steam is the gaseous form of water. Common gases include carbon monoxide, carbon dioxide, nitrogen and oxygen. Gases are absorbed into the bloodstream where they may be beneficial (oxygen) or harmful (carbon monoxide). **Vapours** are substances which are at or very close to their boiling temperatures. They are gaseous in form. Many solvents, such as cleaning fluids, fall into this category. The vapours, if inhaled, enter the bloodstream and some can cause short-term effects (dizziness) and long-term effects (brain damage). **Liquids** are substances which normally exist at a temperature between freezing (solid) and boiling (vapours and gases). They are sometimes referred to as fluids in health and safety legislation. **Mists** are similar to vapours in that they exist at or near their boiling temperature but are closer to the liquid phase. This means that there are very small liquid droplets, suspended and present in the vapour. **A mist** is produced during a spraying process (such as paint spraying). Many industrially produced mists can be very damaging if inhaled, producing similar effects to vapours. It is possible for some mists to enter the body through the skin or by ingestion with food.

Fumze is a collection of very small metallic particles (less than 1 nm) which have condensed from the gaseous state. They are most commonly generated by the welding process. The particles tend to be within the respirable range (approximately 0.4-1.0 urn) and can lead to long-term permanent lung damage. The exact nature of any harm depends on the metals used in the welding process and the duration of the exposure.

7.1.2 Forms of biological agent

As with chemicals, biological hazards may be transported by any of the following forms of agent.

- *Fungi* are very small organisms, sometimes consisting of a single cell, and can appear plant like (e.g. mushrooms and yeast). Unlike plants, they cannot produce their own food but either live on dead organic matter or on living animals or plants as parasites. Fungi reproduce by producing spores, which can cause allergic reactions when inhaled. The infections produced by fungi in humans may be mild, such as athlete's foot, or severe, such as ringworm. Many fungal infections can be treated with antibiotics.
- *Moulds* are a particular group of very small fungi which, under damp conditions, will grow on surfaces such as walls, bread, cheese, leather and canvas. They can be beneficial (penicillin) or cause allergic reactions (asthma). Asthma attacks, athlete's foot and farmer's lung are all examples of fungal infections.
- *Bacteria* are very small single-celled organisms which are much smaller than cells within the human body. They can live outside the body and be controlled and destroyed by antibiotic drugs. There is evidence that some bacteria are becoming resistant to antibiotics. This has been caused by the widespread misuse of antibiotics. It is important to note that not all bacteria are harmful to humans. Bacteria aid the digestion of food, and babies would not survive without their aid to break down the milk in their digestive system. Legionellosis, tuberculosis and tetanus are all bacterial diseases.
- *Viruses* are minute non-cellular organisms which can only reproduce within a host cell. They are very much smaller than bacteria and cannot be controlled by antibiotics. They appear in various shapes and are continually developing new strains. They are usually only defeated by the defence and healing mechanisms of the body. Drugs can be used to relieve the symptoms of a viral attack but cannot cure it. The common cold is a viral infection as are hepatitis, AIDS (HIV) and influenza.

A number of diseases including bovine spongiform encephalopathy (BSE) in cattle and Creutzfeldt-Jakob disease (CJD) in humans, are caused by another biological agent known as

a prion. A *prion* is an infectious agent that is composed primarily of protein. Such agents induce existing substances, called polypeptides, in the host organism to take on a rogue form. All known prion diseases affect the structure of the brain or other neural tissue, are currently untreatable and are always fatal.

7.1.3 Main classification of substances hazardous to health

A hazardous substance is one which can cause ill-health to people at work. Such substances may include those used directly in the work processes (glues and paints), those produced by work activities (welding fumes) or those which occur naturally (dust). Hazardous substances are classified according to the severity and type of hazard which they may present to people who may come into contact with them. The contact may occur while working or transporting the substances or might occur during a fire or accidental spillage. There are several classifications but here only the five most common will be described.

- An *irritant* is a non-corrosive substance which can cause skin (dermatitic) or lung (bronchial) inflammation after repeated contact. People who react in this way to a particular substance are *sensitized* or *allergic* to that substance. In most cases, it is likely that the concentration of the irritant may be more significant than the exposure time. Many household substances, such as wood preservatives, bleaches and glues are irritants. Many chemicals used as solvents are also irritants (white spirit, toluene and acetone). Formaldehyde and ozone are other examples of irritants.
- *Corrosive* substances are ones that may destroy living tissue on contact—usually by burning the skin. Usually strong acids or alkalis, examples include sulphuric acid and caustic soda. Many tough cleaning substances, such as kitchen oven cleaners, are corrosive as are many dishwasher crystals.
- *Harmful* is the most commonly used classification and describes a substance which, if swallowed, inhaled or penetrates the skin, *may* pose limited health risks. These risks can usually be minimized or removed by following the instruction provided with the substance (e.g. by using personal protective equipment). There are many household substances which fall into this category including bitumen-based paints and paintbrush restorers. Many chemical cleansers are categorized as harmful. It is very common for substances labelled harmful also to be categorized as irritant.
- *Toxic* substances are poisonous and impede or prevent the function of one or more organs within the body, such as the kidney, liver and heart. A toxic substance is, therefore, a poisonous one. Lead, mercury, pesticides and the gas carbon monoxide are toxic substances. The effect on the health of a person exposed to a toxic substance depends on the concentration and toxicity of the substance, the frequency of the exposure and the effectiveness of the control measures in place.

The state of health and age of the person and the route of entry into the body have influence on the effect of the toxic substance.

- *Carcinogenic* substances are ones which are known for, **or** suspected of, promoting abnormal development of body cells to become cancers. Asbestos, hardwood dust, creosote and some mineral oils are carcinogenic. It is very important that the health and safety rules accompanying the substance are strictly followed.
- *Mutagenic* substances are those which damage genetic material within cells, causing abnormal changes that can be passed from one generation to another.

The effects on health of hazardous substances may be either acute or chronic.

- *Acute* effects are of short duration and appear fairly rapidly, usually during or after a single or short-term exposure to a hazardous substance. Such effects may be severe and require hospital treatment but are usually reversible. Examples include asthma-type attacks, nausea and fainting.
- *Chronic* effects develop over a period of time which may extend to many years. The word 'chronic' means 'with time' and should not be confused with 'severe' as its use in everyday speech often implies. Chronic health effects are produced from prolonged or repeated exposures to hazardous substances resulting in a gradual, latent and often irreversible illness, which may remain undiagnosed for many years. Many cancers and mental diseases fall into the chronic category. During the development stage of a chronic disease, the individual may experience no symptoms.

Risk and safety phrases

The European Union currently requires that risk phrases (R-phrases) appear on each label and safety data sheet for hazardous substances. R-phrases consist of the letter R followed by a number. Similarly safety phrases (S-phrases) for handling precautions are also part of the same requirements.

When a hazardous substance exhibits more than one risk they are combined as a multiple risk phrases. For example a hazardous substance that has multiple risk phrases R23/24/25 would be toxic by inhalation, in contact with skin and if swallowed.

It is important to note that both risk and safety phrases are being phased out following the implementation by the EU of the Globally Harmonized System of Classification and Labelling of Chemicals (GHS)

During 2010 within the EU these phrases will begin to change to 'Hazard Statements' and 'Precautionary Statements' as the new Global Harmonized System (GHS) starts to be introduced. The symbols will also begin to change. Safety Data Sheets for chemical substances should all use the new terminology from December 2010 and for chemical mixtures from June 2015. See Appendix 14.5 for more information on the symbols and statements.

Worldwide, there are many different laws to identify hazardous chemicals (classification) and to communicate this information to users. This is often confusing as the same chemical can have different hazard descriptions in different countries. The UN brought together experts from different countries to create the GHS.



Figure - Existing European symbols and the New GHS International Symbols.

The aim of GHS is to have, throughout the world, the same:

- criteria for classifying chemicals according to their health, environmental and physical hazards;
- hazard communication requirements for labeling and safety data sheets.

Table - Examples of the new hazard warning (H) and precautionary statements (P)

Hazard warning statement (H)	Precautionary statement (P)
H240 – Heating may cause an explosion H320 – Causes eye irritation H401 – Toxic to aquatic life	P102 – Keep out of reach of children P271 – Use only outdoors or in well-ventilated area P410 – Protect from sunlight

The United Nations Globally Harmonized System of Classification and Labelling of Chemicals (UN GHS) provides a basis for globally uniform physical, environmental, health and safety information on hazardous chemicals through the harmonization of the criteria for their classification and labelling. It was developed at UN level with the aim of overcoming

differing labelling information requirements on physical, health and environmental hazards for the same chemicals around the world. Moreover, it also aims to lower barriers to trade caused by the fact that every time a product was exported, it mostly had to be classified and labelled differently because of differing criteria.

The UN GHS is not a formal treaty, but instead is a non-legally binding international agreement. This means that countries (or trading blocs like the EU) must create local or national legislation to implement the GHS.

Outside the EU many other countries have subscribed to implementing the GHS into domestic law, including the US, Canada, New Zealand, Brazil, China, the Philippines, Russia, Japan, Mexico, South Africa and various other African countries. The stage of implementation ranges from those countries which already have or are about to have in place their own GHS implementing scheme (e.g. EU, Japan, New Zealand, South Korea) to those countries where focused activities on and development of a GHS implementing scheme are ongoing (e.g. the US) and to further countries which have just started their discussions with the view to implement the GHS. Each individual country employs its specific domestic legal instruments, e.g. sector-specific acts or national standards, to implement the GHS.

The EU legislation on classification, labelling and packaging consists of three acts: The Dangerous Substances Directive (Directive 67/548/EEC, DSD), the Dangerous Preparations Directive (Directive 1999/45/EC, DPD) and the new Regulation on classification, labelling and packaging of substances and mixtures, Regulation (EC) No 1272/2008 (CLP Regulation or CLP) which entered into force on 20th January 2009 and applies directly in all member states.

Further information on the stage of implementation of the UN GHS in different countries is available on the UN ECE website, see: http://www.unece.org/trans/danger/publi/ghs/implementation_e.html

Under the new CLP Regulations there are:

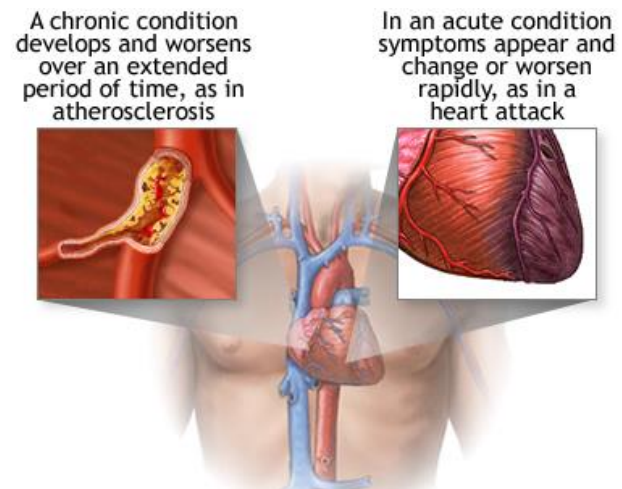
- new scientific criteria to assess hazardous properties of chemicals;
- two new harmonized hazard warning symbols for labels (known as 'pictograms');
- a new design for existing symbols;
- new harmonized **hazard warning (H)** and **precautionary statements (P)** for labels, which will replace the existing risk and safety phrases.

7.1.4 Difference between acute and chronic health effects

The difference between acute and chronic when used for diseases is that acute means extremely severe pain, brief and dangerous disease whereas chronic refers to a medical condition that lasts over a long period.

Chronic also means something always present and recurring or something habitual. Acute may refer to a geometrical angle that is less than ninety degrees and it is called an acute angle.

People often get confused with these terms acute and chronic in medical conditions. Usually, acute means sudden onset of a disease or injury whereas chronic diseases develop slowly and gradually. Acute condition happens when you cut yourself with a knife or catch a cold whereas chronic medical condition is when you suffer from pain and disease over an extended period of time. In an acute medical condition, a person may recover fast and be relieved of the symptoms soon but in a chronic medical condition, the disease may last a lifetime and it may take longer to get relief from the disease.



Acute conditions are severe and sudden in onset. This could describe anything from a broken bone to an asthma attack. A chronic condition, by contrast is a long-developing syndrome, such as osteoporosis or asthma. Note that osteoporosis, a chronic condition, may cause a broken bone, an acute condition. An acute asthma attack occurs in the midst of the chronic disease of asthma. Acute conditions, such as a first asthma attack, may lead to a chronic syndrome if untreated.

Acute injuries can become chronic medical conditions. For instance, if someone severely hurts his back, he can develop chronic backache pain.

Acute disease symptoms also last for a short time whereas chronic disease symptoms may take more than three months to subside eventually.

The term acute in diseases is not an indication of the severity of the disease. It is used to indicate the length or period of time the disease or pain lasted or how fast it developed. Some examples of acute diseases are bad throat and influenza whereas examples of chronic diseases that are persistent and may recur are kidney trouble, diabetes or cancer etc.

In some cases acute diseases resolve themselves whereas in the case of chronic disease the patient may have to be hospitalized or taken to the doctor often. Chronic Patients with chronic diseases are required to take prescribed medication for longer periods of time whereas patients with acute diseases may not require any medication at all. They can also get over-the-counter medicines to relieve pain and symptoms. Acute health effects can be reversed but chronic health effects are often known to be irreversible.

7.2 Assessment of health risks

7.2.1 Routes of entry of hazardous substances into the body and body reaction in the form of superficial and cellular defense mechanisms with particular reference to the hazardous substances

There are three principal routes of entry of hazardous substances into the human body:

- ***inhalation*** - breathing in the substance with normal air intake. This is the main route of contaminants into the body. These contaminants may be chemical (e.g. solvents or welding fume) or biological (e.g. bacteria or fungi) and become airborne by a variety of modes, such as sweeping, spraying, grinding and bagging. They enter the lungs where they have access to the bloodstream and many other organs;
- ***absorption through the skin*** - the substance comes into contact with the skin and enters through either the pores or a wound. Tetanus can enter in this way as can toluene, benzene and various phenols;
- ***ingestion*** - through the mouth and swallowed into the stomach and the digestive system. This is not a significant route of entry to the body. The most common occurrences are due to airborne dust or poor personal hygiene (not washing hands before eating food, drinking or smoking)

Another rare entry route is by *injection or skin puncture*. The abuse of compressed air lines by shooting high pressure air at the skin can lead to air bubbles entering the bloodstream. Accidents involving hypodermic syringes in a health or veterinary service setting are rare but illustrate this form of entry route.

The most effective control measures which can reduce the risk of infection from biological organisms are disinfection, proper disposal of clinical waste (including syringes), good

personal hygiene and, where appropriate, personal protective equipment. Other measures include vermin control, water treatment and immunization.

There are five major functional systems within the human body - respiratory, nervous, cardiovascular (blood), urinary and the skin.

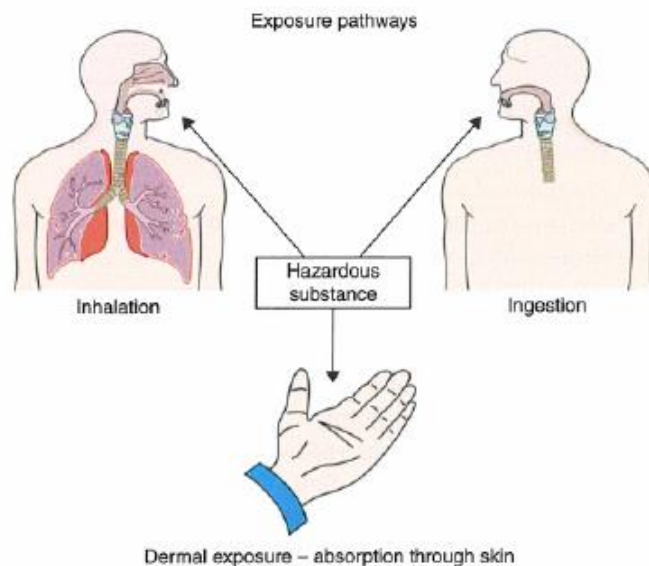


Figure - Hazardous substances - principal routes of entry into the human body.

The respiratory system

This comprises the lungs and associated organs (e.g. the nose). Air is breathed in through the nose, and passes through the trachea (windpipe) and the bronchi into the two lungs. Within the lungs, the air enters many smaller passageways (bronchioles) and thence to one of 300 000 terminal sacs called alveoli. The alveoli are approximately 0.1 mm across, although the entrance is much smaller. On arrival in the alveoli, there is a diffusion of oxygen into the bloodstream through blood capillaries and an effusion of carbon dioxide from the bloodstream. While soluble dust which enters the alveoli will be absorbed into the bloodstream, insoluble dust (respirable dust) will remain permanently, leading to possible chronic illness.

The whole of the bronchial system is lined with hairs, known as cilia. The cilia offer some protection against insoluble dusts. These hairs will arrest all non-respirable dust (above 5 μm) and, with the aid of mucus, pass the dust from one hair to a higher one and thus bring the dust back to the throat (this is known as the ciliary escalator). It has been shown that smoking damages this action. The nasal hairs in the nose will normally trap large particles (greater than 20 μm) before they enter the trachea. There are over 40 conditions that can affect the lungs and/or airways and impinge on the ability of a person to breathe normally.

Respirable dust tends to be long thin particles with sharp edges which puncture the alveoli walls. The puncture heals producing scar tissues which are less flexible than the original walls - this can lead to fibrosis. Such dusts include asbestos, coal, silica, some plastics and talc. The possible indicators of a dust problem in the workplace are fine deposits on surfaces, people and products or blocked filters on extraction equipment. Ill-health reports or complaints from the workforce could also indicate a dust problem.

Acute effects on the respiratory system include bronchitis and asthma and chronic effects include fibrosis and cancer. Hardwood dust, for example, can produce asthma attacks and nasal cancer.

Finally, asphyxiation, due to a lack of oxygen, is a problem in confined spaces particularly when MIG (metal inert gas) welding is taking place.

The nervous system

The nervous system consists primarily of the brain, the spinal cord and nerves extending throughout the body. Any muscle movement or sensation (e.g. hot and cold) is controlled or sensed by the brain through small electrical impulses transmitted through the spinal cord and nervous system. The effectiveness of the nervous system can be reduced by **neurotoxins** and lead to changes in mental ability (loss of memory and anxiety), epilepsy and narcosis (dizziness and loss of consciousness). Organic solvents (trichloroethylene) and heavy metals (mercury) are well-known neurotoxins. The expression 'mad hatters' originated from the mental deterioration of top hat polishers in the 19th century who used mercury to produce a shiny finish on the top hats.

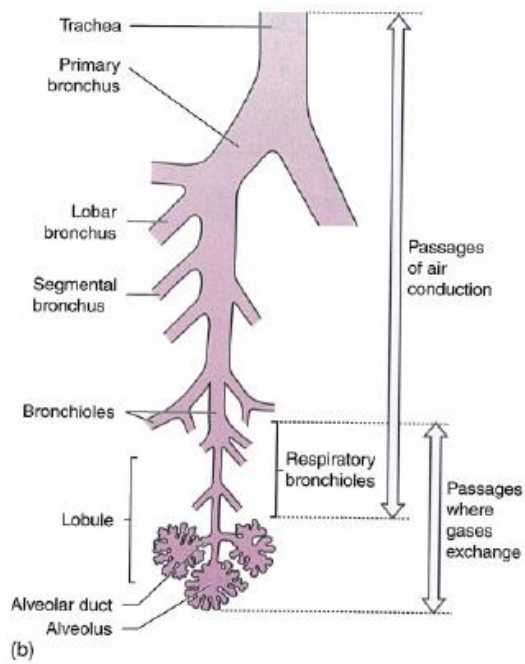
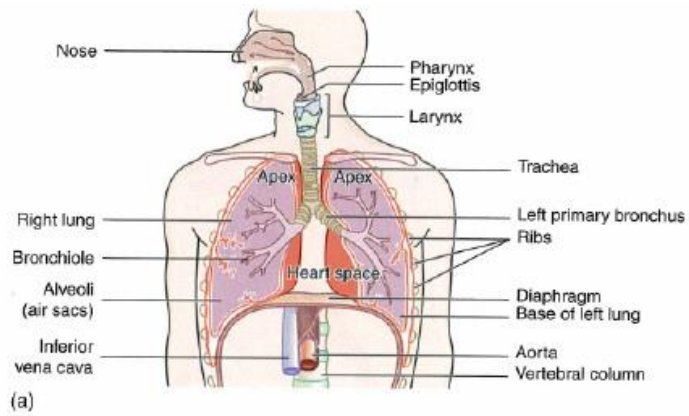


Figure – The upper and lower respiratory system.

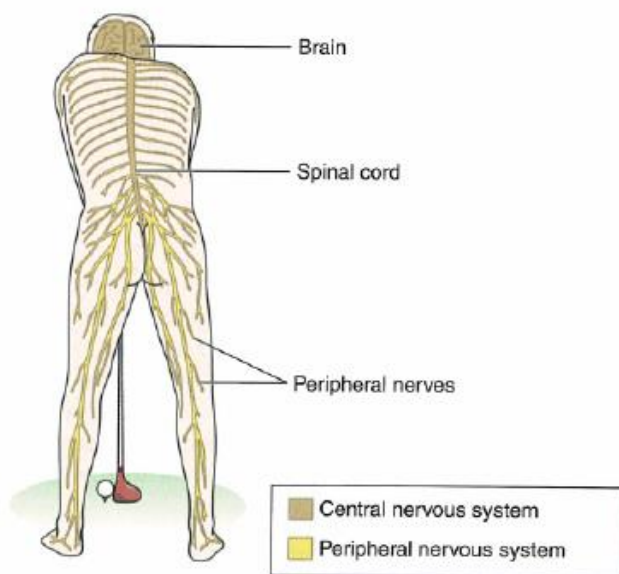


Figure – The nervous system.

The cardiovascular system

The blood system uses the heart to pump blood around the body through arteries, veins and capillaries. Blood is produced in the bone marrow and consists of a plasma within which are red cells, white cells and platelets. The system has three basic objectives:

- to transport oxygen to vital organs, tissues and the brain and carbon dioxide back to the lungs (red cell function);
- to attack foreign organisms and build up a defence system (white cell function);
- to aid the healing of damaged tissue and prevent excessive bleeding by clotting (platelets).

There are several ways in which hazardous substances can interfere with the cardiovascular system. Benzene can affect the bone marrow by reducing the number of blood cells produced. Carbon monoxide prevents the red cells from absorbing sufficient oxygen and the effects depend on its concentration. Symptoms begin with headaches and end with unconsciousness and possibly death.

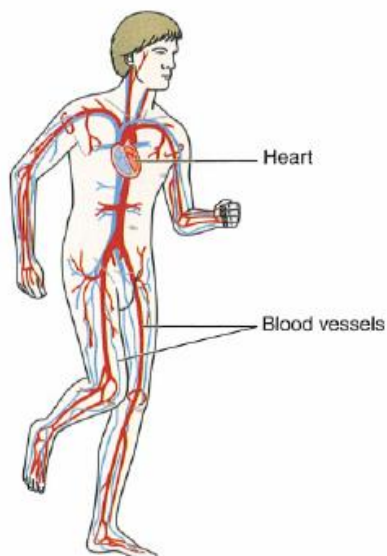


Figure - The cardiovascular system.

The urinary system

The urinary system extracts waste and other products from the blood. The two most important organs are the liver (normally considered part of the digestive system) and kidney, both of which can be affected by hazardous substances within the bloodstream.

The liver removes toxins from the blood, maintains the levels of blood sugars and produces protein for the blood plasma. Hazardous substances can cause the liver to be too active or inactive (e.g. xylene), lead to liver enlargement (e.g. cirrhosis caused by alcohol) or liver cancer (e.g. vinyl chloride).

The kidneys filter waste products from the blood as urine, regulate blood pressure and liquid volume in the body and produce hormones for making red blood cells. Heavy metals (e.g. cadmium and lead) and organic solvents (e.g. glycol ethers used in screen printing) can restrict the operation of the kidneys possibly leading to failure.

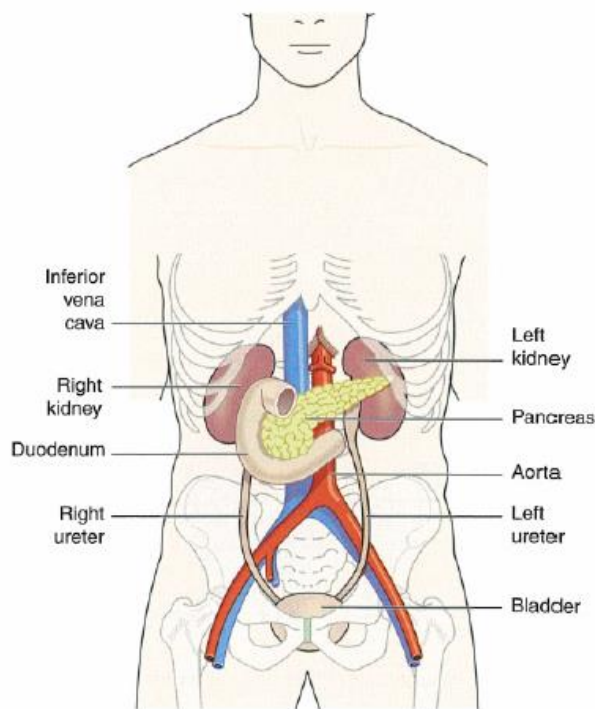


Figure – Parts of the urinary system.

The skin

The skin holds the body together and is the first line of defence against infection. It regulates body temperature, is a sensing mechanism, provides an emergency food store (in the form of fat) and helps to conserve water. There are two layers - an outer layer called the epidermis (0.2 mm) and an inner layer called the dermis (4 mm). The epidermis is a tough protective layer and the dermis contains the sweat glands, nerve endings and hairs.

The most common industrial disease of the skin is *dermatitis* (non-infective dermatitis). It begins with a mild irritation on the skin and develops into blisters which can peel and weep and may become septic. It can be caused by various chemicals, mineral oils and solvents. There are two types:

irritant contact dermatitis - occurs soon after contact with the irritant substance and the condition reverses after contact ceases (detergents and weak acids);

allergic contact dermatitis - caused by a skin sensitizer such as turpentine, epoxy resin, solder flux and formaldehyde that exerts its effects via the immune system. Once sensitized to a substance, a severe dermatitis may occur following a small exposure to the same substance at a later date.

Dermatitis is on the rise and, in the UK, is costing business more than £20 million a year, even though the cost of control measures to prevent the disease is minimal. Workers in the hotel and catering industry are particularly vulnerable to this debilitating disease.

For many years, dermatitis was seen as a 'nervous' disease which was psychological in nature. Nowadays, it is recognized as an industrial disease which can be controlled by good personal hygiene, personal protective equipment, use of barrier creams and health screening of employees. Dermatitis can appear anywhere on the body but it is normally found on the hands. Therefore, gloves should always be worn when there is a risk of dermatitis.

The risks of dermatitis occurring increases with the presence of skin cuts or abrasions, which allow chemicals to be more easily absorbed, and also depend on the type, sensitivity and existing condition of the skin.

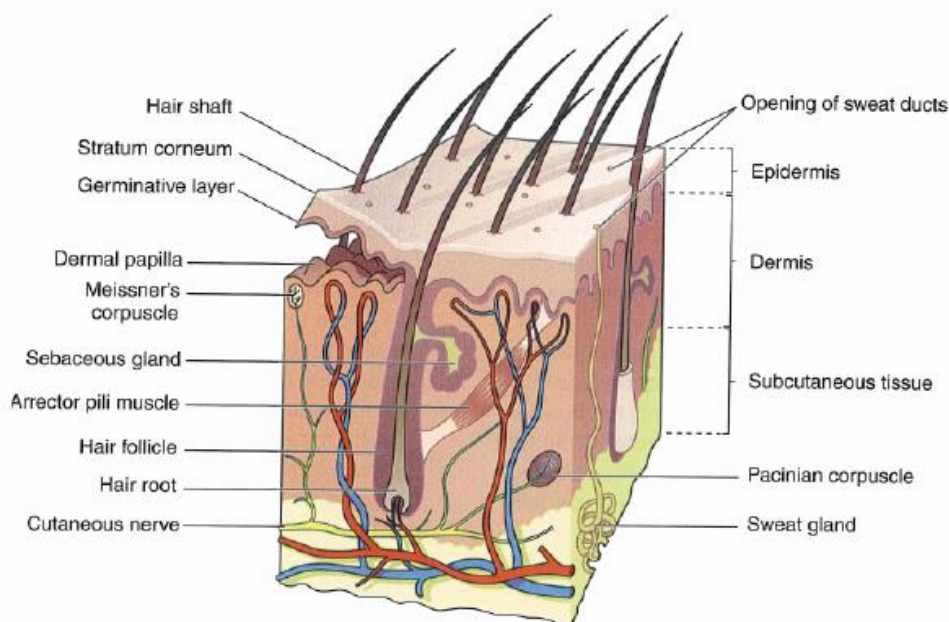


Figure – The skin – main structure in the dermis.

7.2.2 Factors to be taken into account when assessing health risks

A hazardous substance assessment is very similar to a risk assessment but is applied specifically to hazardous substances. The UK HSE has suggested five steps for such assessments but within these steps there are a number of sub-sections. The steps are as follows.

Step1

Gather information about the substances, the work and working practices. Assessors should:

- identify the hazardous substances present or likely to be present in the workplace, the categories and numbers of persons (e.g. employees and visitors);
- gather information about the hazardous substances including the quantity of the substances used;
- identify the hazards from these substances by reviewing labels, material safety data sheets, HSE guidance and published literature;
- decide who could be affected by the hazardous substances and the possible routes of entry to people exposed (i.e. inhalation, ingestion or absorption). There is a need to look at both the substances and the activities where people could be exposed to hazardous substances.

Step 2

Evaluate the risks to health either individually or collectively. Assessors should:

- evaluate the risks to health including the duration and frequency of the exposure of those persons to the substances;
- evaluate the level of exposure, for example the concentration and length of exposure to any airborne dusts, gases, fumes or vapours;
- consider any WELs;
- decide if existing and potential exposure present any insignificant risks to health or they pose a significant risk to health.

Step 3

Decide what needs to be done to control the exposure to hazardous substances. Assessors should:

- evaluate the existing control measures, including any PPE and RPE, for their effectiveness (using any available records of environmental monitoring) and compliance with relevant legislation;
- decide on additional control measures, if any are required;
- decide what maintenance and supervision of the use of the control measures are needed;
- plan what to do in an emergency;
- set out how exposure should be monitored;
- decide what, if any, health surveillance is necessary; decide what information, instruction and training is required.

Step 4

Record the assessment. Assessors should:

- decide if a record is required (five or more employed, and significant findings);
- decide on the format of the record;
- decide on storage and how to keep records available to employees, safety representatives, etc.

Step 5

Review the assessment. Assessors should:

- decide when a review is necessary (e.g. changes in substances used, processes or people exposed);
- decide what needs to be reviewed.

It is important that the assessment is conducted by somebody who is competent to undertake it. Such competence will require some training, the extent of which will depend on the complexities of the workplace. For large organizations with many high-risk operations, a team of competent assessors will be needed. If the assessment is simple and easily repeated, a written record is not necessary. In other cases, a concise and dated record of the assessment together with recommended control measures should be made available

to all those likely to be affected by the hazardous substances. The assessment should be reviewed on a regular basis, particularly when there are changes in work processes or substances or when adverse ill-health is reported.

7.2.3 Source of information

There are other important sources of information available for a hazardous substance assessment.

- **Product labels** include details of the hazards associated with the substances contained in the product and any precautions recommended. They may also bear one or more of the hazard classification symbols and/or risk phrases.
- **Guidance documents e.g., UK HSE Guidance Note EH40, EU list of Indicative Limit Values, ACGIH list of Threshold Limit Values (US) –**

Many people are exposed to a variety of substances at work, e.g. chemicals, fumes, dusts etc, which can have a harmful effect on their health. If exposure to these hazardous substances is not properly controlled, it may cause ill health in a number of ways. Exposure limits are established concentrations which, if not exceeded, will not generally cause adverse effects to the exposed worker. Guidance documents e.g., UK HSE Guidance Note EH40, EU list of Indicative Limit Values, ACGIH list of Threshold Limit Values (US) are very good source of authenticated information on Exposure levels.

The published exposure levels were developed as guidelines or recommendations in the control of potential health hazards and are not fine lines between safe and unsafe exposures, nor are they a relative index of toxicity.

- **ACGIH list of Threshold limit value (TLV)**

The most commonly used workplace exposure limits are the Threshold Limit Values TLVs, guidelines proposed by the American Conference of Governmental Industrial Hygienists (ACGIH®).

The threshold limit value (TLV) of a chemical substance is a level to which it is believed a worker can be exposed day after day for a working lifetime without adverse health effects. Strictly speaking, TLV is a reserved term of the American Conference of Governmental Industrial Hygienists (ACGIH). However, it is sometimes loosely used to

refer to other similar concepts used in occupational health and toxicology. TLVs, along with biological exposure indices (BEIs), are published annually by the ACGIH.

The TLV is an estimate based on the known toxicity in humans or animals of a given chemical substance, and the reliability and accuracy of the latest sampling and analytical methods. It is not a static definition since new research can often modify the risk assessment of substances and new laboratory or instrumental analysis methods can improve analytical detection limits. The TLV is a recommendation by ACGIH, with only a guideline status. As such, it should not be confused with exposure limits having a regulatory status, like those published and enforced by the Occupational Safety and Health Administration (OSHA).

- **EU list of Indicative Limit Values**

In the law of the European Union, indicative limit values, more exactly indicative occupational exposure limit values (IOELVs), are human exposure limits to hazardous substances specified by the Council of the European Union based on expert research and advice.

They are not binding on member states but must be taken into consideration in setting national occupational exposure limits. Some member states have pre-existing national limits lower than the IOELV and are not required to revise these upwards. In practice, most member states adopt the IOELV but there are some variances upwards and downwards.

- **UK HSE Guidance Note EH40**

Workplace Exposure Limits are set by the Health and Safety Commission and published annually with updates by the Health and Safety Executive in Guidance Note EH40 Workplace Exposure Limits. The work in establishing WELs is undertaken by the Advisory Committee on Toxic Substances (ACTS) and its scientific subcommittee. This book contains advice and guidance about:

- European occupational exposure limits
- Exposure levels and
- Approved workplace exposure limits

- **Material safety data sheets** are another very useful source of information for hazard identification and associated advice. Manufacturers of hazardous substances are obliged to supply such sheets to users, giving details of the name, chemical composition and properties of the substance. Information on the nature of the

health hazards and any relevant exposure standard (OEL) should also be given together with recommended exposure control measures and personal protective equipment. The sheets contain useful additional information on first-aid and fire-fighting measures and handling, storage, transport and disposal information. The data sheets should be stored in a readily accessible and known place for use in the event of an emergency, such as an accidental release.

Other sources of information include trade association publications, industrial codes of practice and specialist reference manuals.

Limitations of information in assessing risks to health

The actual doses received by workers can and do vary due to factors like:

- Their work rate, as the faster they are working the more air they may inhale compared to someone exposed to the same substance, doing the same task at a lower work rate. Such eventualities are not allowed for in the exposure limit framework
- Errors in estimating exposure(s) may be significant
- Toxicological data on which limits are not themselves infallible
- Chemicals can enter the body by routes other than that of inhalation, as previously discussed e.g. by absorption
- Many substances do not have assigned limits.
- This means an organisation with limited technical expertise has the difficult task of setting an 'in-house' limit.
- Information provided by manufacturers and suppliers of hazardous chemicals and that contained within worker exposure limit sources may vary
- May be very technical and require a specialist to explain its relevance to a given activity
- Some substances have good toxicological information, usually gained from past experience of harm
- Many others have a limited amount of useful toxicological information available to guide us as to the harm they may produce

7.2.4 Role and limitations of hazardous substance monitoring

Monitoring means measuring to show that control is adequate. It has nothing to do with the state of a worker's health.

When do you need to monitor?

Monitoring is appropriate:

- when you need to show compliance with a WEL (**W**orkplace **E**xposure **L**imit) or BMGV (**B**iological **M**onitoring **G**uidance **V**alue)
- when you need to show that control equipment or personal protective equipment is working well enough

Monitoring can also indicate the spread of contamination, eg surface wipes.

Screening, eg colorimetric detector tubes, meters, provides indicators of worker exposure only.

Personal air monitoring measures how much of a substance the worker inhales.

Biological monitoring measures how much of a substance has entered the body.

7.3 Occupational exposure limits

An occupational exposure limit is an upper limit on the acceptable concentration of a hazardous substance in workplace air for a particular material or class of materials. It is typically set by competent national authorities and enforced by legislation to protect occupational safety and health. It is an important tool in risk assessment and in the management of activities involving handling of dangerous substances.

There are many dangerous substances for which there are no formal occupational exposure limits. In these cases, hazard banding or control banding strategies can be used to ensure safe handling.

Occupational Exposure Limits (OELs) have been established for airborne workplace chemicals by multiple regulatory and authoritative organizations around the world for well over 60 years now. With the changing regulatory arena, shifting centers of manufacturing growth, and the move towards a more global view on occupational hygiene issues, it is important for the Occupational Hygiene profession to understand the current and growing issues impacting the continued viability of OEL's in our professional practice.

7.3.1 Purpose of occupational exposure limits

One of the main purposes of a hazardous substance assessment is to adequately control the exposure of employees and others to hazardous substances. This means that such substances should be reduced to levels which do not pose a health threat to those exposed to them day after day at work. Recommended or mandatory occupational exposure limits (OELs) have been developed in many countries for airborne exposure to gases, vapours and particulates. The levels of the OEL-values for some hazardous substances vary between countries. The reasons for this variation include differences in assessment methods and the assessments on the actual risks of the hazardous substances themselves. It is often not possible to compare exposure limits between countries because of the differing approaches.

The most widely used limits, called threshold limit values (TLVs), are those issued in the USA by the American Conference of Governmental Industrial Hygienists (ACGIH).

For airborne exposures, there are four types of limits in common use:

- the time-weighted average (TW(A) exposure limit -the maximum average concentration of a chemical in air for a normal 8-hour working day and 40-hour week;
- the short-term exposure limit (STEL) - the maximum average concentration to which workers can be exposed for a short period (usually 15 minutes);
- the ceiling value - the concentration that should not be exceeded at any time.
- maximum permissible concentrations or threshold level values (TLVs).

The variations between countries are shown by the following examples.

In the **USA**, a Permissible Exposure Limit (PEL) is also used and is the maximum amount or concentration of a chemical that a worker may be exposed to under OSHA Regulations. PELs can be defined in two different ways:

- Ceiling values (denoted by C) - at no time should this exposure limit be exceeded.
- 8-hour Time Weighted Averages (TWA) - are an average value of exposure over the course of an 8 hour work shift. TWA levels are usually lower than ceiling values.

Recommended exposure limits are developed and periodically revised by the National Institute for Occupational Safety and Health (NIOSH). These recommendations are then published and transmitted to the Occupational Safety and Health Administration (OSHA) for use in promulgating legal standards. Permissible exposure limits are published in the U.S. Code of Federal Regulations, Occupational Safety and Health Standards on Toxic and Hazardous Substances.

Some States also have their own exposure limits, for example: in California, permissible exposure limits for chemical contaminants are listed in the California Code of Regulations, Control of Hazardous Substances Order. In Michigan, permissible exposure limits for air contaminants are listed in the Occupational Health Standards published by the Department of Consumer and Industry Services. In Minnesota, the Minnesota Department of Labor and Industry publishes permissible exposure limits for air contaminants. In Washington, permissible exposure limits for air contaminants are published in the Safety and Health Rules of the Washington State Department of Labor and Industries.

In **Australia**, exposure standards are available on the Hazardous Substances Information System (HSIS) database of the Australian Safety and Compensation Council (formerly the Australian National Occupational Health and Safety Commission, NOHSC). The HSIS provides access to two data sets, one for hazardous substance information and the other for exposure standard information.

In **Canada**, occupational exposure limits in Canada are regulated within each Province. In Alberta, exposure limits are listed in the Chemical Hazards Regulation. In British Columbia, exposure limits are generally determined with reference to the Threshold Limit Values (TLVs) adopted by the American Conference of Governmental Industrial Hygienists (ACGIH).

In **Germany**, rules for limiting exposure to hazardous substances in the workplace and a list of occupational exposure limits are published in Germany by the Federal Institute for Occupational Safety and Health.

In **New Zealand**, exposure limits are available in Workplace Exposure Standards effective from 2002 published by the Occupational Safety and Health Service of the Department of Labour.

In **South Africa**, occupational exposure limits for airborne pollutants in the Republic of South Africa are issued by both the Department of Labour and the Department of Minerals and Energy. Values are listed on the site of the South Africa Institute of Occupational Hygiene.

In the **European Union**, the legal basis for the preparation of occupational exposure limits and biological limits in the European Union is contained in Directive 98/24/EC on chemical agents and Directive 2004/37/EC on carcinogens and mutagens. Indicative Occupational Exposure Limit Values (IOELVs) are adopted through Commission Directives while Binding Occupational Exposure Limit Values (BOELVs) are adopted through Council and European Parliament Directives. On 7 February 2006, the Commission adopted Directive 2006/15/CE establishing a second list of Indicative Occupational Exposure Limit Values (IOELVs). Figure 14.8 shows an example of chemical storage in France.

In the **United Kingdom**, under the 2006 amendments to the COSHH Regulations 2002, the HSE has assigned WELs to a large number of hazardous substances and publishes any updates in a

publication called 'Occupational Exposure limits'EH40. The WEL is related to the concentration of airborne hazardous substances that people breathe over a specified period of time - known as'time-weighted average'. Before the introduction of WELs, there were two types of exposure limit published - the maximum exposure limit (MEL) and the occupational exposure standard (OES).

The COSHH (Amendment) Regulations 2006 replaced the OES/MEL system with a single WEL. This removed the concern of HSE that the OES was seen as a 'safe' limit rather than a 'likely safe' limit. Hence, the WEL must not be exceeded. Hazardous substances which have been assigned a WEL fall into two groups.

Substances which are carcinogenic or mutagenic (having a risk phase R45, R46 or R49) or could cause occupational asthma (having a risk phase R42, or R42/43 or listed in section C of the HSE publication 'Asthma-gen? Critical assessment for the agents implicated in occupational asthma' as updated from time to time) or are listed in Schedule 1 of the COSHH Regulations. These are substances which were assigned a MEL before 2005. The level of exposure to these substances should be reduced as far as is reasonably practicable.

2. All other hazardous substances which have been assigned a WEL. Exposure to these substances by inhalation must be controlled adequately to ensure that the WEL is not exceeded. These substances were previously assigned an OES before 2005. For these substances, employers should achieve adequate control of exposure by inhalation by applying the principles of good practice outlined in the Approved Code of Practice.

The WELs are subject to time-weighted averaging. There are two such Time-weighted Averages (TWA): the long-term exposure limit (LTEL) or 8-hour reference period and the short-term exposure limit (STEL) or 15-minute reference period. The 8-hour TWA is the maximum exposure allowed over an 8-hour period so that if the exposure period was less than 8 hours the WEL is increased accordingly with the proviso that exposure above the LTEL value continues for no longer than 1 hour

For example, if a person was exposed to a hazardous substance with a WEL of 100 mg/m³ (8-hour TWA) for 4 hours, no action would be required until an exposure level of 200 mg/m³ was reached (exposure at levels between 100 and 200 mg/m³ should be restricted to 1 hour).

If, however, the substance has an STEL of 150 mg/m³, then action would be required when the exposure level rose above 150 mg/m³ for more than 15 minutes.

The STEL always takes precedence over the LTEL. When a STEL is not given, it should be assumed that it is three times the LTEL value.

The publication EH40 is a valuable document for the health and safety professional as it contains much additional advice on hazardous substances for use during the assessment of health risks, particularly where new medical information has been made public. The HSE is

constantly revising WELs and introducing new ones and it is important to refer to the latest publication of EH40.

It is important to stress that if a WEL from Group 1 is exceeded, the process and use of the substance should cease immediately and employees should be removed from the immediate area until it can be made safe. In the longer term the process and the control and monitoring measures should be reviewed and health surveillance of the affected employees considered.

The over-riding requirement for any hazardous substance which has a WEL from Group 1, is to reduce exposure to as low as is reasonably practicable.

Finally, there are certain limitations on the use of the published WELs:

- They are specifically quoted for an 8-hour period (with an additional STEL for many hazardous substances). Adjustments must be made when exposure occurs over a continuous period longer than 8 hours.
- They can only be used for exposure in a workplace and not to evaluate or control non-occupational exposure (e.g. to evaluate exposure levels in a neighbourhood close to the workplace, such as a playground). WELs are only approved where the atmospheric pressure varies from 900 to 1100 millibars. This could exclude their use in mining and tunnelling operations. They should also not be used when there is a rapid build-up of a hazardous substance due to a serious accident or other emergency. Emergency arrangements should cover these eventualities.

The fact that a substance has not been allocated a WEL does not mean that it is safe. The exposure to these substances should be controlled to a level which nearly all of the working population could experience all the time without any adverse effects to their health.

7.3.2 Long term and short term limits

Effects of exposure to substances hazardous to health vary considerably depending on the nature of the substance and the pattern of exposure. Some effects require prolonged or accumulated exposure.

The long-term (8-hour TWA) exposure limit is intended to control such effects by restricting the total intake by inhalation over one or more workshifts, depending on the length of the shift. Other effects may be seen after brief exposures. Short-term exposure limits (usually 15 minutes)

may be applied to control these effects. For those substances for which no short-term limit is specified, it is recommended that a figure of three times the long-term limit be used as a guideline for controlling short-term peaks in exposure. Some workplace activities give rise to

frequent short (less than 15 minutes) periods of high exposure which, if averaged over time, do not exceed either an 8-hour TWA or a 15-minute TWA. Such exposures have the potential to cause harm and should be subject to reasonably practicable means of control unless a 'suitable and sufficient' risk assessment shows no risk to health from such exposures.

In some situations such as in submarines and saturation diving, the occupational exposure is essentially continuous. In these cases, a continuous exposure limit should be derived by dividing the 8-hour TWA exposure limit by a factor of 5. Further information can be found in EH75/2.

Both the long-term and short-term exposure limits are expressed as airborne concentrations averaged over a specified period of time. The period for the long-term limit is normally eight hours, when a different period is used this is stated. The averaging period for the short-term exposure limit is normally 15 minutes, such a limit applying to any 15-minute period throughout the working shift. Exposure to substances hazardous to health should be calculated according to the approved method, which is reproduced in the section 'Calculation methods'.

7.3.3 Significance of time weighted averages

The TWA for the exposure to a chemical can be used when both the chemical concentration and time for exposure varies over time. It is thus used as the average exposure to a contaminant to which workers may be exposed without adverse effect over a period such as in an 8-hour day or 40-hour week (an average work shift). They are usually expressed in units of ppm (volume/volume) or mg/m³.

7.3.4 Limitations of exposure limits

Exposure limits are established concentrations which, if not exceeded, will not generally cause adverse effects to the worker exposed. However, because of wide variation in individual susceptibility, a small percentage of workers may experience discomfort from some substances at concentrations at or below the established limit; a smaller percentage may be affected more seriously by aggravation of a pre-existing condition.

Exposure levels are intended for use as guidelines or recommendations in the control of potential health hazards and are not fine lines between safe and unsafe exposures, nor are they a relative index of toxicity.

The limits are based on industrial experience, and human and animal experimental evidence.

Exposure levels for many hazardous chemicals are included in the **Regulation respecting the Control of Exposure to Biological or Chemical Agents - made under the Occupational Health & Safety Act of Ontario (O.Reg. 654/86)**. These are expressed as follows:-

TWAEV - Time-Weighted Average Exposure Value: The average airborne concentration of a biological or chemical agent to which a worker may be exposed in a work day or a work week.

STEV - Short Term Exposure Value: The maximum airborne concentration of a chemical or biological agent to which a worker may be exposed in any 15 minute period, provided the TWAEV is not exceeded.

CEV - Ceiling Exposure Value: The maximum airborne concentration of a biological or chemical agent to which a worker may be exposed at any time.

SKIN - This notation indicates that direct or airborne contact with the product may result in significant absorption of the product through the skin mucous membranes or eyes. Inclusion of this notation is intended to suggest that preventative action be taken against absorption of the agent through these routes of entry.

Except in certain circumstances these levels must be achieved without workers being required to wear and use personal protective equipment.

Note: The exposure limits listed on the MSDS may differ from the Ontario legal exposure limit.

Other notable occupational exposure limits that one may encounter on a Material Data Sheet (MSDS) are:-

1. Permissible Exposure Levels (*PELs*) of the USA Occupational Safety and Health Administration (*OSHA*).
2. Threshold Limit Values (*TLVs*) of the American Conference of Governmental Industrial Hygienists (*ACGIH*).

7.3.5 Application of relevant limits

The TLV is an estimate based on the known toxicity in humans or animals of a given chemical substance, and the reliability and accuracy of the latest sampling and analytical methods. It is not a static definition since new research can often modify the risk assessment of substances and new laboratory or instrumental analysis methods can improve analytical detection limits. The TLV is a recommendation by ACGIH, with only a guideline status. As such, it should not be confused with exposure limits having a regulatory

status, like those published and enforced by the Occupational Safety and Health Administration (OSHA).

Workplace Exposure Limits should not be considered as relative toxicity criteria nor be used in non-occupational control of contamination, nor should they be applied to an exposure longer than the normal work period, nor be quoted to establish the existence or nonexistence of an occupational disease.

The terms maximum allowable concentration (M.A.C.) and threshold limit value (T.L.V.) differ in their respective meanings. The M.A.C. is a ceiling concentration whereas the T.L.V. is a time-weighted average of the concentration of the hazardous agent in the atmosphere. The value attributed to M.A.C. or T.L.V. will vary with the criteria decided upon for the response selected. This response may be a clinical or biochemical change in human subjects resulting from the hazardous agent. The fact that the limit values referred to as “maximum allowable concentrations” without further definition led to criticism for conveying a confusing impression that these values are of truly safe-level thresholds.

7.3.6 Comparison of measurements to exposure limits established by competent national authorities or internationally recognised standards.

It is the responsibility of the competent authority to specify what exposure limits should be used, and the responsibility of the employer to obtain this information from the competent authority for any particular hazard and to compare the exposure limits values with exposure levels in workplaces, to verify whether exposure is being properly controlled.

The International Programme on Chemical Safety (IPCS) produces IPCS International Chemical Safety Cards, which are peer-reviewed assessment documents. International organizations, such as the

International Organization for Standardization (ISO) and the International Atomic Energy Agency (IAEA), produce technical standards on the measurement and control of several ambient factors with the objective of their being transferred to regional or national legislation.

- Consider relevant occupational exposure limits
- Measurements should be compared with these limits or recognised standards
- Establish the presence of a workplace hazard, the level of risk and will indicate the need to establish prevention and control measures
- Effectiveness of prevention and control measures will need to be if the occupational exposure limits are to be met

Ensuring the occupational exposure limit is not exceeded

- Reduce to as low as is reasonably practicable
- Considered to be a maximum allowable concentration
- By working “at the limit” employers do not allow for sensitive people who may be affected by relatively low exposures
- Nor do they account for variations or inaccuracies in monitoring, sudden surges of contaminant or partial failures of control measures.

7.4 Control measures

7.4.2 The principles of good practice for the control of exposure to substances hazardous to health

To prevent ill-health due to the exposure to hazardous substances, employers are expected to develop suitable and sufficient control measures by:

1. identifying hazards and potentially significant risks;
2. taking action to reduce and control risks;
3. keeping control measures under regular review.

In order to assist employers with these duties, the UK HSE has produced the following eight principles of good practice:

- (a) Design and operate processes and activities to minimize the emission, release and spread of substances hazardous to health.
- (b) Take into account all relevant routes of exposure -inhalation, skin absorption and ingestion - when developing control measures.
- (c) Control exposure by measures that are proportionate to the health risk.
- (d) Choose the most effective and reliable control options which minimize the escape and spread of substances hazardous to health.
- (e) When adequate control of exposure cannot be achieved by other means, provide, in combination with other control measures, suitable personal protective equipment.

- (f) Check and review regularly all elements of control measures for their continuing effectiveness.
- (g) Inform and train all employees on the hazards and risks from the substances with which they work and the use of control measures developed to minimize the risks.
- (h) Ensure that the introduction of control measures does not increase the overall risk to health and safety.

All these principles are embodied in the following sections on the control measures for hazardous substances.

The frequency and type of future monitoring of exposure levels will depend on the exposure found in relation to recognized exposure limits. If the exposure level is very much lower than the limit and there is no change in process or other reason, then repeat measurement may only be needed occasionally.

If the exposure level is relatively high, then measurement may be needed several times between assessment reviews, to ensure that these levels have not been altered by some unidentified factor.

Hierarchy of control measures

The prevention or adequate control of exposure to hazardous substances by measures other than personal protective equipment taking into account the degree of exposure and current knowledge of the health risks and associated technical remedies can be listed in a hierarchy of control measures as follows:

- elimination;
- substitution;
- provision of engineering controls;
- provision of supervisory (people) controls; provision of personal protective equipment.

Examples where engineering controls are not reasonably practicable include emergency and maintenance work, short-term and infrequent exposure and where such controls are not technically feasible.

Measures for preventing or controlling exposure to hazardous substances include one or a combination of the following:

- elimination of the substance;
- substitution of the substance (or the reduction in the quantity used);

- total or partial enclosure of the process;
- local exhaust ventilation;
- dilution or general ventilation;
- reduction of the number of employees exposed to a strict minimum;
- reduced time exposure by task rotation and the provision of adequate breaks;
- good housekeeping;
- training and information on the risks involved;
- effective supervision to ensure that the control measures are being followed;
- personal protective equipment (such as clothing, gloves and masks);
- welfare (including first-aid);
- medical records;
- health surveillance.

The ILO Code of Practice 'Ambient factors in the workplace' makes a series of recommendations for the prevention and control of risks from hazardous substances. It recommends that where the assessment of hazards or risks shows that control measures are inadequate or likely to become inadequate, risks should be:

- (a) eliminated by ceasing to use such hazardous substances or replacing them with less hazardous substances or modified processes;
- (b) minimized by designing and implementing a programme of action;
- (c) reduced by minimizing the use of toxic substances, where feasible.

Recommended control measures for implementing such a programme could include any combination of the following:

- (a) good design and installation practice:
 - (i) totally enclosed process and handling systems;
 - (ii) segregation of the hazardous process from the operators or from other processes;
 - (iii)** plants, processes or work systems which minimize generation of, or suppress or contain hazardous dusts, fumes and gases and which limit the area of contamination in the event of spills and leaks;
 - (iv) partial enclosure, with local exhaust ventilation;
 - (v) local exhaust ventilation;
 - (vi) sufficient general ventilation;

- (b) work systems and practices:

- (i) reduction of the numbers of workers exposed and exclusion of non-essential access;
- (ii) reduction in the period of exposure of workers;
- (iii)** regular cleaning of contaminated walls, surfaces, etc.;
- (iv) use and proper maintenance of engineering control measures;
 - (v) provision of means for safe storage and disposal of substances hazardous to health;
- (c) personal protection:
 - (i) where the above measures do not suffice, suitable personal protective equipment should be provided until such time as the risk is eliminated or minimized to a level that would not pose a threat to health;
 - (ii) prohibition of eating, chewing, drinking and smoking in contaminated areas;
 - (iii)** provision of adequate facilities for washing and changing and for storage of clothing (everyday clothing separated from work clothing), including arrangements for laundering contaminated clothing;
 - (iv) use of signs and notices;
 - (v) adequate arrangements in the event of an emergency.

Exposure to the following types of hazardous substances may require appropriate health surveillance:

- (a) substances (dusts, fibres, solids, liquids, fumes, gases) that have a recognized systemic toxicity;
- (b) substances known to cause chronic effects (e.g. occupational asthma);
- (c) substances known to be sensitizers, irritants or allergens;
- (d) substances that are known or suspected carcinogens, teratogens (affects embryos) or mutagens;
- (e) other substances likely to have adverse health effects under particular work conditions or in case of fluctuations in ambient conditions.

The code also requires that employers should ensure that workers have sufficient, specific and systematic training and information on:

- (a) the nature and degree of hazards and risks from hazardous substances which may occur, particularly in the case of an emergency;
- (b) the protection of their safety and health and that of others from hazardous

substances which may be present, in particular by using correct and prescribed methods for the handling, storage and transport of hazardous substances, and waste disposal;

- (c) the correct and effective use of control and protection measures and of personal protective equipment.

This information should also be transmitted, where appropriate, to subcontractors and their workers.

Preventative control measures

Prevention is the safest and most effective of the control measures and is achieved either by changing the process completely or by substituting for a less hazardous substance (the change from oil-based to water-based paints is an example of this). It may be possible to use a substance in a safer form, such as a brush paint rather than a spray.

The EU has introduced chemical safety regime REACH (Registration, Evaluation and Authorization of Chemicals) Regulations, which restrict the use of high-risk substances or substances of very high concern and require that safer substitutes must be used.

Manufacturers and importers of chemicals are responsible for understanding and managing the risks associated with their products.

The Regulations apply to many common items, such as glues, paints, solvents, detergents, plastics, additives, polishes, pens and computers. The three main types of REACH dutyholder are:

- **Manufacturers/importers** - businesses that manufacture or import (from outside the EU) 1 tonne or more of any given substance each year are responsible for registering a dossier of information about that substance with the European Chemicals Agency. If substances are not registered, then the data on them will not be available and it will no longer be legal to manufacture or supply them within the EU. Suppliers will be obliged to carry out an inventory and identify where in the supply chain the chemicals come from. Under the REACH system, industry will also have to prepare risk assessments and provide control measures for safe use of the

substance by downstream users and get community-wide authorizations for the use of any substances considered to be of high concern.

- **Downstream users** - downstream users include any businesses using chemicals, which probably includes most businesses in some way. Companies that use chemicals have a duty to use them in a safe way, and according to the information on risk management measures that should be passed down the supply **chain**.
- **Other users in the supply chain** - however, in order for suppliers to be able to assess these risks they need information from the downstream users about how they are used. REACH provides a framework in which information can be passed both up and down supply chains by using the safety data sheet. This should accompany materials down through the supply chain so that users are provided with the information that they need to ensure chemicals are safely managed. It is envisaged that, in the future, the safety data sheets will include information on safe handling and use.

An important aspect of chemical safety is the need for clear information about any hazardous chemical properties. The classification of different chemicals according to their characteristics (for example, those that are corrosive, or toxic to fish) currently follows an established system, which is reflected in REACH.

Elimination or substitution of hazardous substances or form of substance

Elimination - if a hazard exists then the most appropriate control is to eliminate it completely by not using a particular substance. For example, it may be possible to eliminate the use of chemical adhesives by fastening items together with screws or nails.

Substitution - when it is not possible to eliminate the use of a chemical substance, it may be possible to use a safer alternative, for example, using water based paint instead of a solvent based paint.

Engineering controls

The simplest and most efficient engineering control is the segregation of people from the process; a chemical fume cupboard is an example of this as is the handling of toxic substances in a glove box. Modification of the process is another effective control to reduce human contact with hazardous substances.

More common methods, however, involve the use of forced ventilation - local exhaust ventilation and dilution ventilation.

Local exhaust ventilation

Local exhaust ventilation removes the hazardous gas, vapour or fume at its source before it can contaminate the surrounding atmosphere and harm people working in the vicinity. Such systems are commonly used for the extraction of welding fumes and dust from woodworking machines. All exhaust ventilation systems have the following five basic components.

1. *A collection hood and intake* - sometimes this is a nozzle-shaped point which is nearest to the work-piece, while at other times it is simply a hood placed over the workstation. The speed of the air entering the intake nozzle is important; if it is too low then hazardous fumes may not be removed (air speeds of up to 1 m/s are normally required).
2. *Ventilation ducting* - this normally acts as a conduit for the contaminated air and transports it to a filter and settling section. It is very important that this section is inspected regularly and any dust deposits removed. It has been known for ventilation ducting attached to a workshop ceiling to collapse under the added weight of metal dust deposits. It has also been known for them to catch fire.
3. *Filter or other air cleaning device* - normally located between the hood and the fan, the filter removes the contaminant from the air stream. The filter requires regular attention to remove contaminant and to ensure that it continues to work effectively.
4. *Fan* - this moves the air through the system. It is crucial that the correct type and size of fan is fitted to a given system and it should only be selected by a competent person. It should also be positioned so that it can easily be maintained but does not create a noise hazard to nearby workers.
5. *Exhaust duct* - this exhausts the air to the outside of the building. It should be checked regularly to ensure that the correct volume of air is leaving the system and that there are no leakages. The exhaust duct should also be checked to ensure that there is no corrosion due to adverse weather conditions.

Controlling Airborne Contaminants at Work, HSG258, HSE Books, is a very useful document on ventilation systems.

Such ventilation systems should be inspected at least every 14 months by a competent person to ensure that they are still operating effectively.

The effectiveness of a ventilation system will be reduced by damaged ducting, blocked or defective filters and poor fan performance. More common problems include the unauthorized extension of the system, poor initial design, poor maintenance, incorrect adjustments and a lack of inspection or testing.

Routine maintenance should include repair of any damaged ducting, checking filters, examination of the fan blades to ensure that there has been no dust accumulation, tightening all drive belts and a general lubrication of moving parts.

The local exhaust ventilation system will have an effect on the outside environment in the form of noise and odour. Both these problems can be reduced by regular routine maintenance of the fan and filter. The waste material from the filter may be hazardous and require the special disposal arrangements described later in this chapter.

Dilution (or general) ventilation

Dilution (or general) ventilation uses either natural ventilation (doors and windows) or a fan-assisted forced ventilation system to ventilate the whole working room by inducing a flow of clean air, using extraction fans fitted into the walls and the roof, sometimes assisted by inlet fans. It operates by either removing the contaminant or reducing its concentration to an acceptable level. It is used when airborne contaminants are of low toxicity, low concentration and low vapour density or contamination occurs uniformly across the workroom.

Paint-spraying operations often use this form of ventilation as does the glass reinforced plastics (GRP) boat-building industry - these being instances where there are no discrete points of release of the hazardous substances. It is also widely used in kitchens and bathrooms. It is not suitable for dust extraction and where it is reasonably practicable to reduce levels by other means (Figure 14.12).

There are limitations to the use of dilution ventilation. Certain areas of the workroom (e.g. corners and beside cupboards) will not receive the ventilated air and a buildup of hazardous substances occurs. These areas are known as 'dead areas'. The flow patterns are also significantly affected by doors and windows being opened or the rearrangement of furniture or equipment.

Use and limitations of dilution ventilation

Occasionally it is not possible to extract a contaminant close to the point of origin. If the quantity of contaminant is small, uniformly evolved and of low toxicity: it may be possible to dilute the contaminant by inducing large volumes of air to flow through the contaminated region.

Dilution ventilation is most successfully used to control vapours, e.g. organic vapours from low-toxicity solvents, but is seldom successfully applied to dust and fumes, as it will not prevent inhalation. In cold weather this method has self-evident implications for cost and thermal discomfort.

Dilution ventilation provides a flow of air into and out of the working area and does not give any control at the source of the contaminant. The background concentration of the contaminant in the working area is reduced by the addition of fresh (i.e., uncontaminated) air, but there is little, if any, reduction in direct exposure at the process.

Supervisory or people controls

Many of the supervisory controls required for hazardous substance assessments are part of a good safety culture. These include items such as systems of work, arrangements and procedures, effective communications and training. Additional controls when hazardous substances are involved are as follows:

- Reduced time exposure - thus ensuring that workers have breaks in their exposure periods. The use of this method of control depends very much on the nature of the hazardous substance and its STEL.
- Reduced number of workers exposed - only persons essential to the process should be allowed in the vicinity of the hazardous substance. Walkways and other traffic routes should avoid any area where hazardous substances are in use.
- Eating, drinking and smoking must be prohibited in areas where hazardous substances are in use.
- Any special rules, such as the use of personal protective equipment, must be strictly enforced.

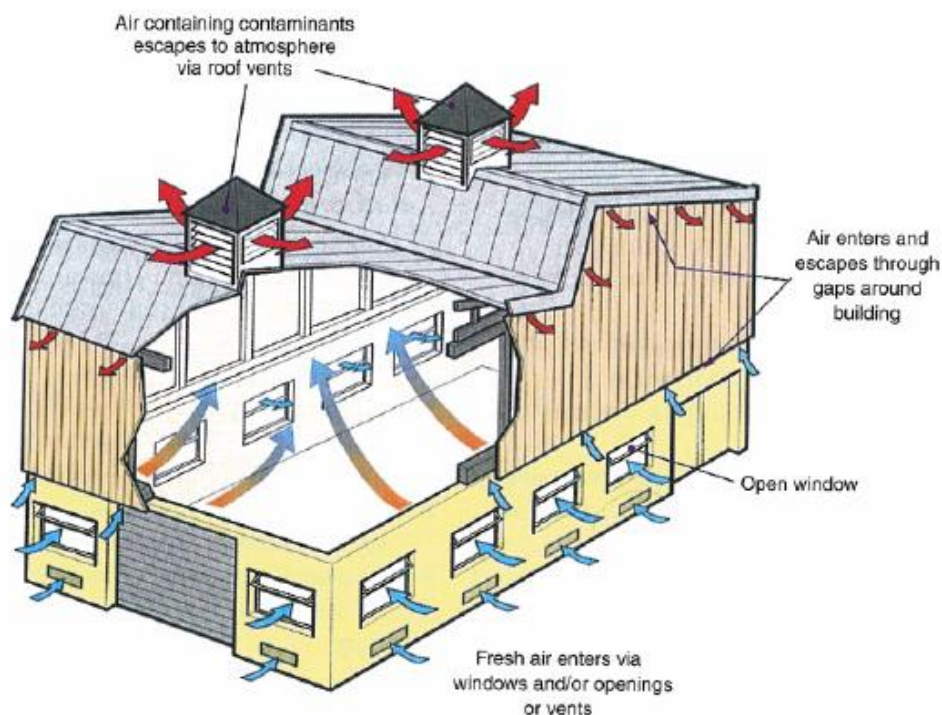


Figure – Natural ventilation in a building.

Personal protective equipment

Personal protective equipment is to be used as a control measure only as a last resort. It does not eliminate the hazard and will present the wearer with the maximum health risk if the equipment fails. Successful use of personal protective equipment relies on good user training, the availability of the correct equipment at all times and good supervision and enforcement.

The 'last resort' rule applies in particular to RPE within the context of hazardous substances. There are some working conditions when RPE may be necessary:

- during maintenance operations;
- as a result of a new assessment, perhaps following the introduction of a new substance;
- during emergency situations, such as fire or plant breakdown;
- where alternatives are not technically feasible.



Figure - Personal protective equipment at work

The principal requirements of PPE are as follows:

- personal protective equipment which is suitable for the wearer and the task;
- compatibility and effectiveness of the use of multiple personal protective equipment;
- a risk assessment to determine the need and suitability of proposed personal protective equipment;
- a suitable maintenance programme for the personal protective equipment;
- suitable accommodation for the storage of the personal protective equipment when not in use; information, instruction and training for the user of personal protective equipment;

- the supervision of the use of personal protective equipment by employees and a reporting system for defects.

Types of personal protective equipment

There are several types of personal protective equipment such as footwear, hearing protectors and hard hats which are not primarily concerned with protection from hazardous substances; those which are used for such protection include:

- respiratory protection PPE;
- hand and skin protection PPE;
- eye protection PPE;
- protective clothing.

For all types of personal protective equipment, there are some basic standards that should be reached. The personal protective equipment should fit well, be comfortable to wear and not interfere with other equipment being worn or present the user with additional hazards (e.g. impaired vision due to scratched eye goggles). Training in the use of particular personal protective equipment is essential, so that it is not only used correctly, but the user knows when to change an air filter or to change a type of glove. Supervision is essential, with disciplinary procedures invoked for non-compliance with personal protective equipment rules.

It is also essential that everyone who enters the proscribed area, particularly senior managers, wear the specified personal protective equipment.

Respiratory protective equipment

Respiratory protective equipment can be used to reduce the risk of harm from dusts, gases, vapours, mists, fume and micro-organisms. Respiratory protective equipment can be subdivided into two categories: respirators (or face masks), that filter and clean the air, and breathing apparatus that supplies breathable air.

Respirators should not be worn in air which is dangerous to health, including oxygen deficient atmospheres. They are available in several different forms but the common ones are:

- a *filtering half mask* often called disposable respirator-made of the filtering material. It covers the nose and mouth and removes respirable size dust particles. It is normally replaced after 8-10 hours of use. It offers protection against some vapours and gases;
- a *half-mask respirator* - made of rubber or plastic and covering the nose and mouth.

Air is drawn through a replaceable filter cartridge. It can be used for vapours, gases or dusts but it is very important that the correct filter is used (a dust filter will not filter vapours);

- a *full-face mask respirator* - similar to the half-mask type but covers the eyes with a visor;
- a *powered respirator* - a battery-operated fan delivers air through a filter to the face mask, hood, helmet or visor.

Breathing apparatus is used in one of three forms:

- *self-contained breathing apparatus* - where air is supplied from compressed air in a cylinder and forms a completely sealed system;
- *fresh air hose apparatus* - fresh air is delivered through a hose to a sealed face mask from an uncontaminated source. The air may be delivered by the wearer, by natural breathing or mechanically by a fan;
- *compressed air line apparatus* - air is delivered through a hose from a compressed air line. This can be either continuous flow or on demand. The air must be properly filtered to remove oil, excess water and other contaminants and the air pressure must be reduced. Special compressors are normally used.

The selection of appropriate RPE and correct filters for particular hazardous substances is best done by a competent specialist person.

There are several important technical standards which must be considered during the selection process. The following information will be needed before a selection can be made:

- details of the hazardous substance, in particular whether it is a gas, vapour or dust or a combination of all three;
- presence of a beard or other facial hair which could prevent a good leak-free fit (a simple test to see whether the fit is tight or not is to close off the air supply, breathe in and hold the breath. The respirator should collapse onto the face. It should then be possible to check to see if there is a leak);
- the size and shape of the face of the wearer and physical fitness;
- compatibility with other personal protective equipment, such as ear defenders;
- the nature of the work and agility and mobility required.

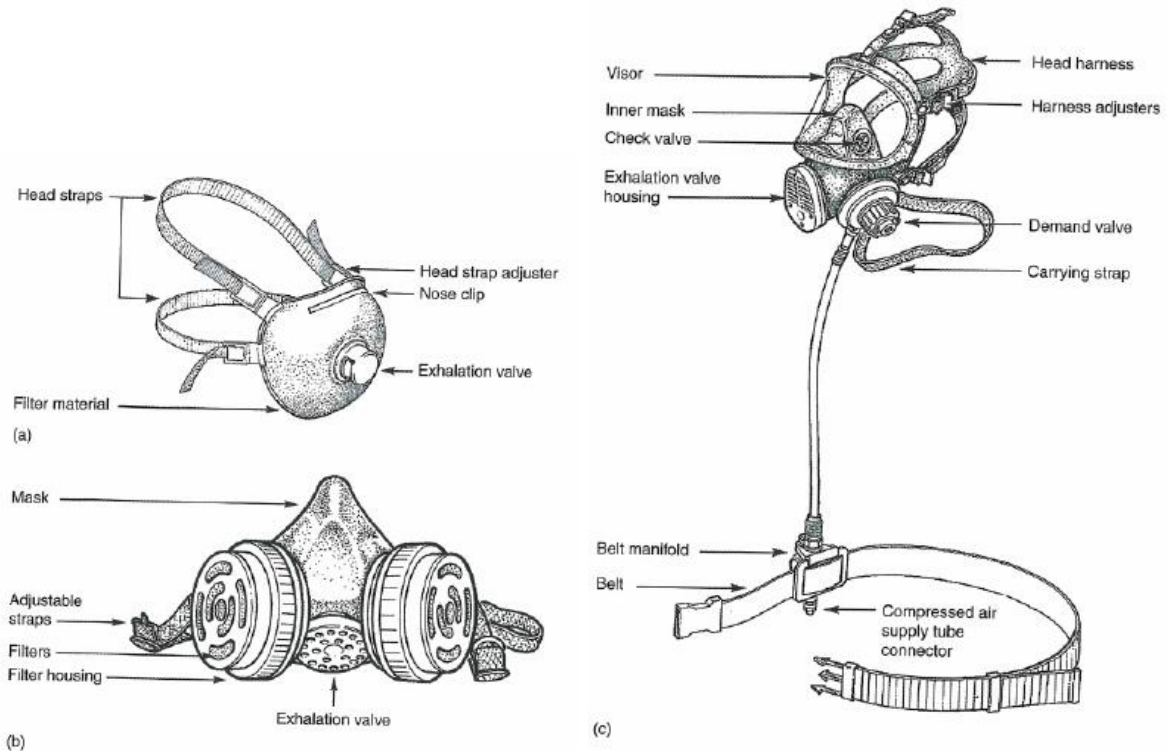


Figure - Types of respiratory protective equipment, (a) Filtering half mask, (b) half mask re-usable with filters, (c) compressed air line breathing apparatus with full-face mask fitted with demand valve.

Filters and masks should be replaced at the intervals recommended by the supplier or when taste or smell is detected by the wearer.

All RPE should be examined at least once a month except for disposable respirators. A record of the inspection should be kept for at least five years. There should be a routine cleaning system in place and proper storage arrangements.

Respiratory Protective Equipment - A Practical Guide for Users, H5G53, HSE Books, contains comprehensive advice and guidance on RPE selection, use, storage, maintenance and training, and should be consulted for more information.

Hand and skin protection

Hand and skin protection is mainly provided by gloves (arm shields are also available). A wide range of safety gloves is available for protection from chemicals, sharp objects, rough working and temperature extremes. Many health and safety catalogues give helpful guidance for the selection of gloves. For protection from chemicals, including paints and solvents, impervious gloves are recommended. These may be made of PVC, nitrile or neoprene. For sharp objects, such as trimming knives, a Kevlar-based glove is the most effective. Gloves should be regularly inspected for tears or holes since this will obviously allow skin contact to take place.

Another effective form of skin protection is the use of barrier creams and these come in two forms - pre-work and after-work. Pre-work creams are designed to provide a barrier between the hazardous substance and the skin. After-work creams are general purpose moisturisers which replace the natural skin oils removed either by solvents or by washing.

Eye protection

Eye protection comes in three forms - spectacles (safety glasses), goggles and face visors. Eyes may be damaged by chemical and solvent splashes or vapours, flying particles, molten metals or plastics, non-ionizing radiation (arc welding and lasers) and dust. Spectacles *are* suitable for low-risk hazards (low-speed particles such as machine swarf). Some protection against scratching of the lenses can be provided but this is the most common reason for replacement. Prescription lenses are also available for people who normally wear spectacles.

Protective clothing

Protective clothing includes aprons, boots and headgear (hard hats and bump caps). Aprons are normally made of PVC and protect against spillages but can become uncomfortable to wear in hot environments. Other lighter fabrics are available for use in these circumstances. Safety footwear protects against falling objects, collision with hard or sharp objects, hot or molten materials, slippery surfaces and chemical spills. It has metal toecaps and comes in the form of shoes, ankle boots or knee-length boots and is made of a variety of materials dependent on the particular hazard (e.g. thermally insulated against cold environments). It must be used with care near live, unpro-~~tected~~-against electricity. Specialist advice is needed for use with flammable liquids.

Appropriate selection of safety footwear involves the matching of the workplace hazards to the performance requirements of the footwear. The key issues are:

- the type of hazard (e.g. physical, chemical or thermal)
- the type of environment (e.g. indoors or out of doors)
- the ergonomics of the job (e.g. standing up, constant movement).

The footwear must have the correct grip for the environment, a hard wearing sole unit and, possibly, a good shock-absorbing capability.

It is important to note that appropriate personal protective equipment should be made available to work-related visitors and other members of the public visiting workplaces where hazardous substances are being used. It is also important to stress that managers and supervisors must lead by example, particularly if there is a legal requirement to wear particular personal protective equipment. Refusals by employees to wear mandatory personal protective equipment must lead to some form of disciplinary action.

Personal hygiene and protection regimes

Good standards of sanitation, hand cleansing, showers and clothing storage facilities are a prerequisite to personal hygiene. Welfare facilities should cater for the direct needs of workers and the elimination of the health hazards to which they may be exposed, e.g. the risk of dermatitis. Personal hygiene control measures include the following:

- Strict control over decontamination procedures, particularly before eating, drinking, smoking or leaving the premises at termination of work;
- A prohibition on eating, drinking and smoking wherever there may be a risk of hand-to-mouth contamination, e.g. Handling dangerous substances;
- Use of barrier creams and other forms of skin protection directly related to the risks;
- Procedures for sanitisation of eye, face and hearing protection, or the use of disposable forms of protection;
- Total prohibition of workers returning home whilst wearing contaminated protective clothing;
- Training at induction and on a regular basis in the principles of personal hygiene and its relationship to existing health risks;
- Linking personal hygiene requirements with current industrial relations policy;
- Formulation and formalisation of a company hygiene policy accompanied by strict enforcement.

Vaccination

If the risk assessment concludes there is a risk of exposure to biological agents for which effective vaccines are readily available, these should be offered. It is recommended that employers keep a vaccination record. The Regulation requires that the employer provides protective measures such as vaccination to workers free of charge.

Certain occupations, such as water treatment/sewage workers, medical profession, have a higher than average risk from some biological hazards. These Staff from these occupations may need to be immunised against common high risks, for example, hepatitis B. They should be consulted and informed that the Vaccination is intrusive. Moreover Employers need the permission of workers before adopting this method

Health/medical surveillance and biological monitoring

Health surveillance is about putting in place systematic, regular and appropriate procedures to detect early signs of work-related ill health among employees exposed to certain health risks; and acting on the results.

If a formal system of health surveillance is in place, then staff must be informed of the collective results of this surveillance, and the medical records resulting from it must be kept for a number of years from the date of the last entry, the UK for example the record retention period in such circumstances is 40 years.

Alternatively, the self-assessment examination can be replaced by the use of a suitable questionnaire. If substance-related problems are experienced, the employees affected should be removed from their work with the hazardous substance at an early stage.

Whether or not some form of health surveillance is part of company policy, a recommended activity is to have some form of pre-employment medical.

This could take the form of a formal medical, or the completion of a simple health questionnaire.

The rationale for this is twofold;

- Firstly to obtain some baseline health data, and
- Secondly to consider the rejection of new employees with a medical history of sensitisation (e.g. asthma) if known sensitisers are to be used.

Biological monitoring

This can be defined as a regular measuring activity where selected validated indicators of the uptake of toxic substances are determined in order to prevent health impairment.

Biological monitoring could well feature in the health or medical surveillance of persons exposed to hazardous substances under the COSHH Regulations. It is undertaken through the determination of the effects certain substances produce on biological samples of exposed individuals, and these determinations are used as biological indicators.

Biological monitoring may be useful in circumstances where:

- There is likely to be significant skin absorption and/or gastrointestinal tract uptake following ingestion
- Control of exposure depends on RPE

- There is a reasonably well-defined relationship between biological monitoring and effect
- It gives information on accumulated dose and target organ burden which is related to toxicity

Biological Monitoring Values (BMGVs)

Some substances for which suitable biological monitoring techniques are available are assigned biological monitoring guidance values (BMGV) in the UK HSE guidance note EH 40.

BMGV have been assigned to over nine substances such as butan-2-one and mercury.

Two types of BMGV are assigned,

- Health guidance values (HGV) and
- Benchmark guidance values (BGV).

Health guidance values are set at a value at which there is no indication from the scientific evidence that the substance being monitored is likely to be injurious to health.

It is assumed that occasionally slightly exceeding the relevant HGV is unlikely to cause either short- or long-term effects. However, regularly exceeding the HGV indicates that control measures may not be adequate.

Current work practices should therefore be assessed as to how they can be improved to reduce exposure. Benchmark guidance values are not health based and they are set at a level of 90% of biological monitoring results from a representative sample of workplaces which had adopted good hygiene practices.

If a result exceeds the BGV, adverse health effects may not occur. However, such a result indicates that control measures may not be adequate. Current work practices should therefore be assessed as to how they can be improved to reduce exposure.

Examples of Biological Monitoring Values (BMGVs)

Substance	Biological monitoring guidance value	Sampling time
Butan-2-one	70µmol butan-2-one/L in urine	Post shift
Carbon monoxide	30ppm carbon monoxide in end-tidal breath	Post shift
Lindane (Organo chlorine pesticide)	35nmol/L(10µg/L of Lindane in whole blood (equivalent to 70nmol/Lidane in plasma)	Random

Xylene, o-, m-, p- or mixed isomers	650 mmol methyl hippuric acid/mol creatinine in urine	Post shift
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Further control of substances that can cause cancer, asthma or genetic damage that can be passed from one generation to another

Keep carcinogenic or mutagenic substances to be used in the workplace to the minimum needed for the process and, where appropriate, store and transport them on site in closed containers, clearly labeled and with clearly visible warning and hazard signs.

Clearly label and securely store carcinogenic or mutagenic waste products until they are removed by a competent specialist contractor, or disposed of safely on site by incineration or in some other way that does not put employees at risk or contaminate the outside environment;

Clearly identify the areas in which exposure to carcinogens or mutagens may occur and take measures to prevent the spread of contamination within and beyond these areas.

Where there is a risk of an area being contaminated by a carcinogenic or mutagenic substance, employers should ensure that:

- Employees do not eat, drink, smoke or apply cosmetics in the areas concerned; appropriate warning signs are prominently displayed;
- Ensure where areas are set aside for employees and others to eat, drink and smoke, they should be without risk of being contaminated by a carcinogenic or mutagenic substance;
- Appropriate hygiene measures are in place, including cleaning procedures to remove any contamination from walls, doors, tools, equipment, clothing, PPE, other surfaces etc.;
- Adequate washing facilities are provided so that employees who are exposed to a carcinogen or mutagen can maintain a high standard of personal hygiene.

7.5 Specific agents

Asbestos is a term used for a number of naturally occurring minerals which have crystallised to form long thin fibres and fibre bundles. Asbestos fibres would not be visible to the naked eye.

The fibres have high tensile strength, and chemical, electrical and heat resistance, and were widely used for these properties; either raw (e.g. asbestos textiles and insulation pickings), or more often, combined with other materials (fireproofing, insulations, boards, asbestos cement sheets etc.).

The three main types of asbestos which have been commercially used are:

- Crocidolite (often referred to as 'blue asbestos')
- Amosite (often referred to as 'brown asbestos')
- Chrysotile (often referred to as 'white asbestos')

All are dangerous, but blue and brown asbestos are known to be more dangerous than white. The different types cannot usually be identified by their colour alone.

Where asbestos is affected by heat or chemicals, or combined with other substances, the colour and appearance can change. There is no simple test to identify the different types of asbestos. Laboratory analysis is required. They often occur as mixtures and unless employer are sure which type of asbestos fibres are present employer must treat the material as if it contains blue or brown.

7.5.1 Health risks and controls associated with asbestos

Diseases from asbestos exposure take a long time to develop. Most cases of lung cancer or asbestosis in asbestos workers occur 15 or more years after initial exposure to asbestos. Tobacco smokers who have been exposed to asbestos have a "far greater-than-additive" risk for lung cancer than do nonsmokers who have been exposed, meaning the risk is greater than the individual risks from asbestos and smoking added together. The time between diagnosis of mesothelioma and the time of initial occupational exposure to asbestos commonly has been 30 years or more. Cases of mesotheliomas have been reported after household exposure of family members of asbestos workers and in individuals without occupational exposure who live close to asbestos mines.

Asbestos Facts

- When asbestos fibers are inhaled, most fibers are expelled, but some can become lodged in the lungs and remain there throughout life. Fibers can accumulate and cause scarring and inflammation. Enough scarring and inflammation can affect breathing, leading to disease.
- The term “naturally occurring asbestos” refers to the mineral as a natural component of soils or rocks as opposed to asbestos in commercial products, mining or processing operations. Naturally occurring asbestos can be released from rocks or soils by routine human activities, such as construction, or natural weathering processes. If naturally occurring asbestos is not disturbed and fibers are not released into the air, then it is not a health risk.
- People are more likely to experience asbestos-related disorders when they are exposed to high concentrations of asbestos, are exposed for longer periods of time, and/or are exposed more often.
- Inhaling longer, more durable asbestos fibers (such as tremolite and other amphiboles) contributes to the severity of asbestos-related disorders.
- Exposure to asbestos can increase the likelihood of lung cancer, mesothelioma, and non-malignant lung conditions such as asbestosis (restricted use of the lungs due to retained asbestos fibers) and changes in the pleura (lining of the chest cavity, outside the lung).
- Changes in pleura such as thickening, plaques, calcification, and fluid around the lungs (pleural effusion) may be early signs of asbestos exposure. These changes can affect breathing more than previously thought. Pleural effusion can be an early warning sign for mesothelioma (cancer of the lining of the lungs).
- Most cases of asbestosis or lung cancer in workers occurred 15 years or more after the person was first exposed to asbestos.
- Most cases of mesothelioma are diagnosed 30 years or more after the first exposure to asbestos.
- Asbestos-related disease has been diagnosed in asbestos workers, family members, and residents who live close to asbestos mines or processing plants.
- Health effects from asbestos exposure may continue to progress even after exposure is stopped.
- Smoking or cigarette smoke, together with exposure to asbestos, greatly increases the likelihood of lung cancer. See Cigarette Smoking, Asbestos Exposure, and your Health.

Health Risks of Asbestos Exposure

Chronic exposure to asbestos may increase the risk of lung cancer, mesothelioma, and nonmalignant lung and pleural disorders. Evidence in humans comes from epidemiologic studies as well as numerous studies of workers exposed to asbestos in a variety of

occupational settings. Tremolite asbestos exposure has been associated with an increased incidence of disease in vermiculite miners and millers from Libby, Montana. This evidence is supported by reports of increased incidences of nonmalignant respiratory diseases, lung cancer, and mesothelioma in villages in various regions of the world that have traditionally used tremolite-asbestos whitewashes in homes or have high surface deposits of tremolite asbestos and by results from animal studies.

Risk Factors

Various factors determine how exposure to asbestos affects an individual:

- Exposure concentration - what was the concentration of asbestos fibers?
- Exposure duration - how long did the exposure time period last?
- Exposure frequency - how often during that time period was the person exposed?
- Size, shape and chemical makeup of asbestos fibers:

Long and thin fibers are expected to reach the lower airways and alveolar regions of the lung, to be retained in the lung longer, and to be more toxic than short and wide fibers or particles. Wide particles are expected to be deposited in the upper respiratory tract and not to reach the lung and pleura, the sites of asbestos-induced toxicity. Short, thin fibers, however, may also play a role in asbestos pathogenesis. Fibers of amphibole asbestos such as tremolite asbestos, actinolite asbestos, and crocidolite asbestos are retained longer in the lower respiratory tract than chrysotile fibers of similar dimension.

- Individual risk factors, such as a person's history of tobacco use (smoking) and other pre-existing lung disease, etc.

Note, cigarette smoke and asbestos together significantly increase your chances of getting lung cancer. Therefore, if you have been exposed to asbestos you should stop smoking. This may be the most important action that you can take to improve your health and decrease your risk of cancer.

7.5.2 Managing asbestos in buildings

This guidance is for, anyone who is responsible for maintenance and repairs in a building, which may contain asbestos. The 'duty to manage' asbestos is included in the Control of Asbestos Regulations 2012. You are a 'dutyholder' if:

- you own the building;
- you are responsible through a contract or tenancy agreement;
- you have control of the building but no formal contract or agreement; or

- in a multi-occupancy building, you are the owner and have taken responsibility for maintenance and repairs for the whole building.

What buildings are affected?

- All non-domestic buildings, whatever the type of business.
- The common areas of domestic buildings, eg halls, stairwells, lift shafts, roof spaces.
- All other domestic properties are not affected by the duty to manage
- If you are not the dutyholder but have information about the building, you must co-operate with the dutyholder, eg leaseholders must allow managing agents access for inspection.

Why manage asbestos?

Breathing in air containing asbestos fibres can lead to asbestos-related diseases, mainly cancers of the lungs and chest lining. Asbestos is only a risk to health if asbestos fibres are released into the air and breathed in. Past exposure to asbestos currently kills around 4500 people a year in Great Britain. Workers who carry out building maintenance and repair are particularly at risk.

There is usually a long delay between first exposure to asbestos and the onset of disease. This can vary from 15 to 60 years. Only by preventing or minimising these exposures now can asbestos-related disease eventually be reduced.

It is now illegal to use asbestos in the construction or refurbishment of any premises, but many thousands of tonnes of it were used in the past and much of it is still in place. There are three main types of asbestos that can still be found in premises, commonly called 'blue asbestos' (crocidolite), 'brown asbestos' (amosite) and 'white asbestos' (chrysotile). All of them are dangerous carcinogens, but blue and brown asbestos are more hazardous than white. Despite their names, you cannot identify them just by their colour.

Any buildings built or refurbished before the year 2000 may contain asbestos. As long as the asbestos-containing material (ACM) is in good condition, and is not being or going to be disturbed or damaged, there is negligible risk. But if it is disturbed or damaged, it can become a danger to health, because people may breathe in any asbestos fibres released into the air.

Who is at risk?

The more asbestos fibres breathed in, the greater the risk to health. Therefore, workers who may be exposed to asbestos when carrying out maintenance and repair jobs are at particular risk. Such workers include:

- construction and demolition contractors, roofers, electricians, painters and decorators, joiners, plumbers, gas fitters, plasterers, shop fitters, heating and ventilation engineers, and surveyors;
- anyone dealing with electronics, eg phone and IT engineers, and alarm installers;
- general maintenance engineers and others who work on the fabric of a building.

If asbestos is present and can be readily disturbed, is in poor condition and not managed properly, others who may be occupying the premises could be put at risk.

Where is asbestos found in buildings?

Asbestos was used in many parts of buildings, below is a sample of uses and locations where asbestos can be found:

Asbestos product	What it was used for
Sprayed asbestos (limpet)	Fire protection in ducts and to structural steel work, fire breaks in ceiling voids etc
Lagging	Thermal insulation of pipes and boilers
Asbestos insulating boards (AIB)	Fire protection, thermal insulation, wall partitions, ducts, soffits, ceiling and wall panels
Asbestos cement products, flat or corrugated sheets	Roofing and wall cladding, gutters, rainwater pipes, water tanks
Certain textured coatings	Decorative plasters, paints
Bitumen or vinyl materials	Roofing felt, floor and ceiling tiles

High risk materials



Asbestos pipe lagging



Asbestos insulating board (AIB)



Perforated AIB ceiling tiles



Door with AIB panel

What does the duty to manage asbestos involve?

The duty to manage asbestos is included in the Control of Asbestos Regulations 2012. The duty requires you to manage the risk from asbestos by:

- finding out if there is asbestos in the premises (or assessing if ACMs are liable to be present and making a presumption that materials contain asbestos, unless you have strong evidence that they do not), its location and what condition it is in;
- making and keeping an up-to-date record of the location and condition of the ACMs or presumed ACMs in your premises;
- assessing the risk from the material;
- preparing a plan that sets out in detail how you are going to manage the risk from this material;
- taking the steps needed to put your plan into action;
- reviewing and monitoring your plan and the arrangements made to put it in place; and
- setting up a system for providing information on the location and condition of the material to anyone who is liable to work on or disturb it.

Anyone who has information on the whereabouts of asbestos in your premises is required to make this available to you as the dutyholder, but you will need to assess its reliability.

Those who are not dutyholders, but control access to the premises, have to co-operate with you in managing the asbestos.

How can you comply with the duty?

This section tells you what you need to do to comply with the duty. There is a checklist setting out the whole process of managing the risk from asbestos further on in this leaflet. You can use this to check that you are taking the right steps. If you prefer, the HSE website hosts a web-based tool to take you through the steps (www.hse.gov.uk/asbestos/managing/index.htm).

Although you may appoint a competent person to carry out all or part of the work to meet the requirements of the duty, you will have to be involved in the final assessment of the

potential risk. In particular, you will know how the premises are used and what disturbance is likely to occur. The section 'Step 2 - Assess the condition of any ACMs' provides advice on doing this.

Remember, the responsibility for complying with the duty to manage the potential risk remains yours if you are responsible for maintaining relevant parts of a building.

► Step 1 Find out if asbestos is present

- Was the building built or refurbished before 2000?
 - If Yes, assume asbestos is present.
 - If No, asbestos is unlikely to be present – no action required.
- Do you already have information on asbestos in your building?
- Walk around your building to identify all ACMs or presumed ACMs, including areas not normally visited like roof voids, store rooms etc.

ACMs may be present if the building was constructed or refurbished before 2000. All asbestos use was prohibited by 1999. You need to do all that you reasonably can to find them by:

- looking at building plans and any other relevant information, such as builders' invoices, which may tell you if and where asbestos was used in the construction or refurbishment of the premises;
- carrying out a thorough inspection of the premises both inside and out to identify materials that are, or may be asbestos; and
- consulting others, such as the architects, employees or safety representatives, who may be able to provide you with more information and who have a duty of co-operation to make this available.

If the building's age or the information you obtain provide strong evidence that no ACMs are present, then you do not need to do anything other than to record why this evidence indicates there is no asbestos present.

You should always presume any material contains asbestos unless there is strong evidence to suggest it does not. Some material obviously does not contain asbestos such as glass, solid wooden doors, floorboards, bricks and stone.

► Step 2 Assess the condition of any ACMs

- Assess the amount and condition of any ACMs, or presumed ACMs in the building to tell you how likely they are to release asbestos fibres into the air.

The type of ACM, the amount of it and its condition will determine its potential to release asbestos fibres into the air, if disturbed. This will help you decide what you need to do next. The condition of ACMs can be considered by addressing a series of questions:

- Is the surface of the material damaged, frayed or scratched?
- Are the surface sealants peeling or breaking off?
- Is the material becoming detached from its base? (This is a particular problem with pipe and boiler lagging and sprayed coatings.)
- Are protective coverings, designed to protect the material, missing or damaged?
- Is there asbestos dust or debris from damage near the material?

If the ACMs in your premises are in poor condition, you will have to arrange repairs or have them sealed, enclosed or removed.

► Step 3 Survey and sample for asbestos

- Have a suitably trained person conduct a survey to identify ACMs.
- Have the materials analysed to prove if asbestos is present, and what type it is.

You may choose to employ a suitably trained person to do a survey of the premises to identify ACMs, particularly if you are planning maintenance or refurbishment of the premises or installing wiring or pipework/ducting. The survey should identify what types of ACMs are present, where they are and what condition they are in. You should ask the person or organisation:

- if they are accredited or certificated for asbestos survey work;
- for evidence of their training and experience in such work; and
- for evidence that they have suitable liability insurance.

HSE provides further information on asbestos surveys in its guidance document HSG264 *Asbestos: The survey guide*.

If you suspect materials contain asbestos, you may need to have samples analysed. Often, this is the only certain way of identifying if a material does contain asbestos. Samples should only be taken by suitably trained people.

Do not break or damage any material which may contain asbestos to try to identify it.

Organisations that sample and analyse asbestos need to be accredited by the United Kingdom Accreditation Service (UKAS). UKAS also run an accreditation scheme for organisations that do asbestos surveys. An accredited company is likely to employ suitably trained people for these types of work, but you should check what the firm is accredited for, as some will only be qualified to do surveys and take samples and others only to analyse samples (the UKAS website address is: www.ukas.com).

Surveys may also be undertaken by other competent surveyors who have the appropriate combination of qualifications and experience. Firms are generally listed in Yellow Pages and other business directories. Organisations that carry out asbestos analysis and identification are listed under 'laboratories' or 'asbestos analysts'. Alternatively, you can contact UKAS, see www.ukas.com/tools/contact-ukas.asp.

► Step 4 Keep a written record or register

- Write down the ACMs you have found, where they are and their condition.
- Record the roles and responsibilities for managing asbestos in your organisation.

You need to prepare a record that shows where the asbestos or presumed asbestos is, the type if known, its form, and what condition it is in. This record needs to be simple, clear and always available at the premises so that you, or any other person that needs to know where the ACMs are, can easily find them. It could be a plan or diagram, a written list or a computer-based record – storing it electronically can make it easier to update.

There may be some areas of the premises which you cannot look at, such as in roofs and heating ducts and behind wall partitions. You should note these on your drawing and presume ACMs may be present, unless you have strong evidence for thinking this is highly unlikely. If you have employed an external organisation to conduct a survey for you, they should provide you with a written record or with the information so you can create your own.

► Step 5 Act on your findings

- Your plan should include passing on your asbestos register to any worker/contractor carrying out maintenance work on your property.
- Assess the potential risk from the ACMs – how likely are they to be disturbed?
- Draw up a priority plan for action.

You must assess whether the ACMs are being, or are likely to be disturbed. Consider the following factors:

- the information gathered on the location, amount and condition of the ACM;
- if the ACM is in a position where it is likely to be disturbed;
- how much ACM is present;
- whether there is easy access to the ACM;
- whether people work near the ACM in a way that is liable to disturb it;
- if it is close to areas in which people normally work when it is disturbed;
- the numbers of people who use the area where the ACM is; and
- if maintenance work, refurbishment or other work on the premises is likely to be carried out where the ACM is.

You will need to prepare and implement a plan to manage these risks:

- Give high priority to damaged material and materials likely to be disturbed; these will need to be repaired, sealed, enclosed or removed using trained personnel – if unsure, seek specialist advice from an asbestos surveyor, a laboratory or a licensed contractor.
- If the material is in good condition and is unlikely to be worked on or disturbed, it is usually safer to leave it in place and manage it.

Repair and removal

Some damaged asbestos can be made safe by repairing it and either sealing or enclosing it to prevent further damage. If this can be done safely, mark the area after it has been repaired and make sure it is on your record of asbestos locations.

If asbestos is likely to be disturbed during routine maintenance work or daily use of the building, it will release fibres. If it cannot be easily repaired and protected, you should have it removed. This work must be carried out by someone trained and competent to carry out the task.

Remember, most work on asbestos insulation, asbestos insulating board and lagging, including sealing and removal, should normally be done by a contractor licensed by HSE.

Managing asbestos left in place

If you decide to leave in place ACMs or presumed ACMs that are in good condition, make sure it is on your record and keep this information up to date.

You must make sure that everyone who needs to know about the asbestos is told about its presence, eg maintenance workers, contractors. You can label ACMs clearly with the asbestos warning sign or use some other warning system (for example colour coding).

If you decide not to label the asbestos, you need to make sure that those who might work on the material know that it contains or may contain asbestos, before they start work, eg when you ask for a quote for a job. You can then agree the precautions necessary to prevent exposure.

It can save time and prevent confusion if you make a note of the location of non-asbestos material, which could be mistaken for asbestos.

Remember, anyone who may work on asbestos must be trained and use safe working methods. Most work with asbestos needs to be done by a licensed contractor.



Asbestos warning label

▶ **Step 6** Keep your records up to date

- Regularly reinspect any ACMs in your premises and update your records;
- Monitor and review the effectiveness of your action plan.

Even after your action plan is completed, you need to continue to manage the risks from asbestos left in place in your building. Walk around your building to review your record and update it as necessary. Look at the ACMs left in place, including those you have sealed or enclosed, to see if they have deteriorated or been damaged or disturbed in any way. The time between inspections will depend on the type of material, where it is and its condition, but it should be at least every six to 12 months.

You will need to check that the arrangements to control the risk set out in your plan, have been put in place and are working effectively. You must also review the plan if there are significant changes that will affect these arrangements, for example if you do different sorts of work on the premises, or if any of the ACMs are removed.

Checklist

- **Find** You must check if materials containing asbestos are present or are liable to be present
- **Condition** You must check what condition the material is in
- **Presume** You must assume the material contains asbestos unless you have strong evidence that it does not
- **Identify** If you are planning to have maintenance or refurbishment of the building carried out or the material is in poor condition, you may wish to arrange for the material to be sampled and identified by a specialist

- **Record** Record the location and condition of the material on a plan or drawing
- **Assess** You must decide if the condition or the location means the material is likely to be disturbed
- **Plan** Prepare and implement a plan to manage these risks

7.5.3 Health risks and controls associated with other specific agents: blood borne viruses, carbon monoxide, cement, legionella, leptospira, silica, wood dust; workplace circumstances in which they might be present.

Blood borne viruses

Blood-borne viruses (BBVs) are viruses that some people carry in their blood and can be spread from one person to another. Those infected with a BBV may show little or no symptoms of serious disease, but other infected people may be severely ill. You can become infected with a virus whether the person who infects you appears to be ill or not – indeed, they may be unaware they are ill as some persistent viral infections do not cause symptoms. An infected person can transmit (spread) blood-borne viruses from one person to another by various routes and over a prolonged time period.

The most prevalent BBVs are:

- human immunodeficiency virus (HIV)- a virus which causes acquired immunodeficiency virus (AIDS), a disease affecting the body's immune system;
- hepatitis B (HBV) and hepatitis C; BBVs causing hepatitis, a disease affecting the liver.

As well as through blood, these viruses can also be found and transmitted through other body fluids, for example:

- vaginal secretions;
- semen; and
- breast milk.

Unless contaminated with blood, minimal risk of BBV infection is carried by:

- urine;
- saliva;

- sweat;
- tears;
- sputum;
- vomit; and
- faeces.

The presence of blood in these bodily fluids and materials isn't always obvious, so care should still always be taken to avoid infection.

Carbon monoxide

Carbon monoxide (CO) is a colourless, odourless, tasteless, poisonous gas produced by incomplete burning of carbon-based fuels, including gas, oil, wood and coal. Carbon-based fuels are safe to use. It is only when the fuel does not burn properly that excess CO is produced, which is poisonous. When CO enters the body, it prevents the blood from bringing oxygen to cells, tissues, and organs.

You can't see it, taste it or smell it but CO can kill quickly without warning. According to the HSE statistics every year around 11 people die from CO poisoning caused by gas appliances and flues that have not been properly installed, maintained or that are poorly ventilated. Levels that do not kill can cause serious harm to health if breathed in over a long period. In extreme cases paralysis and brain damage can be caused as a result of prolonged exposure to CO. Increasing public understanding of the risks of CO poisoning and taking sensible precautions could dramatically reduce this risk.

There are signs that you can look out for which indicate incomplete combustion is occurring and may result in the production of CO;

- Yellow or orange rather than blue flames (except fuel effect fires or flueless appliances which display this colour flame)
- Soot or yellow/brown staining around or on appliances
- Pilot lights that frequently blow out
- Increased condensation inside windows

There are a number of simple steps that gas consumers can take to keep themselves safe.

Carbon Monoxide can be produced by any combustion appliance, including those that burn fossil fuels e.g. oil, wood and coal. If you have one of these appliances you should make sure that it is serviced and maintained by a competent person and the chimney is regularly swept.

Cement

The main causes of injury are:

- Injured while handling, lifting or carrying
- Slipping, tripping or falling on the same level
- Hit by moving, flying or falling object
- Fall from a height

The main causes of occupational ill health are:

- Musculoskeletal disorders (MSDs)
- Skin disease, e.g. Dermatitis
- Respiratory disease, e.g. Occupational Asthma

Industry specific guidance

Wet cement

Contact with wet cement can cause both dermatitis and burns.

For further information about this and the measures to take to reduce the risks

Carbon dioxide is a colourless and odourless gas which is heavier than air. It represses the respiratory system, eventually causing death by asphyxiation. At low concentrations it will cause headaches and sweating followed by a loss of consciousness. The greatest hazard occurs in confined spaces, particularly where the gas is produced as a by-product.

Isocyanates are volatile organic compounds widely used in industry for products such as printing inks, adhesives, and two-pack paints (particularly in vehicle body shops) and in the manufacture of plastics (polyurethane products). They are irritants and sensitizers. Inflammation of the nasal passages, the throat and bronchitis are typical reactions to many isocyanates. When a person becomes sensitized to an isocyanate, very small amounts of the substance often provoke a serious reaction similar to an extreme asthma attack. Isocyanates also present a health hazard to fire fighters. They are subject to a Workplace Exposure Limit (WEL) and Respiratory Protective Equipment (RP(E)) should be worn.

Asbestos appears in three main forms: crocidolite (blue), amosite (brown) and chrysotile (white). The blue and brown asbestos are considered to be the most dangerous and may be found in older buildings where they were used as heat insulators around boilers and hot water pipes and as fire protection of structure. White asbestos has been used in asbestos cement products and brake linings. It is difficult to identify an asbestos product by its colour alone - laboratory identification is usually required. Many asbestos-containing materials (ACMs) are difficult to distinguish from other materials. It is easy to drill or cut ACMs

unwittingly and release large quantities of airborne fibres that could cause long-term health problems to the operator. Asbestos produces a fine fibrous dust of respirable dust size which can become lodged in the lungs. The fibres can be very sharp and hard, causing damage to the lining of the lungs over a period of many years. This can lead to one of the following diseases:

- asbestosis or fibrosis (scarring) of the lungs;
- lung cancer;
- mesothelioma
- cancer of the lining of the lung or,
- in rarer cases, the abdominal cavity.

If asbestos is discovered during the performance of a contract, work should cease immediately and the employer informed. Typical sites of asbestos include ceiling tiles, asbestos cement roof and wall sheets, sprayed asbestos coatings on structural members, loft insulation and asbestos gaskets. In most countries, asbestos has its own legislation. These cover the need for a risk assessment, a method statement covering removal and disposal, air-monitoring procedures and the control measures (including personal protective equipment and training) to be used.

Lead is a heavy, soft and easily worked metal. It is used in many industries but is most commonly associated with plumbing and roofing work. Lead enters the body normally by inhalation but can also enter by ingestion and skin contact. It is a cumulative poison that is stored in, and then released from the bones. Excretion is via the faeces and urine. The main targets for lead are the spinal cord and the brain, the blood and blood production. The effects are normally chronic and develop as the quantity of lead builds up. Headaches and nausea are the early symptoms followed by anaemia, muscle weakening and (eventually) coma. Regular blood tests are a legal and sensible requirement as are good ventilation and the use of appropriate personal protective equipment. High personal hygiene standards and adequate welfare (washing) facilities are essential and must be used before smoking or food is consumed. The reduction in the use of leaded petrol was an acknowledgement of the health hazard represented by lead in the air. If lead is to be used in the workplace, risk assessments should be undertaken and engineering controls put in place. Lead can be transferred to an unborn child through the placenta and, therefore, offer additional protection to women of reproductive capacity. Medical surveillance in the form of a blood test of all employees who come into contact with lead operations, is recommended and such tests should take place at least once a year.

Silica is the main component of most rocks and is a crystalline substance made of silicon and oxygen. It occurs in quartz (found in granite), sand and flint. Harm is caused by the inhalation of silica dust, which can lead to silicosis (acute and chronic), fibrosis and

pneumoconiosis. The dust which causes the most harm is respirable dust which becomes trapped in the alveoli. This type of dust is sharp and very hard and, probably, causes wounding and scarring of lung tissue. As silicosis develops, breathing becomes more and more difficult and eventually as it reaches its advanced stage, lung and heart failure occur. It has also been noted that silicosis can result in the development of tuberculosis as a further complication. Hard rock miners, quarrymen, stone and pottery workers are most at risk. Health surveillance is recommended for workers in these occupations at initial employment and at subsequent regular intervals. Prevention is best achieved by the use of good dust extraction systems and respiratory protective equipment.

Leptospirosis (*Weil's disease*) is caused by contact with *Leptospira* bacteria found in the urine of rats. Weil's disease starts with flu-like symptoms, severe headache and vomiting and muscle pains followed by jaundice, liver and kidney failure and, in up to 20% of cases, it can be fatal. It enters the body either through the skin or by ingestion. The most common source is contaminated water in a river, sewer or ditch and workers, such as canal or sewer workers, are most at risk. Leptospirosis is always a risk where rats are present, particularly if the associated environment is damp. Good, impervious protective clothing, particularly Wellington boots, is essential in these situations and the covering of any skin wounds. For workers who are frequently in high-risk environments (sewer workers), immunization with a vaccine may be the best protection. Weil's disease is, strictly, a severe form of leptospirosis. The symptoms of leptospirosis are similar to influenza but those for Weil's disease are anaemia, nose bleeds and jaundice. While the most common source of infection is from the urine of rats, Leptospirosis (Hardjo) has been found in other animals, such as cattle; therefore, farm and veterinary workers may also be at risk.

Legionella is an airborne bacterium and is found in a variety of water sources. It produces a form of pneumonia caused by the bacteria penetrating to the alveoli in the lungs. This disease is known as Legionnaires' disease, named after the first documented outbreak at a State Convention of the American Legion held at Pennsylvania in 1976. During this outbreak, 200 men were affected, of whom 29 died. That outbreak and many subsequent ones were attributed to air-conditioning systems. The legionella bacterium cannot survive at temperatures above 60°C but grows between 20°C and 45°C, being most virulent at 37°C. It also requires food in the form of algae and other bacteria. Control of the bacteria involves the avoidance of water temperatures between 20°C and 45°C, avoidance of water stagnation and the build-up of algae, sludge, sediments and organic materials and the use of suitable water-treatment chemicals. This work is often done by a specialist contractor.

The most common systems at risk from the bacterium are:

- water systems incorporating a cooling tower;
- water systems incorporating an evaporative condenser;
- hot and cold water systems and other plant where the water temperature may exceed 20°C.

Where plant at risk of the development of legionella exists, the following is recommended:

- a written 'suitable and sufficient' risk assessment;
- the preparation and implementation of a written control scheme involving the treatment, cleaning and maintenance of the system;

- temperature control between 20 and 60°C;
- appointment of a named person with responsibility for the management of the control scheme;
- the monitoring of the system by a competent person;
- record keeping and the review of procedures developed within the control scheme.

The Code of Practice also covers the design and construction of hot and cold water systems and cleaning and disinfection guidance. There have been several cases of members of the public becoming infected from a contaminated cooling tower situated on the roof of a building. It is required that all cooling towers are registered with the local authority. People are more susceptible to the disease if they are older or weakened by some other illness. It is, therefore, important that residential and nursing homes and hospitals are particularly vigilant.

Hepatitis is a disease of the liver and can cause high temperatures, nausea and jaundice. It can be caused by hazardous substances (some organic solvents) or by a virus. The virus can be transmitted from infected faeces (hepatitis A) or by infected blood (hepatitis B and C). The normal precautions include good personal hygiene, particularly when handling food and in the use of blood products. Hospital workers who come into contact with blood products are at risk of hepatitis as are drug addicts who share needles. It is also important that workers at risk regularly wash their hands and wear protective disposable gloves.

7.6 Safe handling and storage of waste

7.6.1 Basic environmental issues relating to safe handling and storage of waste

Organizations must also be concerned with aspects of the environment. There will be an interaction between the health and safety policy and the environmental policy which many organizations are now developing. Many of these interactions will be concerned with good practice, the reputation of the organization within the wider community and the establishment of a good health and safety culture. The health and safety data sheet, used for a hazardous substance assessment, also contains information of an environmental nature covering ecological information and disposal considerations.

There are three environmental issues which are directly related to the health and safety function. These are:

- air pollution;
- water pollution;
- waste disposal.

Pollution is a term that covers more than the effect on the environment of atmospheric emissions, effluent discharges and solid waste disposal from industrial processes. It also includes the effect of noise, vibration, heat and light on the environment. The EU Solvents Emissions Directive (SED) has produced some tougher rules on the use of solvents in industry to protect the environment. The control of pesticides is an important function of regulatory authorities throughout the world.

Air pollution

The most common airborne pollutants are carbon monoxide, benzene, 1,3-butadiene, sulphur dioxide, nitrogen dioxide and lead. Air pollution is monitored by Environmental Agencies throughout the world. Many of these agencies use the following three basic principles that are used to prevent and control pollution:

- The 'Best Practicable Environmental Option (BPEO)' **which** considers both the environmental and economic costs and benefits of the possible options available to deal with the pollution problem and normally requires a technical solution.
- The 'Best Available Techniques' to minimize the overall environmental impact of a process. These are normally used for less polluting industries and the requirements

are not restricted to pollution control technology but can include employee training and competence and building design and maintenance.

- 'As low as reasonably practicable' applies the same test to an environmental problem as is applied to a health and safety problem. Any high or unacceptable environmental risk should be reduced to as low as is reasonably practicable.



Figure – Air pollution

Water pollution

An ILO report states that 'Water is an integral part of most development activities, from health and sanitation, to the location of human settlements, agricultural production, nutrition, and the maintenance of ecological balance. It may be difficult to accept the idea in many countries where water has been considered as a "free commodity" for generations that it can be an economic good with distribution costs that have to be paid if the service is to remain sustainable'. While the global demand for water has doubled, the amount of usable water available has reduced by 40%.

The problem is particularly serious in many developing economies and it has been predicted that by 2025, approximately two thirds of the world's population might live in countries with moderate to severe water shortages.

The pollution of rivers and other water courses can produce very serious effects on the health of plants and animals which rely on that water supply. National governments throughout the world are responsible for coastal waters, inland fresh water and ground waters. The European Union Groundwater Directive seeks to protect ground water from pollution since this is a source of drinking water. Such sources can become polluted by

leakage from industrial soakaways. Discharges to a sewer are also controlled Environmental Agencies and these agencies define those substances which are prohibited from discharge (e.g. petroleum spirit). If hazardous substances are being used by the organization, safety data sheets give advice on the safe disposal of any residues that remain after the particular process has been completed.

In some countries, the local Water Companies and Environmental Agencies has a legal right to sample discharges into its sewers because it is required to keep a public trade effluent register. These organizations often publish lists of proscribed substances which can only be discharged into a public sewer with the permission from the agencies.

Finally, if oil is stored on the premises, a retaining bund wall should surround the oil store. This will not only ensure that any oil leakage is contained but will also stop the contamination of ground water by fire-fighting foam in the event of a fire.



(a)



(b)

Figure - 17 (a) Water pollution from an oil spillage (b) Water pollution from plastic and other solid waste.

Waste disposal

The principal requirements for safe waste disposal are as follows:

- to handle waste so as to prevent any unauthorized escape into the environment;
- to pass waste only to an officially authorized person;
- to ensure that a written description accompanies all waste. Producers of waste should complete a document that gives full details of the type and quantity of waste for collection and disposal. Copies of the note should be kept for at least two years;

There are several different categories of waste. The important ones are as follows:

- Controlled waste comprises household, clinical, industrial or commercial waste. Controlled waste should only be removed by those holding a Government licence so that the waste is not disposed in a manner likely to cause environmental pollution or harm to human health.
- Hazardous waste which can only be disposed of using special arrangements. These are sometimes substances which are life threatening (toxic, corrosive or carcinogenic) or highly flammable. Clinical waste falls within this category. A consignment note system should accompany this waste at all the stages to its final destination. Before hazardous waste is removed from the originating premises, a contract should be in place with a licensed carrier and it should be stored securely prior to collection to ensure that the environment is protected.

Hazardous waste also covers computer monitors, fluorescent tubes, end-of-life vehicles and television sets. It is important to ensure that hazardous waste is safely managed and its movement is documented. The following points also are important for construction sites:

- Sites that produce more than 200 kg of hazardous waste each year for removal, treatment or disposal may need to register with a Government Agency.
- Different types of hazardous waste must not be mixed.
- Producers must maintain registers of their hazardous wastes.

Some form of training may be required to ensure that employees segregate hazardous and non-hazardous wastes on site and fully understand the risks and necessary safety precautions which must be taken. Personal protective equipment, including overalls, gloves and eye protection, must be provided and used. The storage site should be protected against trespassers, fire and adverse weather conditions. If flammable or combustible wastes are being stored, adequate fire protection systems must be in place. There may also be manual handling issues to be considered. Finally, in the case of liquid wastes, any drains must be protected and bunds used to restrict spreading of the substance as a result of spills.

A hierarchy for the management of waste streams has been recommended by the UK Environment Agency. **Prevention** - by changing the process so that the waste is not produced (e.g. substitution of a particular material).

1. **Reduction** - by improving the efficiency of the process (e.g. better machine maintenance).
2. **Reuse** - by recycling the waste back into the process (e.g. using reground waste plastic products as a feed for new products).
3. **Recovery** - by releasing energy through the combustion, recycling or composting of waste (e.g. the incineration of combustible waste to heat a building).
4. **Responsible disposal** - by disposal in accordance with regulatory requirements.

Element 8 - Physical and psychological health hazards and risk control

Learning outcomes

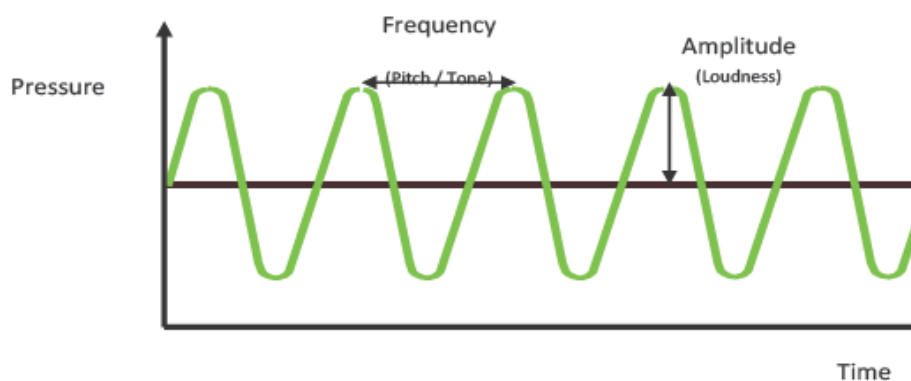
- ✚ Outline the health effects associated with exposure to noise and appropriate control measures
- ✚ Outline the health effects associated with exposure to vibration and appropriate control measures
- ✚ Outline the health effects associated with ionising and non-ionising radiation and appropriate control measures
- ✚ Outline the meaning, causes and effects of work related stress and appropriate control measures.

8.1 Noise

Sound is a physical sensation. Noise can be defined as unwanted sound, or sound that is especially disturbing (Collins, 1993). Noise is a form of energy in the form of a wave, caused by pressure variations, i.e. oscillations (compressions and rarefactions), which can travel in almost any medium, e.g. air, water, metal or wood. Invariably these pressure variations are produced by a vibrating source, which may be solid (e.g. loudspeaker) or result from turbulence in the air, e.g. from exhaust emissions.

At moderate levels noise is harmless, but if it is too loud it can cause permanent damage to hearing. Damaging noise levels are not always uncomfortable people even pay to be subjected to them in nightclubs etc.!

Noise Terminology
Figure : Sound Waves



8.1.1 The physical and psychological effects on hearing of exposure to noise

Hearing Damage

Exposure to high levels of noise on a daily basis can cause:

Acute	Chronic
Stress, raised heart rate Irritability, loss of sleep	
Interference with communication	
Temporary threshold shift	Noise induced hearing loss (permanent threshold shift)
Temporary tinnitus	Permanent tinnitus
Blast deafness	Presbycusis

Table : Acute and Chronic Effects of High Noise Levels

Acute Effects

Stress

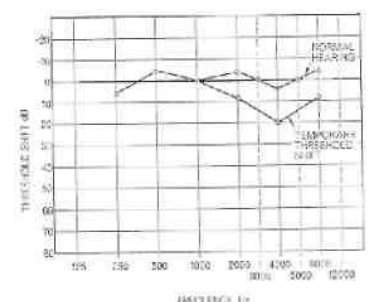
Very high levels of noise have been found to cause muscular tension, tightening of blood vessels, raised heart rate and effects on the digestive system. This is an involuntary reaction and causes stress. Irritability, loss of sleep and stress symptoms may result from even low levels of noise in some circumstances.

Interference with Communication

Inability to hear instructions or warning signals and the misunderstanding of verbal communication can all have serious consequences.

Temporary Threshold Shift (TTS)

The human ear hears noise from 0 decibels, the threshold of hearing. When the ear is exposed to high levels of noise the threshold may



temporarily shift by up to 20 decibels. The ears recover gradually, taking perhaps two days to recover completely.

Temporary Tinnitus

Tinnitus is ringing, buzzing, whining or similar noise in the ears caused by overstimulation of the hair cells (cilia).

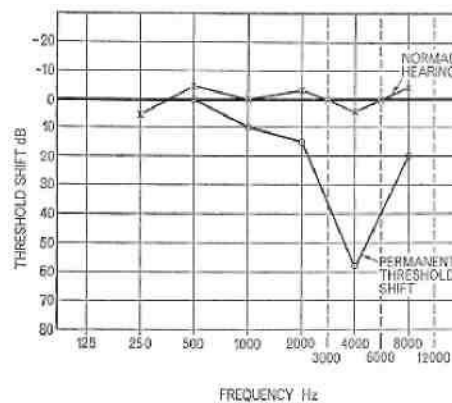
Blast Deafness

Impairment of transmission through the outer and middle ear is often caused by non work-related medical problems such as mumps and other infections. Very high noise levels and blasts can also cause damage. Noise is perceived as painful at 120 dB. Blast deafness is instant permanent hearing loss due to extreme noise levels above 140 dB.

Chronic Effects

Noise Induced Hearing Loss (NIHL)

Noise induced hearing loss (permanent threshold shift) is normally caused by prolonged exposure to high noise levels causing damage to the cilia (hair cells) of the cochlea in the inner ear. This leads to permanent threshold shift at certain frequencies, which worsens with continued exposure. The cells damaged first are those at 4000 Hz, which is the frequency of speech.



Permanent Tinnitus

The causes and symptoms of permanent tinnitus are the same as temporary tinnitus. However, permanent tinnitus causes ongoing distress through sleep deprivation and continued noise.

Presbycusis

Presbycusis is age-related deafness causing a loss of hearing function across all frequencies.

8.1.2 The meaning of terms commonly used in the measurement of sound

Sound Pressure

Pure noise energy is a unit of pressure measured in Pascals (Pa). Atmospheric pressure has a typical value of 100,000 Pa, whereas typical sound pressures detectable by humans are a small fraction of a Pascal (as low as 0.00002Pa at some frequencies).

Frequency

Frequency (perceived by the listener as pitch or tone) is measured in cycles per second (Hz). The human hearing mechanism has a finite range of perception of pitch and varies from 20 Hz to 20,000 Hz or 20 kHz, but is most sensitive at around 4,000 Hz, the frequency of human speech.

Intensity (Loudness)

The amount of pressure changes in the noise determines its amplitude and intensity (perceived by listeners as loudness). When measuring sound therefore we are not so much interested in the actual magnitude of the pressure, we are interested in the magnitude of the variations in pressure. We therefore use a ratio based on the lowest detectable pressure change or the **threshold of hearing**.

Decibel

Noise level is measured in decibels (dB).

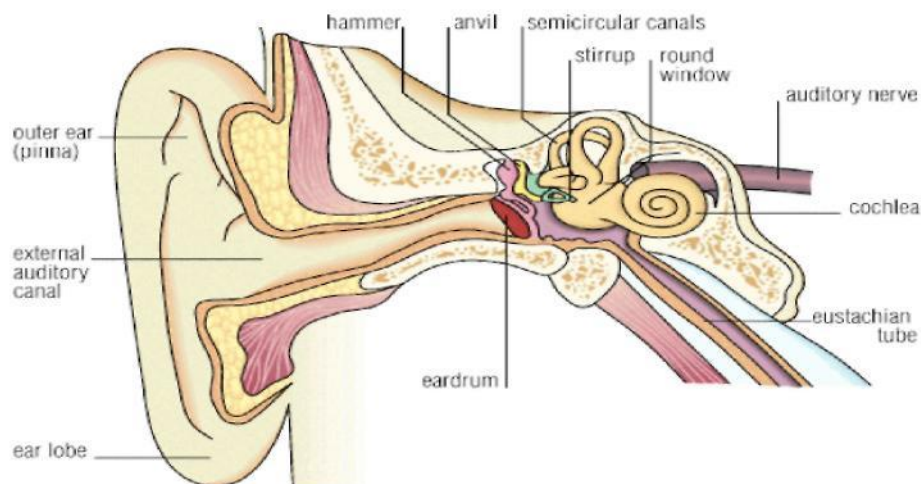
The intensity of sound is a measure of its strength and is measured in watts/m². The loudest sound that can be tolerated (the threshold of pain) is 100,000,000,000,000 times more intense than the quietest (the threshold of hearing). These numbers are too large to be easily used so a logarithmic scale (dB) is used, which is not linear (evenly distributed). Every 1 Bel (i.e. 10 dB) increase means that the sound is 10 times more intense. Unfortunately it typically only seems about twice as loud to most people. Consequently doubling the intensity of noise increases its level by 3 dB.

'A' Weighting Filter

The hearing mechanism is most sensitive and most easily damaged at 4,000Hz, therefore, when measuring noise we need to modify the noise meter (sound level meter - SLM) so that it responds in a similar way to the human ear, i.e. is more sensitive at 4,000 Hz.

The device used in the SLM is an electronic 'filter' known as the 'A' weighting filter, which mimics the sensitivity of human hearing across the frequency range (20 Hz to 20 kHz). The resulting unit of measurement is expressed as dB(A).

The human ear



Sound enters the human ear via the auditory canal and resonates (vibrates) on the eardrum. The vibrations move three small bones: the hammer, anvil and stirrup (malleus, incus and stapes), which cause fluid in the cochlea to move tiny cilia (haircells). As the cilia move they send electrical signals to the brain, which are interpreted as sound.

8.1.3 The need for assessment of exposure

Daily Personal Exposure (LEPD) and Weekly Personal exposure (LEPW)

Exposure to high noise levels can cause incurable hearing damage. The important factors are: the intensity, given in decibel units as dB(A) the frequency and how long people are exposed to the noise, daily.

With the exception of certain peak limits that cause instant damage, e.g. gunshot or cartridge tools, it is the total dose of noise that is of concern. In most work situations the

noise levels will fluctuate considerably throughout the day. The total dose is determined by averaging the level of noise over an 8 hour period for daily exposure and 40 hours for weekly exposure, to give a single level for that period of time, known as the LEPd and the LEPw.

Noise levels **equivalent** to 85 dB(A) for 8 hours:

- 88 decibels for 4 hrs (e.g. heavy traffic)
- 91 decibels for 2 hrs (e.g. circular saw)
- 94 decibels for 1 hr (e.g. an air compressor)
- 97 decibels for 30 min (metal grinder) and
- 100 decibels for 2 minutes (e.g. chain saw).

Exposure Limit and Action Values

The aim is to prevent damage to hearing. At **all levels** employers have a duty to reduce noise so far as is reasonably practicable.

In the UK **The Control of Noise at Work Regulations 2005** specifies lower and upper exposure action values:

Lower Exposure Action Value 80 dB(A) Peak Sound Pressure 135 dB

At these levels the employers should provide information, instruction and training on:

- the nature of risks from exposure to noise
- the organisational and technical measures taken to reduce noise levels
- the exposure limit values and upper and lower exposure action values
- the findings of the risk assessment, including any
- measurements taken, with an explanation
- personal hearing
- why and how to detect and report signs of hearing damage
- the entitlement to health surveillance and
- safe working practices to minimise exposure to noise.

Upper Exposure Action value 85 dB(A)

Peak Sound Pressure 137 dB

At these levels the employers should:

- so far as is reasonably practicable, reduce exposure other than providing hearing protection, e.g. engineering control

Exposure Limit Value 87 dB(A)

Peak sound Pressure 140 dB(A)

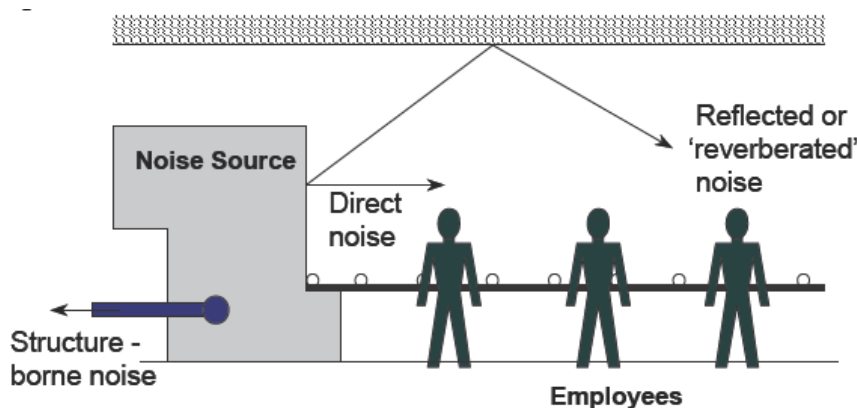
At this level instant hearing damage is likely. The employer should reduce the level and identify why the level was reached and ensure it is not reached again.

8.1.4 Basic Noise Control Measures

Like other forms of pollution, noise can be controlled by attention to the following factors:

- **The Source:** elimination or reduction at source
- **The Path:** providing barriers to the transmission of noise through air or through structures and
- **The Person:**
 - distance - locating the noise source at a distance from people
 - time - limiting the duration of exposure to noise
 - provision of information and training and
 - provision of PPE (personal hearing protection).

Figure: Noise Source, Path and Persons

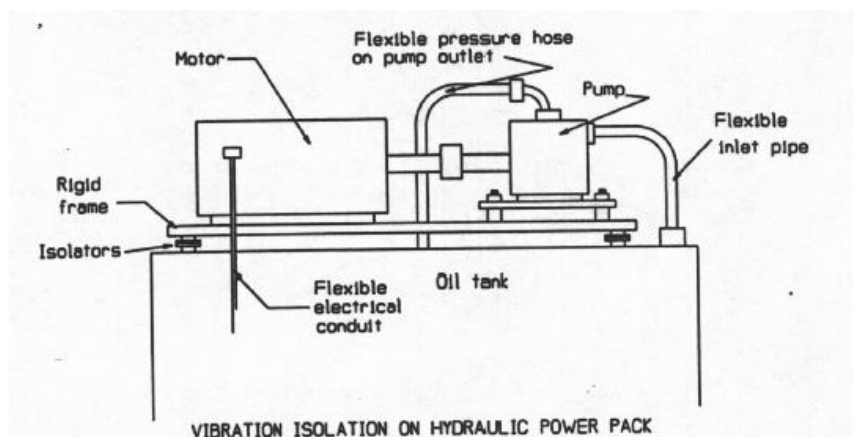


The Source

Design: changing the total or partial design of the whole or a component of the machine, e.g. nylon gears instead of metal.

Damping: adding material to reduce vibration (e.g. heavy metal based paints used on machinery housings or general ventilation systems).

Figure: Vibration Isolation on a Hydraulic Power Pack



Isolate: prevent noise from being transmitted through the structure of the building (floor and walls) by isolating the machinery from the floor, e.g. mounting power presses on anti-vibration feet. This is particularly important where the noise is in the low frequency ranges, which are most easily transmitted through structures, e.g. power presses.

The Path

Screens and barriers: placing an obstacle between the noise source, (a machine), and the employees. They may be ineffective at low noise frequencies. They also only reduce direct noise and will not stop reflective noise. **Enclosure:** placing a sound-proof cover over the noise source, e.g. a compressor housing on a machine.

Absorption: sound in the workroom can be absorbed by means of acoustic absorbent panels on

walls or suspended from the ceiling. In large workrooms, particularly where many noise sources are present, much of the noise will be reflected from the walls and ceiling. Absorbing this energy can significantly reduce the levels of noise to which people are exposed, e.g. ceiling panels in swimming pools, or the cab of a lorry.

Silencers: attachments fitted to the inlet or exhaust (or both) of a moving air or gas stream emitted from the machine. The increased volume of the silencer decreases the speed of the air flow at the exhaust.

Where possible the noise source should be eliminated, e.g. by changing the working method from riveting to bolting a structure by the purchase of quieter equipment, etc., however, where safe place strategies are not possible, safe person strategies should be used:

Distance: positioning the worker away from the noise source will decrease the noise dose received, since the noise level reduces over distance.

Time exposed: halving the time exposed will reduce the noise levels by 3 dB.

Training and information: about the hazard and precautions including:

- the likely noise exposure and the risk to hearing the noise creates
- where and how to obtain hearing protection
- how to report defects in ear protectors and noise control equipment and
- what the employee should do to minimise the risk, such as the proper way to use hearing protection and other noise control equipment, how to look after them.

Ear Protection

PPE is the last choice. In practice ear defenders reduce noise exposure less than is often claimed

because they:

- are not worn correctly, e.g. muffs worn over hair, jewellery or glasses
- are not fitted correctly, e.g. ear plugs not correctly inserted
- are not properly maintained
- are uncomfortable or inconvenient to wear
- need constant management commitment to ensure its use and
- may introduce secondary risks (failure to hear alarms, instructions, vehicles).

Figure 13: Use of Hearing Protection



Where there is no practicable alternative, PPE must be:

- **properly selected** - technically suitable, comfortable, compatible with other PPE such as hard hats, spectacles, etc.
- **properly maintained** - kept in clean and efficient order and
- **properly used** - training and instruction and supervision will be necessary.

To work, hearing protectors need to be worn all the time that people are in the noisy places. If they are left off, even for short periods, even the best protectors cannot greatly reduce noise exposure.

Types of Ear Protectors

Two main types of ear protectors are available:

Ear defenders (muffs) consist of cups filled with sound absorbent material tightly fitting over the ears and held in place by a headband. Ear defenders are generally the most effective because, when fitted correctly, they do not cause irritation and not only reduce noise levels but allow you to hear verbal messages and machine warning signals. However, they are often not compatible with other forms of PPE, e.g. hard hats, safety glasses or visors, they are uncomfortable to wear, and they need a high degree of maintenance in order to achieve adequate protection. They also require adequate clean storage.

Ear plugs are made from glass down, foam or rubber, are fitted into the ear canal and can be disposable or reusable.

Ear plugs are easy to use and cheap. However, it is more difficult to obtain a correct fit unless plugs are individually made or selected. They must be fitted correctly to be effective. Hygiene is important. When fitted with dirty fingers they can introduce infection or cause dermatitis, e.g. when oil is introduced. It is also more difficult to monitor compliance than with ear defenders.



Attenuation

The reduction that ear defenders provide is known as the attenuation. It is a measure of the reduction of both the frequency and intensity. The manufacturers of hearing protection will provide this information and this can be used by a competent person to assess the suitability or otherwise of hearing protection. When 2 types of hearing protection are used the overall protection is not a product of the two levels of attenuation. The maximum protection will only be increased by 6dB.

Noise Measurement

The purpose of noise measurement is to identify those people at risk from hearing damage so that the employer can formulate an action plan for controlling noise exposure. The following steps may be taken:

1. Decide whether there might be a problem. As a guide, if people have to shout to be heard by someone about two metres away, it is possible that noise is above 85 dB(A). If people have to shout to be heard by someone about one metre away, it is possible that noise is above 90 dB(A). In either case a noise assessment should be undertaken.

2. Noise assessment by a competent person. An integrating sound level meter is used to record the noise, the lower the type number of the equipment, the more accurate it is. It should be calibrated. The following will need to be recorded:

- a noise measurements at every operator location and
- the time taken for the operator to carry out the task at each location.

The LEPd is then calculated, for the work at different locations to determine the total daily noise exposure.

An alternative technique for determining noise exposure is to use a dosimeter. A dosimeter is a measuring device, which attaches to the individual and logs his / her noise exposure as they move around the workplace. A calculation can then be made of the LEPd.

3. Decide upon control measures. The highest fractional exposure values are given by the machines or processes, which make the greatest contribution to daily noise exposure. These should be prioritised first. The noise should be controlled at source, where possible. Measures to control the path and person should also be considered. The assessment should determine the adequacy of existing control measures, including the attenuation level of hearing protection.

8.1.5 Role of health surveillance

Health surveillance for hearing damage usually means:

- regular hearing checks in controlled conditions;
- telling employees about the results of their hearing checks;
- keeping health records;
- ensuring employees are examined by a doctor where hearing damage is identified.

Ideally, you would start the health surveillance before people are exposed to noise (ie for new starters or those changing jobs), to give a baseline. It can, however, be introduced at any time for employees already exposed to noise. This would be followed by a regular series of checks, usually annually for the first two years of employment and then at three-yearly intervals (although this may need to be more frequent if any problem with hearing is detected or where the risk of hearing damage is high). The hearing checks need to be carried out by someone who has the appropriate training. The whole health surveillance programme needs to be under the control of an occupational health professional (for example a doctor or a nurse with appropriate training and experience). You, as the employer, have the responsibility for making sure the health surveillance is carried out properly.

Providing health surveillance

You must provide health surveillance (hearing checks) for all your employees who are likely to be regularly exposed above the upper exposure action values, or are at risk for any reason, eg they already suffer from hearing loss or are particularly sensitive to damage.

The purpose of health surveillance is to:

- warn you when employees might be suffering from early signs of hearing damage;
- give you an opportunity to do something to prevent the damage getting worse;
- check that control measures are working. Consult your trade union safety representative, or employee representative and the employees concerned before introducing health surveillance. It is important that your employees understand that the aim of health surveillance is to protect their hearing.

You will need their understanding and co-operation if health surveillance is to be effective.

How can I arrange health surveillance?

Larger companies may have access to in-house occupational health services who may be able to carry out the programme. Where there are no facilities in-house you will need to use an external contractor. You may be able to find out about occupational health services through your trade association, or through local business support organisations.

What should I expect from an occupational health service provider?

A suitable occupational health service provider will be able to show you that they have the training and experience needed. They should be able to: advise you on a suitable programme for your employees;

- set up the programme;
- provide suitably qualified and experienced staff to carry out the work;
- provide you with reports on your employees' fitness to continue work with noise exposure.

Remember

By law, as an employer, you must assess and identify measures to eliminate or reduce risks from exposure to noise so that you can protect the hearing of your employees.

Where the risks are low, the actions you take may be simple and inexpensive, but where the risks are high, you should manage them using a prioritised noise-control action plan.

Where required, ensure that:

- hearing protection is provided and used;
- any other controls are properly used; and
- you provide information, training and health surveillance.

Review what you are doing if anything changes that may affect the noise exposures where you work.

What do I have to do with the results of health surveillance?

Use the results to make sure your employees' hearing is being protected. You will need to:

- keep records of the health surveillance and fitness-for-work advice provided for each employee (but not the confidential medical records which are kept by the doctor). A

health and safety inspector can ask to see the health records as part of their checks that you are complying with the Regulations;

- make employees' records available to them;
- act upon any recommendations made by the occupational health service provider about employees' continued exposure to noise;
- use the results to review and, if necessary, revise your risk assessment and your plans to control risks.

Analysing the results of your health surveillance for groups of workers can give you an insight into how well your programme to control noise risks is working. Use the results to target your noise reduction, education and compliance practices more accurately. Make this information available to employee or safety representatives.

8.1.6 Occupations with potential noise exposure problems

Construction

Some typical noise levels for equipment used on sites are:

- | | |
|----------------|-----------|
| ▪ Disc cutter | 99-115dB |
| ▪ Hammer drill | 102-111dB |
| ▪ Breakers | 103-113dB |
| ▪ Earthmover | 87-94dB |

Uniformed services

Some typical decibel levels for military equipment used are:

- Apache helicopter Pilot 104dB, Co-pilot 101.3dB
- M60 Machine gun 155dB
- Grenade at 150 metres 155dB

Entertainment

- In recognition that the music in these venues is deliberately created for enjoyment and therefore different to other sectors
- It is not uncommon for rock bands to generate noise levels in excess of 110 dB

Manufacturing processes

- Manufacturing processes can produce a great deal of noise
- Particularly forging, shaping, riveting, cutting or grinding
- Many supplementary processes also generate noise
- Cumulative effect of all the different noise levels and frequencies needs to be assessed

Some typical noise levels:

- Conveyor 115dB
- Lathe 96dB
- Packing machine 106dB

Call centres

- Any workplace which has a large volume of people working alongside each other engaged in speaking is at risk of exposure to noise
- The level of noise will depend on the number and proximity of the people
- In addition, the need to speak loudly will be influenced by the effectiveness of any headset worn
- 'Acoustic shock'
- A term used in connection with incidents involving exposure to short duration, high frequency, high intensity sounds through a telephone headset – interference.

8.2 Vibration

Exposure Limit Values and Action Values

If the measurement of the magnitude of vibration indicates that there is a risk to the health of employees who are exposed to vibration and an exposure action value is likely to be reached or exceeded, the employer shall reduce exposure to as low a level as is reasonably practicable. The Exposure action values and Exposure limit values are provided below.

HAVS describes a group of diseases caused by the exposure of the hand and arm to external vibration. Some of these have been described under WRULDs, such as carpal tunnel syndrome. However, the best known disease is **vibration white finger (VWF)** in which the circulation of the blood, particularly in the hands, is adversely affected by the vibration. The early symptoms are tingling and numbness felt in the fingers, usually sometime after the end of the working shift. As exposure continues, the tips of the fingers go white and then the whole hand may become affected. This results in a loss of grip strength and manual dexterity. Attacks can be triggered by damp and/or cold conditions and, on warming, 'pins and needles' are experienced. If the condition is allowed to persist, more serious symptoms become apparent including discoloration and enlargement of the fingers. In very advanced cases, gangrene can develop leading to the amputation of the affected hand or finger. VWF was first detailed as an industrial disease in 1911.

The risk of developing HAVS depends on the frequency of vibration, the length of exposure and the tightness of the grip on the machine or tool. Some typical values of vibration measurements for common items of equipment used in industry are given.

8.2.1 The effects on the body of exposure to vibration

Exposure to vibration may result in a range of health effects, collectively known as hand-arm vibration

syndrome (HAVS). The most well-known health effect is vibration white finger (VWF).

Symptoms

resulting from damage to either the vascular or the neurological systems in the hands include:

- **acute:** tingling or pins and needles in the hands and extremities.
- **chronic:**
- numbness and blanching of the fingers
- swollen painful joints
- reduction in manual dexterity
- reduction in the sensation of touch and ulceration and gangrene in extreme cases.

Carpal tunnel syndrome can also be caused by vibration.

Risk Factors

The following factors influence the risk:

- **frequency of the equipment** between about 2 to 1500 Hz is potentially damaging and more serious at between 5 and 20 Hz
- **magnitude of the energy** measured in m/s^2
- **strength of the grip and other forces** used to hold and guide vibrating tools or work pieces
- **length of time of exposure**

- **frequency of exposure**
- **low temperature** and
- **individual factors**, e.g. smoking, susceptibility to vibration energy, age, health and general well-being.

In Europe, for example, a limit on hand-arm vibration exposure is set. The 8-hourly exposure limit value A (8) is 5 m/s² and if exceeded an employer should:

- reduce exposure
- identify the reason for exceeding the limit and
- modify the control measures to ensure it is not exceeded again.

A hand-arm vibration daily exposure action value of 2.5 m/s² A (8) is set, whereby an employer should introduce health surveillance for employees.

8.2.2 The need for assessment of exposure

The aim of the risk assessment is to help you decide what you need to do to ensure the health and safety of your employees who are exposed to vibration.

Your risk assessment should:

- Identify where there might be a risk from vibration and who is likely to be affected;
- Contain a reasonable estimate of your employees' exposures, and;
- Identify what you need to do to comply with the law eg whether vibration control measures are needed, and, if so, where and what type; and
- Identify any employees who need to be provided with health surveillance and whether any are at particular risk.

You must record the findings of your risk assessment. You need to record in an action plan anything you identify as being necessary to comply with the law, setting out what you have done and what you are going to do, with a timetable and saying who will be responsible for the work.

You will need to review your risk assessment if circumstances in your workplace change and affect exposures. Also review it regularly to make sure that you continue to do all that is reasonably practicable to control the vibration risks. Even if it appears that nothing has

changed, you should not leave it for more than about two years without checking whether a review is needed.

How do I get started?

If you answered 'yes' to any of the questions in the section 'Do you have a vibration problem?' you will need to assess the risks to decide whether any further action is needed, and plan how you will do it.

To carry out your risk assessment you will need to identify whether there is likely to be a significant risk from hand-arm vibration. You should:

- Find out from your employees and their supervisors which, if any, processes involve regular exposure to vibration (eg processes using the equipment listed in 'Which jobs and tools produce a risk?' or other vibrating equipment);
- See whether there are any warnings of vibration risks in equipment handbooks;
- Ask employees if they have any of the HAVS symptoms described in these web pages and whether the equipment being used produces high levels of vibration or uncomfortable strains on hands and arms.

Consultation

It is important during this whole process to discuss hand-arm vibration with your supervisors, employees and the trade union safety representative or employee representative. You will need to develop and agree a policy for managing vibration risks which will provide reassurance to your employees about their job security and to explain why co-operating with your risk control measures and health surveillance programme will be in their best interests.

Assess who is at risk

If there is likely to be a risk you need to assess who is at risk and to what degree. The risk assessment needs to enable you to decide whether your employees' exposures are likely to be above the EAV or ELV and to identify which work activities you need to control.

Competence

You could do the risk assessment yourself or appoint a competent person to do it for you. The person who does the risk assessment should have read and understood these pages, have a good knowledge of the work processes used in your business and be able to collect and understand relevant information. They should also be able to develop a plan of action based on their findings and ensure it is introduced and effective. They will need to:

- Make a list of equipment that may cause vibration, and what sort of work it is used for;
- Collect information about the equipment from equipment handbooks (make, model, power, vibration risks, vibration information etc);
- Make a list of employees who use the vibrating equipment and which jobs they do;
- Note as accurately as possible how long employees' hands are actually in contact with the equipment while it is vibrating – in some cases this 'trigger time' may only be a few minutes in several hours of work with the equipment;
- Ask employees which equipment seems to have high vibration and about any other problems they may have in using it, eg its weight, awkward postures needed to use the tool, difficulty in holding and operating it;
- Record the relevant information they have collected and their assessment of who is likely to be at risk.

How should I use this information?

Group your work activities according to whether they are high, medium or low risk. Plan your action to control risks for the employees at greatest risk first. Your rough groupings could be based on the following:

High risk (above the ELV)

Employees who regularly operate:

- Hammer action tools for more than about one hour per day; or
- Some rotary and other action tools for more than about four hours per day.

Employees in this group are likely to be above the exposure limit value set out in the Regulations. The limit value could be exceeded in a much shorter time in some cases, especially where the tools are not the most suitable for the job.

Medium risk (above the EAV)

Employees who regularly operate:

- Hammer action tools for more than about 15 minutes per day; or
- Some rotary and other action tools for more than about one hour per day.

Employees in this group are likely to be exposed above the exposure action value set out in the Regulations.

Do I need to measure my employees' exposure to vibration?

The rough groupings described above should be enough for you to do a basic risk assessment which will enable you to decide whether exposures are likely to exceed the exposure action value and exposure limit value and to allow you to plan and prioritise your control actions effectively. For further information see 'Control the risks'.

Alternatively, you may choose either to use available vibration data or to have measurements made to estimate exposures if you want to be more certain of whether the risk is high, medium or low. A more detailed exposure assessment may help you:

- Decide which control actions might be most effective and practicable in reducing vibration exposure;
- Be more certain whether exposures are likely to exceed the action or limit values;
- Check whether your controls are effective.

If you decide to do this, read 'Estimating exposure'.

8.2.3 Basic vibration control measures

Reducing the vibration energy can be achieved by:

Eliminate the risk:

- alter the work processes to eliminate or reduce the use of vibrating tools

Reduce the degree of vibration:

- selecting low vibration equipment
- selecting ergonomically designed equipment
- maintenance of equipment and tools
- reducing the grip and push forces associated with work equipment

Other factors:

- reducing the time workers are exposed
- introducing health surveillance / health promotion programme
- wearing warm weatherproof clothing in cold or wet areas
- wearing gloves and / or using heating pads to keep hands warm and
- information and training on the nature and risks and early indications of the injury and the methods of reporting signs of the injury.

8.2.4 Role of health surveillance

The role of health surveillance is to provide early detection of work related ill-health.

- It will assist with the identification of symptoms of the effects of vibration on health
- Health surveillance can prevent or diagnose any health effect linked with exposure to vibration
- Health surveillance should be carried out for all workers where there is a risk to their health due to being exposed to vibration
- A record of health shall be kept of any worker who undergoes health surveillance

If the risk assessment indicates that there is a risk to the health of employees who are exposed to vibration or likely to be exposed to vibration at or above the exposure action level, the employer shall ensure the exposed employees are placed in an appropriate health surveillance program. The Health surveillance, which shall be intended to prevent or diagnose any health effect linked with exposure to vibration, shall include:

- Medical evaluation from a physician that has experience in diagnosing and treating vibration related injuries and diseases, knowledge of the work environment and vibration exposures;
- Documentation of any links between the exposure and identifiable disease or adverse health effect;
- A requirement that when a vibration related injury or illness occurs, the treating physician shall review the job duties of the employee and determine if there is alternative work or light duties that can be performed by the employee during their recovery.

Record Keeping - Exposure monitoring, medical surveillance, examination and consultation records shall be kept for a minimum of the period of employment plus 30 years.

8.3 Radiation

8.3.1 The types of, and differences between, non-ionising and ionising radiation (including radon) and their health effects

Radiation is the emission of energy from matter. There are two types of radiation:

- **non-ionising radiation:** can cause heating effects in the body, e.g. ultraviolet from arc welding, radio waves, microwaves and
- **ionising radiation:** has sufficient energy to penetrate, ionise (change in the electrical charge of an atom) and damage body tissue and organs, e.g. x-rays, gamma rays used in non-destructive testing of metal structures. The health effects of exposure to ionising radiation are more severe than those from exposure to ionising radiation.

Non-Ionising Radiation

Type	Examples of commercial use
Infrared	Heating and brazing.
Lasers	Bar code readers, surveying, cutting.
Microwaves	Signal transmission, food preparation.
Radio frequencies	Radio transmissions, radar, welding of plastics (RF welding).
Ultra-violet	Commercial tanning, curing of glues inks, welding (arc eye).

Table: Examples of Non-ionising Radiation

Health Effects

The health effects from exposure to non-ionising radiation are:

- burns
- erythema (reddening of the skin)
- cataracts
- arc eye and
- temporary sterility.

Forms Of Non-Ionising Radiation

Non-ionising radiation includes energy radiated across a wide range of frequencies from long wave radio waves to visible laser light.

Infrared Light

Just outside the visible spectrum, infrared light is emitted from red-hot materials, such as molten metal and glass. It can cause cataracts of the eyes. Tinted eye protection will provide protection by filtering out the infrared range. The skin should also be protected by overalls, etc.

Lasers

'LASER' is an abbreviation for 'Light Amplification by Stimulated Emission of Radiation'. Laser light has a narrow range of frequencies and is highly directional. These features bring two hazards, firstly the light can travel great distances, and secondly, extreme optical intensities can be achieved with relatively small energy sources. The narrow beam of light can focus on the retina to cause severe burns. Since some lasers operate at non-visible frequencies, the eye may not have the natural protection of the blink response.



Lasers are used for:

- cutting
- alignment of structures, e.g. bridges, tunnels
- entertainment
- navigation
- communication (fibre optics)
- printing.

There are various classifications for lasers according to their potential for harm. The potential depends on both their frequency and their energy.

Class 1 / 1M	Inherently safe (low power) or safe by engineering design (total enclosure).
Class 2 / 2M	Low power / visible frequency. Adequate protection by blink response.
Class 3R	Medium power with expanded beam diameters. Some protection by blink response but direct viewing with optical aids could be hazardous.
Class 3B	Medium power lasers requiring interlocked enclosures and strict operating procedures particularly during setting and adjusting, etc.
Class 4	High power lasers, generally used in restricted areas. Eye protection must be worn at all times and reflective surfaces avoided.

Table: Laser Hazards and Precautions

8.3.2 Typical occupational sources of non-ionising and ionising radiation

Microwaves

Microwaves are used for cooking, communications, etc. They cause materials to heat internally. The health problem associated with this is that there is no sensation of heat, due to the absence of nerve cells in the internal organs. Microwave systems used in communications and security systems have been thought to be harmless but this is not proven. The main precaution is enclosure of the waves by engineering design, e.g. interlocked doors, etc.

Radar / Radio Frequencies

Radio frequencies can cause burns and are suspected of being associated with leukaemia. Close proximity to powerful transmitters should be avoided by means of strict isolation procedures, e.g. permit-to-work systems, etc.

Ultra-Violet Light

Ultra-violet light is a component of sunlight, which has become more of a hazard with depletion of the ozone layer and the loss of some of its filtering effect. Sunlight causes a chemical reaction, which can result in temporary reddening of the skin. Operators working externally should cover up and apply sun cream. Arc welding produces ultra-violet light. Looking at the flash causes a painful but temporary condition known as 'arc eye'. Welders should wear full body covering (overalls, etc. and tinted eye protection). People in the vicinity should be prevented from looking at the direct or indirect welding arc by means of screens.

8.3.3 The basic means of controlling exposures to non-ionising and ionising radiation

Control measures include:

- **time:** reducing the duration of exposure
- **distance:** increasing the distance between the source and the person
- **shielding:** providing a barrier between the source and the person
- **PPE,** e.g. eye protection and foundry workers jackets to reduce the effects of radiant heat and
- **skin creams.**

Ionising Radiation

There are four main types of ionising radiation:

- 1. Alpha 'Particles'**
- 2. Beta 'Particles'**
- 3. Gamma Rays And**
- 4. X-Rays.**

The first three arise from radioactive substances, whereas x-rays are generated in machines.

Alpha Particles

Alpha particles are: **Figure 18: Alpha Particle**

- positively charged energy 'particles'
- heavy and slow moving
- capable of causing considerable internal damage if inhaled or ingested into the body
- stopped by paper, a few centimetres of air or by the layers of dead skin on the outside of the body and
- used as sealed sources.

Examples of use are: smoke detectors, 'anti-static' devices to remove dust and protect sensitive electronic components during assembly.

Beta Particles

Beta particles are:

- negatively charged particles
- very light and fast moving
- capable of travelling long distances before their energy is lost because they are small and
- less likely to collide with other atoms in the air, etc.
- capable of penetrating the surface of the skin
- cause damage externally or internally and
- stopped by metal, e.g. aluminium.

Examples of use are: thickness testing of materials and moisture content gauges.

Gamma Rays

Gamma rays are:

- waves of energy emitted during the radioactive decay of a substance extremely high frequency, short wave
- capable of penetrating the body causing internal and external harm and
- stopped by lead or thick concrete.

Examples of use are: non-destructive testing (NDT) and radiotherapy medical treatment.



X-Rays

X-rays have the same properties as gamma rays but are generated.

X-rays are:

- generated by machines, cease when the
- machine is switched off
- waves of energy
- extremely high frequency, short wave
- capable of penetrating the body causing internal and external harm and
- stopped by lead or thick concrete.

Examples of use are: medical, non-destructive testing e.g. used to test integrity of metal airplane propellers.

Health Effects of Ionising Radiation

Ionising radiation causes damage to individual cells in the body tissues.

Cells may:

- die or
- fail to divide to produce new cells or
- produce new cells that are abnormal.

The severity of the health effect depends on:

- the type of radiation
- the absorbed dose
- the rate at which the dose was absorbed and
- the radio sensitivity of the tissues involved, e.g. brain.

The effects are the same, whether from a radiation source outside the body or from material within.

Acute effects from high dose	Chronic effects long-term exposure
Erythema: reddening of the skin. Radiation sickness - nausea, vomiting, diarrhoea. Hair loss. Death.	Mutagenic cancers: various organs, leukaemia. Sterility. Hereditary defects: future children. Teratogenic effect: unborn child in womb. Other effects: eye cataracts, skin damage and death.

Table : Acute and Chronic Effects of Ionising Radiation

Monitoring Exposure

Ionising radiation can be measured using film badges, geiger tubes and a number of other methods. Personal monitoring provides the means to measure and record radiation doses

received by individual workers. Maximum dose limits are based on an international agreement and prescribed in national laws. Records should be kept for 50 years, or until the person reached 75.

Protection measures for ionising radiation depend upon dose limitation. This can be achieved in three ways:

- 1. Time**
- 2. Distance and**
- 3. Shielding.**

1. Time

The length of time that persons are exposed to ionising radiation should be kept to a minimum. The main control measure is to ensure that the dose to which persons at risk have been exposed is constantly monitored. Once the cumulative dose limit has been reached they should be removed from exposure.

Half-life

Each individual radioactive substance has a characteristic decay period or half-life, which is the time taken to lose half of its energy. This influences the risk. If there is a radioactive spillage and the half life of the substance is measured in hours the area will be evacuated until the level of radiation reduces. However, if the half-life of the substance is measured in years the radiation will be high for a significant time, requiring a high level of precautions to clean the spill. The half-life also has implications for use:

- Barium has a short half-life (hours) and is used within the body for medical diagnostic tracing. Its short half-life reduces the risk to the patient and
- Uranium has a long half-life (billions of years!) and is used to produce electrical energy for many years.

2. Distance

Segregation by distance reduces the risk to health. Most forms of radiation used in industry will only travel short distances, therefore restricted areas and other controls are required particularly to protect those not involved in the actual operation. In the case of beta radiation for example, the use of tweezers or forceps to handle some sources will greatly reduce the exposure. The energy of ionizing radiation is reduced with distance. It reduces by a quarter for every unit of distance a person stands away from the source.

3. Shielding

- enclosures, ranging from concrete and / or lead to cardboard depend upon the type of radiation used. A sheet of paper stops alpha particles a thin sheet of aluminium

will stop beta particles. Gamma rays will pass through most materials, but will be stopped by thick lead or concrete and

- barriers or screens.

Other Factors

- PPE, e.g. whole body radiation suits
- environmental and personal monitoring, e.g. film badges
- correct disposal of radiation materials
- training and supervision and
- good hygiene practices.

8.3.4 Radiation Protection Strategy

In addition to the physical control measures a people management strategy is required.

Radiation Protection Adviser (RPA)

An RPA is a health physicist (often a consultant) who is the company's expert for setting up the local rules, any emergency procedures and monitoring regimes required, etc.

Radiation Protection Supervisor (RPS)

An RPS is a member of management who in a supervisory role will ensure that the local rules and if necessary any emergency procedures (specified by the RPA) are followed on a daily basis.

Classified Worker

A classified worker is aged over 18, subject to annual medical examinations and the wearing of a film badge.

Controlled Area

A controlled area is an area that is controlled because of radiation hazard (3/10th of max permissible dose) and access is only permissible by Classified Workers under the control of the RPS, and working to local rules determined by the RPA.

Supervised Area

A supervised area is an area where there is a lower risk of radiation hazard than a controlled area (1/10th of max permissible dose) and access is permissible to anyone under the control of the RPS, working to local rules determined by the RPA.

8.3.5 Role of radiation monitoring and Health surveillance

Role of radiation monitoring

In general, it is appropriate to monitor for contamination wherever areas are designated as controlled because of the presence of unsealed radioactive substances, except where the nature of the substances makes such monitoring impracticable (eg radioactive gases). A radiation monitoring programme should be organised, in general, according to the following elements:

- Routine monitoring, which is associated with continuing operations;
- Operational monitoring, intended to provide information about a particular operation; and
- Special monitoring, which is used in the case of an actual or suspected abnormal situation.

Any monitoring programme, either of workers or the workplace, should be adjusted as experience is gained, so that the type, frequency and extent of the measurements are periodically reviewed to ensure that protection efforts are optimised.

Non-ionising radiation

Monitoring of workplace levels of non-ionising radiation is important for both radio frequency and optical forms of radiation

They are not a visible hazard and levels may increase and not be obvious until harm is done to workers

Ionising radiation

Where workers are exposed to ionising radiation, the employer should ensure that levels of ionising radiation are adequately monitored and that working conditions in those areas are kept under review

The main functions of monitoring are to:

- Check that areas have been correctly designated for the hazards that exist
- Identify any changes to radiation exposure levels
- Detect breakdowns in controls or systems
- Ensure workers use the controls provided and report any defects
- Ensure workers use personal protection where its use is designated as mandatory

- Provide information on those who may be at risk and in need of health surveillance

The three types of personal monitoring devices commonly used by industrial radiographers are:

- Film badge dosimeter.
- Pocket dosimeter.
- Thermoluminescence dosimeter (TLD).

Role of Health surveillance

The employer should provide health surveillance of workers engaged in radiation work and ensure that all assessments to protect the health of workers are carried out. Such health surveillance of workers engaged in radiation work should be based on the general principles of Occupational Health Services Convention, 1985 (No. 161), and Recommendation, 1985 (No. 171).

Health surveillance should be established in order to

- Assess the health of the workers;
- Help ensure initial and continuing compatibility between the health of the workers and their work;
- Provide reference data useful in the case of accidental exposure or occupational disease.

Health surveillance of workers engaged in radiation work should include appropriate medical surveillance carried out by a physician experienced in occupational and radiation health, who would be responsible for such surveillance in the light of the hazard involved and the type of work being carried out.

The health surveillance of workers engaged in radiation work should be carried out by an approved medical practitioner.

Health surveillance for normal conditions of work should include:

- Health assessment appropriate to the specific tasks to be performed, before the worker begins the assignment;
- Periodic health surveillance during the assignment;
- Special health surveillance when needed and as prescribed by the competent authority for workers engaged in radiation work;
- Assessment when a pregnancy is reported;
- Other health assessments as required by the competent authority.

The health surveillance following an abnormal exposure should include special assessment when the results of radiological surveillance indicate that the individual has received radiation dose equivalents in excess of twice the relevant dose limits.

Records should be kept for such periods as may be specified by the competent authority for different record types, e.g. long term for individual doses and health records and radioactive waste-disposal records; medium term for incoming and outgoing shipments of radioactive materials; or short term for instrument calibration records.

Record keeping is needed for:

- Demonstrating the degree of compliance with the radiation protection regulations and the requirements as laid down in this code;
- Medical purposes;
- The evaluation of dose trends;
- The evaluation of collective doses; and Epidemiological studies and evaluations of health effects.

8.4 Stress

8.4.1 Meaning of 'work related stress'

Stress is defined as:

'the adverse reaction people have to excessive pressures or other types of demand placed on them'. (HSE, 2003).

The definition makes an important distinction between the:

- **Beneficial Effects** of reasonable pressure and challenge (which can best imulating, motivating, and can give a 'buzz')
- **Excessive Pressure** resulting in stress, which is the natural but distress in reaction to demands that a person perceives they cannot cope with.

Workplace stress itself is not an illness but if it is intense or for a prolonged period of time then deterioration in the sufferers' health may ensue. Typical health effects associated with prolonged levels of stress are:

Physical effects	Psychological effects
Headaches.	Increased anxiety.

Dizziness. Aching neck and shoulders. Skin rashes. Prone to infections. Panic attacks. Raised heart rate, increased blood pressure. Heart disease. Stomach ulcers.	Reduced concentration. Irritability and sudden mood changes. Inability to cope. Reduced work output / performance. Increased drug use, e.g. alcohol, tobacco. Poor sleeping pattern.
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Table: Physical and Psychological Effects of Stress

Identification of Stress

Stress within the organisation may be identified by:

- informal observation and conversation with personnel and supervisors
- performance appraisal with an opportunity for open discussion of problems
- monitoring of attendance records and conducting 'return to work' interviews
- sickness absence / ill-health trends
- data showing reduced productivity and
- high staff turnover.

Work-related stress can have consequences for organisations as well as the individuals working within them, e.g.

- an increase in sickness absence
- reduced staff morale
- reduced staff performance and
- staff seeking alternative employment.

Organisations then have the expense of recruiting, inducting, and training new members of staff as well as dealing with issues such as conflict, poor relationships and disciplinary problems.

8.4.2 Causes, effects and control measures

1. Culture: of the organisation and how it approaches work-related stress, e.g. communication, consultation, staff support systems, working hours

2. Demands: workload too high or too low, shift work and unsocial hours, excessive overtime, and exposure to violence and bullying

3. Control: how much control the person has in the way they do their work, e.g. work planning, use of acquired skills, repetitive or monotonous work

4. Relationships: between employees, e.g. physical violence, threatened or actual, verbal abuse such as repeated shouting and swearing, malicious gossip victimisation such as excessive supervision, unjustified picking off adults, prevention of career development sexual harassment and discrimination due to gender, race or disability

5. Change: how organisational change is managed and communicated in the organisation, e.g. new technology, restructuring, redundancies, and unclear objectives

6. Role: job insecurity, fear of redundancy, being unclear about role, responsibilities and expectations, conflicting roles, e.g. the conflict of different job demands such as working for more than one manager

7. Individual: skills not matched to the task, inadequate training, unclear job description, and fair and open feedback on the work and role, illness, financial worries, family commitments and

8. Environment: inadequate lighting, problems with glare, cramped or untidy working conditions, security problems, extremes of temperature and / or humidity, inadequate ventilation, draughty conditions, high noise and vibration levels, inadequate welfare facilities and poor weather conditions for those working outside.

Risk Assessment

A stress risk assessment should be carried out in different departments, etc. and for individuals where signs of stress occur.

Control Measures Individual	Job	Organisation
Selecting employees with appropriate skills and aptitude.	Clearly defined roles.	Clear work objectives.
Training, e.g. interpersonal skills and time management.	Comfortable working environment.	Communication.
	Realistic work schedules.	Employee involvement
	Availability of a grievance procedure.	Management support, training and development.
	Prompt and impartial investigation of stress (signs / complaints).	Management of change.
		Risk management, openness.
		Management style.

	Work flexibility, e.g. home working, flexible working hours.	
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Table: Stress Control Measures