ELEMENT 9 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 the appropriate control measures
- Outline the causes and effects of stress at work and appropriate control measures

9.1 NOISE

Noise is the result of air being continuously compressed followed by rarification, the frequency or number of compressions per second will determine the pitch, the pressure exerted will determine the loudness.

Example: A high pitch noise, like a high note on a piano, will be at a far higher frequency than a deep rumble of thunder.

Noise is an unwanted sound which has the potential to cause injury. Noise levels of over 80 dB(A) are believed to damage the hearing mechanism. Noise damage is usually accumulative and can occur over a long period of time.

The sounds which can be detected by the human hearing mechanism are over a vast **frequency** range, if measured in Watts /m_3 they would range from 0.000 000 000 001 to 1 Watt. Therefore to simplify measuring sound we use the **Decibel**, this ranges from 0, which is the threshold of the human ear, upwards, at 140 dB the human ear can be damaged and the threshold of pain is reached. The decibel measures the **intensity** of the sound energy or loudness. The **pitch or frequency** of the sound is measured in hertz, the number of cycles per second. The higher the number the higher the pitch of the sound.

The (A) weighting, also used with the term dB, refers to a special filter which adapts a noise meter to ensure it only picks out the sounds heard by the human hearing mechanism and not sounds which the human hearing mechanism cannot hear.

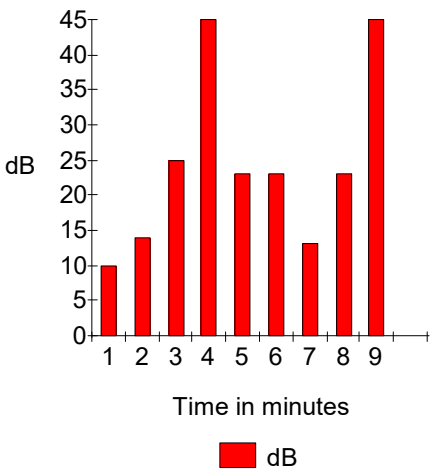
Exposure to noise can be measured in dB (A) as at one moment in time but noise can also be measured to give a person's exposure over an eight hour shift. This is shown as L_{epd}. (Long Term Exposure Period) or LEX (length of exposure).

a. Noise levels

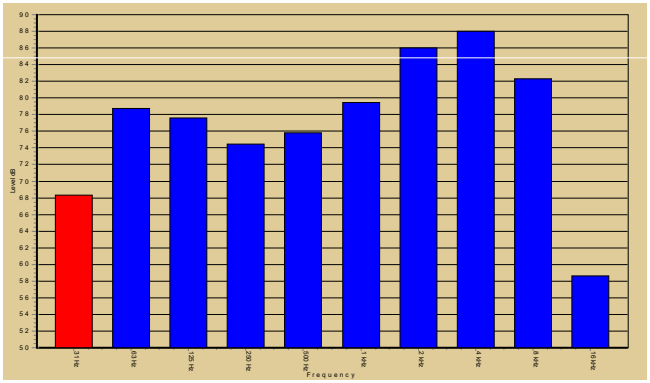
Level	Effect
140dB	Instantaneous damage and pain
120dB	Is physically painful, and should be avoided
100dB	Short periods of exposure causes temporary loss of acuity (threshold shift) whilst longer exposures are likely to cause irreparable damage to auditory organs
90dB	Long term exposure at this level normally causes permanent hearing loss
80dB	Long periods of exposure cause both mental, bodily fatigue and hearing loss

This shows a basic noise assessment where the general noise levels were recorded every minute. A frequency band analysis is a more detailed assessment where the pitch or tone of each sound is recorded separately.

Noise Measurements

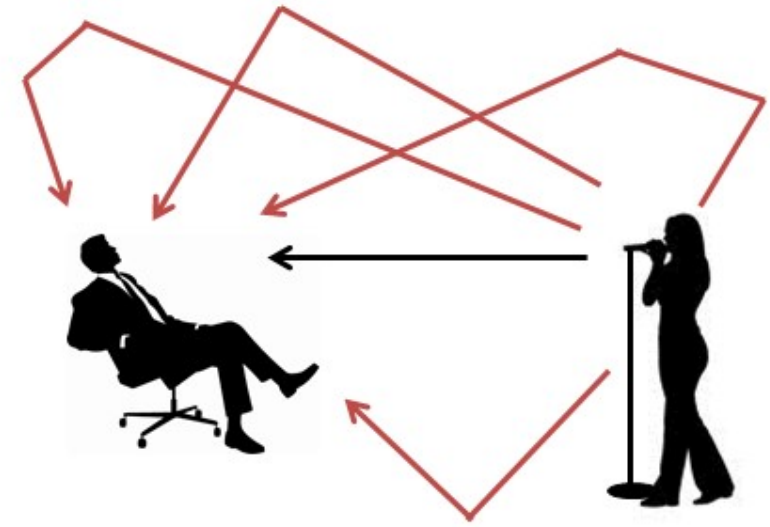


Frequency Band Analysis



b. NOISE TRANSMISSION

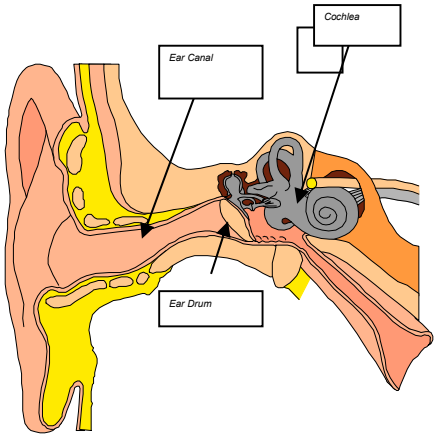
Noise is transmitted by its source directly through the air, however it will also vibrate through the floor and reverberate from the ceilings and walls. All three paths must be considered when selecting the best way to reduce noise levels.



c. THE HEARING MECHANISM

The following explanation is a simplified explanation of how humans hear.

The sound wave travels through the pinna (outer ear) down the ear canal, vibrating the ear drum. This vibration is passed on through the three little bones (hammer, anvil, stirrup) into the cochlea. In here there are millions of little nerve endings which detect sound of different pitches. As they detect relevant sounds they sway and create an electric signal which is sent to the brain, thus we hear.



d. WHAT INJURIES CAN WE SUFFER?

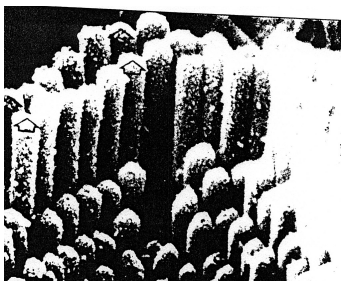
TEMPORARY THRESHOLD SHIFT

This is when the small nerve endings within the cochlea sway to pass on sound waves, however if we are subjected to loud noise for any period of time, these nerve endings will start to lean over and not return to an upright position straight away, thus reducing our perception to sound.

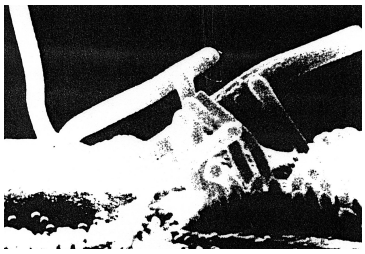
This explains why when we are listening to the car radio, after a short period of time we cannot hear the radio as well, our natural reaction is to turn the radio up. If we forget to turn the radio off when we get out the car, the following morning we are blasted by the loud radio. The reason the following morning that this sounds so loud, is because on the journey home we were experiencing a temporary threshold shift as our hearing mechanism had been defending itself.

NOISE INDUCED HEARING LOSS

If we are subjected to noise levels on a continuous basis over a period of time, our nerve endings will not just bend over but will wear away completely. If this happens, our perception to sound is not just reduced but will be completely destroyed at the frequency of the noise listened to. There is no cure for noise induced hearing loss, even a hearing aid will not be able to restore our hearing sufficiently if the nerve endings have completely worn away.



Nerve Endings in Normal Position



Damaged Nerve Endings

OCCUPATIONAL DEAFNESS

This occurs when the employee has lost 50dB of hearing on one or both ears. They may be eligible for a disability benefit.

TINNITUS

This is a ringing or buzzing in the ears, it can be brought on after being subjected to high and continuous levels of noise. The quieter the surrounding noise levels are, the louder the buzzing that is heard by the individual. There is no known cure for this condition however it can affect some people on a temporary basis. This can be an acute or chronic condition.

PRESBYCUSIS

This is the way in which we all naturally lose our perception to sounds in the higher frequency ranges. Even though this occurs naturally, it can be brought on prematurely by being subjected to noise.

ACUTE ACOUSTIC TRAUMA

After a sudden explosion or very loud sound the hearing mechanism can be damaged irreversibly. This is an acute condition and can lead to total deafness.

STRESS/FATIGUE

Even low levels of noise at certain pitches can prove stressful and annoying in the workplace. People may lose concentration and therefore be more likely to have an accident.

ACOUSTIC SHOCK

Acoustic shock' is a term used in connection with incidents involving exposure to short duration, high frequency, high intensity sounds through a telephone headset. Some

sources suggest that these incidents are associated with a range of physiological and psychological symptoms that have been reported amongst headset wearers. It has not been established whether the reported symptoms are caused directly by exposure to these unexpected sounds. There is no clear single cause of these incidents, but one cause may be interference on the telephone line. Although call handlers may be shocked or startled by the sounds, exposure to them should not cause hearing damage as assessed by conventional methods.

e. CONTROL OF NOISE AT WORK REGULATIONS 2005

Lower exposure action values

80dB (A) daily or weekly exposure

Peak sound pressure 135 dB(C)

If any of these levels are met the employer must:

- Carry out suitable and sufficient risk assessment
- Takes steps to eliminate or if not reasonable practicable to as low a level as possible
- Provide ear defenders and make them available
- Provide health surveillance if they are identified as being at risk from the effects of noise
- Use and Maintain Equipment
- Employees to report any problems

Upper Exposure Action Values

85 dB(A) daily or weekly

Peak sound pressure of 137 dB(C)

If these levels are met the employer must:

- Carry out suitable and sufficient risk assessment
- Take steps to eliminate the noise
- Establish a programme of organisation and technical issues to reduce exposure to as low a level as is reasonably practicable (Hierarchy of control)
- Provide ear defenders and ensure they are used
- Set up noise zones with signs
- Prohibit entry unless ear defenders are used
- Provide health surveillance if they are identified as being at risk from the effects of noise
- Use and Maintain Equipment
- Employees to report any problems

Exposure Limit Values

87dB(A) weekly or daily- Whatever the noise level no more than this amount is permitted to enter the ear.

An employee must not be subject to these exposure limit values taking into account the wearing of any ear defenders. The data from manufacturers can be used taking into account whether the ear defenders are in good condition, are the correct type and properly worn.

Weekly exposure values can be used where daily exposure varies markedly from day to day, i.e. where power tools are used on one day but not another, it will normally be appropriate when exposure is likely to be 5dB higher on at least two working days.

The risk assessment cannot take into account the protection given by hearing protectors except in the exposure limit value calculations where data from manufacturers can be used.

Noise risk assessments (reg 5)

Any employer likely to expose employees to the lower action limit or above must complete a suitable and sufficient assessment of the risk.

This should consider:-

- Observation of working practices
- Information on equipment/noise sources
- If necessary measurement of noise
- Type, level and duration of noise
- Any peak sound pressures
- Employees at risk
- Effects of any substances which may increase in a noisy environment
- Indirect effects of noise (impact with vehicles etc.)
- Availability of equipment to reduce noise
- Extension of exposure (i.e. working double shifts)
- Reference to health surveillance findings
- **Peak Action Level**

140 dB Peak action level - – the employer must not expose anyone to noise levels of over this level as it will result in instantaneous damage to the ear.

Typical Noise Sources on Site (Source Electronic construction library)

Operator or Task	Mean TWA	SD	Range
Heavy-duty bulldozer	9	5	91-107
Vibrating road roller	97	4	91-104
Light-duty bulldozer	96	2	93-101
Asphalt road roller	95	4	85-103
Wheel loader	94	4	87-100
Asphalt spreader	91	3	87-97
Light-duty grader	89	1	88-91
Power shovel	88	3	80-93
Laborers	90	6	78-107
Crawler crane .35 ton Noninsulated cab	97	2	93-101
Crawler crane ,35 ton Noninsulated cab Insulated cab	94 84	3 3	90-98 80-89
Rubber road cane .35 ton Noninsulated cab Insulated cab	 84 74	 5 9	 78-90 59-87
Rubber wheeled crane, 35 ton Insulated cab	81	4	77-87
Truck-mounted crane	79	2	76-83
Tower crane	74	2	70-76

Noise Levels

Task	Avg. Noise Level (dBA)
Operating forklift	87
Cutting Wood	93
Cutting lawn	94
Installing trench conduit	95.8
Welding	98.4
Grinding	99.7
Chipping Concrete	102.9
Working near Generator	116

Example Professions at risk

Job Title	No. Audiograms taken	No. with Hearing Loss	Percentage with Hearing Loss
Crane operator	116	38	33
Welder	602	176	29
Carpenter	811	214	26
Engineering equipment operator	340	84	24
Wood worker	258	61	24
Motor vehicle operator	983	185	19
Electrician	495	92	19

f. NOISE CONTROL METHODS

Design - Design out noise sources.
Substitution - For example pressing instead of hammering.
Insulation - This provides a barrier to prevent noise energy passing through. High density, low stiffness materials are best e.g. lead, brick & concrete. Timber is a reasonable alternative.
Absorption - This principle is used to reduce noise energy reflected from surfaces (mineral wool/porous materials are best). This includes pipe lagging and ceiling baffles.
Damping - This can be used to reduce impact noise or to minimise noise radiating from vibrating surfaces. Springs and rubber mountings can be used, equally the surface of the material can be thickened as this makes it vibrate less, thus less noise is produced.

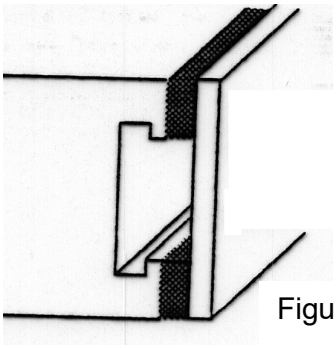


Figure 1

Isolation – This is where the noise/vibration is isolated from the surrounding surfaces, this could be the fitting of wooden pieces to a piece of metal which is vibrating, flexible pipes. Another form of isolation is where the machine is placed into a room or enclosure on its own (see Figure 1).

Noise Enclosures - Noise enclosures are commonly used to control noise exposure. They incorporate a combination of basic noise control principles such as insulation, absorption, damping and isolation. Basic features include a basic Insulating shell composed of heavy insulating material with an inner absorptive lining (see Figure 2).

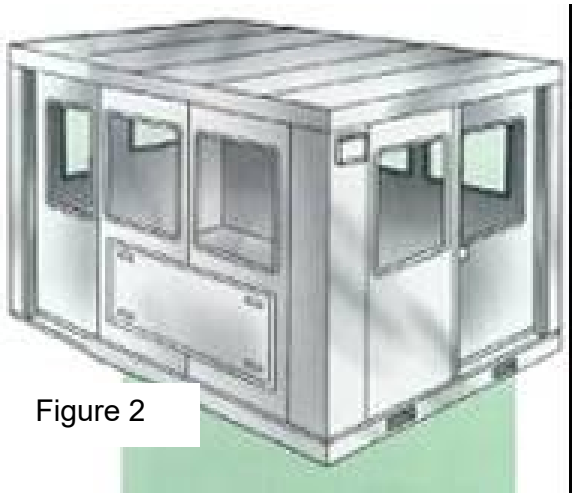


Figure 2

Acoustic Screens/Barriers - These can be effective when placed close to the source or close to the recipient. Good sound insulating materials provide the best screens. Reflecting surfaces should be lined with sound absorbing material.

Silencers - Silencers are used to reduce air noise by progressive absorption either by lining a duct with absorbing material, by use of baffled sections or by sophisticated reactive chambers.

Distance - Moving people away from noise sources can be a cheap and effective means of reducing exposure.

Sound Havens - These enclose the people rather than noise source.

Maintenance/Cleaning - Lack of maintenance is a frequent cause of unnecessary exposure.

Anti noise - A recently developed technique using noise interference to produce a sound wave which is the opposite of the sound. A plus and a minus cancel out the noise.

Administrative options

These can include:-

- Reducing the use of noisy equipment
- Purchasing of noise controlled new machinery
- Restricting access to noisy areas

h. HEARING PROTECTION

For circumstances where it is not reasonably practicable to achieve sufficient reduction of high noise levels, ear protection can be used to reduce employee's exposure.

There are essentially three types: **muffs, valves and plugs**. Selection depends on: The nature and level of noise; the protection afforded; compatibility with work and other protective equipment; fit; comfort and individual preference.

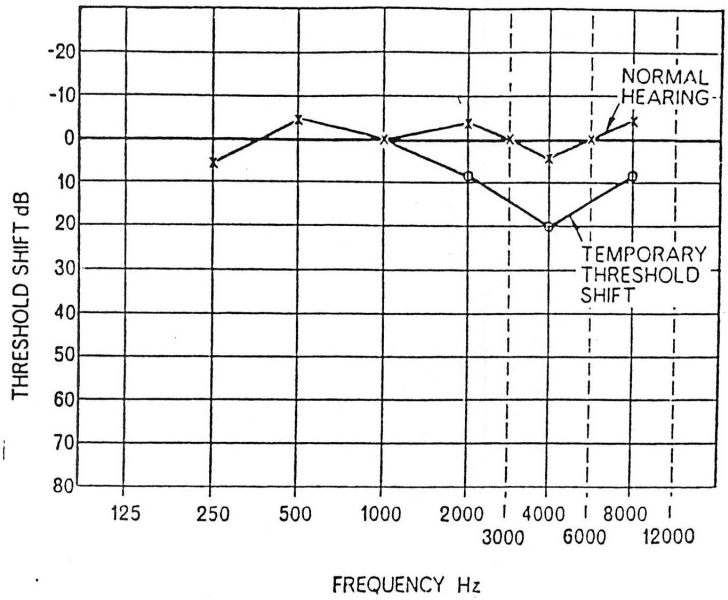
Hearing Protection Programme

It is insufficient both in terms of protection and legal duty to simply issue hearing protection. Where it is decided that ear protectors are necessary, an appropriate hearing protection programme should be introduced. Issues to be considered include selection of equipment; involvement of employees; education and training; clear instruction as to use

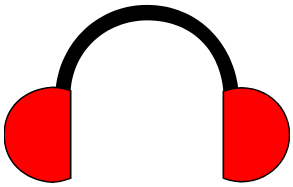
of equipment. Responsibilities need to be clarified on administrative details for issue, storage etc.

Supervision is important as well as reinforcement of training. Records should be kept and the programme timetable kept under review. Audiometry can provide a means of establishing just how well the programme is working.

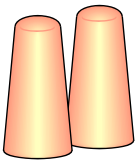
Typical Audiogram



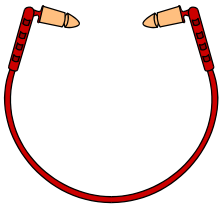
Ear Muffs



Ear Plugs



Ear Valves



		Octave-band centre frequency (Hz)							
		63	125	250	500	1000	2000	4000	8000
Mean attenuation	(dB)	7.4	10.0	14.4	19.6	22.8	29.6	38.8	34.1
Standard deviation	(dB)	3.3	3.6	3.6	4.6	4.0	6.2	7.4	5.2
Assumed noise protection value (APV) = mean attenuation - std.dev	(dB)	4.1	6.4	10.8	15.0	18.8	23.4	31.4	28.9

H	M	L
25	19	13

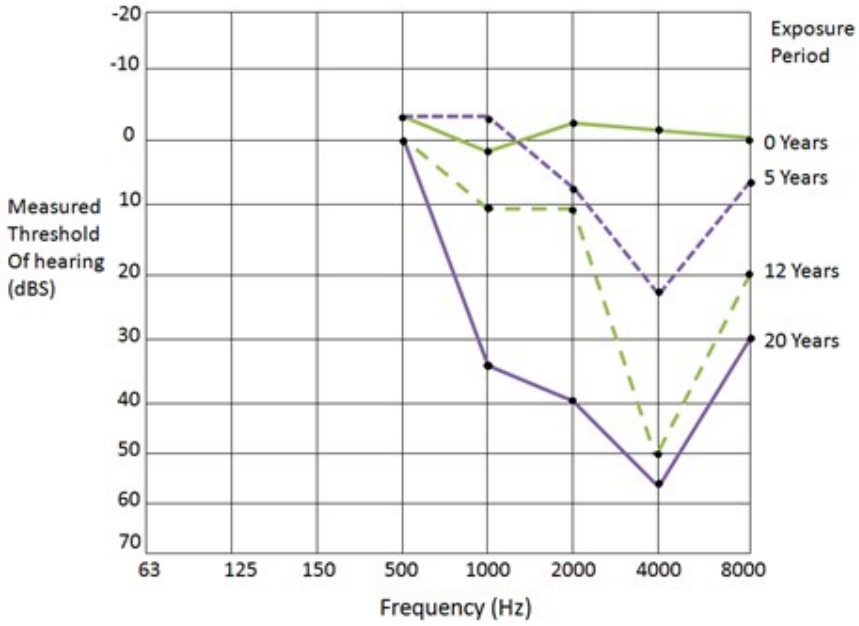
SNR
22

This is the type of information provided with each set or type of ear defenders, which shows how well they reduce noise at different tones. This type of ear defenders is best at 4000 Hz as they reduce the noise level by 31.4 decibels on average. The APV value must be used as this takes into account real life situations where individual ear canals are different sizes and the ear defenders may not fit perfectly.

The SNR is a single number reduction so if you only know the peak sound (dB (C)) then you can use this single figure. This is the amount of noise in decibels it will reduce the loudest sound by. For example if the peak noise is 112, this pair of ear defenders would reduce this by 22 decibels.

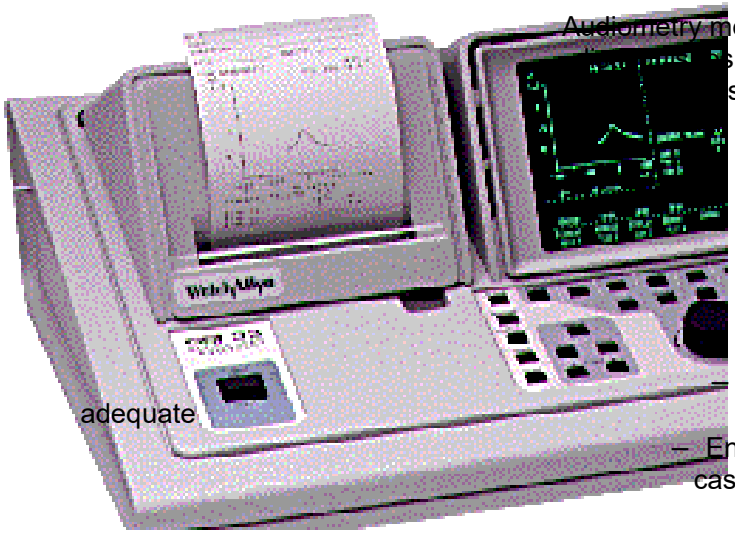
I. HEALTH SURVEILLANCE

- To measure hearing by sending tones to each ear through headphones
- To show how one's hearing compares to normal hearing based on age
- To determine whether hearing is being conserved
- To alert employee and employer for noise, age or medical-related hearing loss



Noise-induced hearing loss

Audiometry refers to the measurement of the hearing acuity of exposed individuals. Measurements are taken for each ear, in octave bands. Audiometry is now a requirement as part of health surveillance for those specifically at risk identified under the Control of Noise at Work Regulations.



Audiometry measures hearing loss and
s between presbycusis, noise-
ss and disease-related hearing

Audiometry allows:

– Establishment of baseline hearing levels (pre-employment or at start of employment)
– Check whether controls are adequate
– End of employment testing, in case of litigation

Audiometry limitations

– Not preventative
– May precipitate claims

– Doesn't identify source
– Possible inaccuracies
– Needs expertise and good facilities

9.2 THE RISKS OF VIBRATION

Hand Arm Vibration (HAV) is vibration transmitted from power tools such as road breakers and lawn mowers or by holding materials being processed by machines such as grinders.

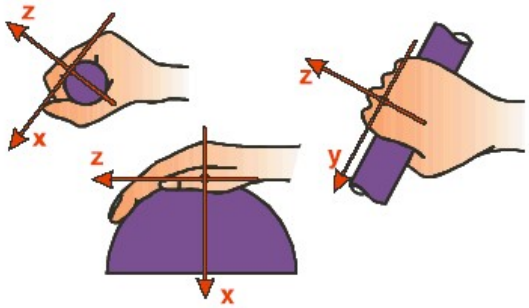
Regular and frequent exposure to high levels of vibration can be hazardous, infrequent use should not cause a problem.

The main symptoms are pain and numbness, loss of the sensation of touch, stiffness of joints, pins and needles and loss of grip. Vibration white finger can result from damage to the small blood vessels in the hand, Symptoms may make it difficult and painful to handle tools and equipment especially in cold weather.

The following types of equipment can expose operators to high levels of hand arm vibration:-

- Chain saws
- Abrasive wheels
- Angle grinders
- Hammer drills
- Hand held grinders or sanders
- Concrete breakers
- Powered lawnmowers & Strimmers

Most manufacturers are trying to reduce the amount of vibration their tools produce but is important that new equipment be assessed prior to purchase. This is to ensure that it is suitable for the job and that it does not present a vibration risk to its user. The lowest vibration level should be selected, this is normally measured in metres per second.



Whole body vibration can lead to nausea and sickness, this can be caused by driving vehicles such as excavators, bull dozers, reach trucks, tractors, lorries and rider operated mowers.

a. THE CONTROL OF VIBRATION AT WORK REGS 2005

Exposure limit values and action values
For hand-arm vibration -
(a) the daily exposure limit value is 5 m/s2 A(8);
(b) the daily exposure action value is 2.5 m/s2 A(8),

For whole body vibration -
(a) the daily exposure limit value is 1.15 m/s2 A(8);
(b) the daily exposure action value is 0.5 m/s2 A(8),

Suitable and sufficient assessment of the risks

This needs to be done by observation of specific working practices, referring to manufacturers guidance and if necessary a measurement of the vibration likely to be above the exposure action value or above an exposure limit value. Risk factors are the vibration level, how long the equipment is used for, posture of the user and the temperature of the environment.

Risk reduction Measures

This must include considering the elimination of the risk or reducing exposure to the lowest level possible. Where 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 by establishing and implementing a programme of organisational and technical measures appropriate to the activity.

The vibration levels used should be based on equipment the same or similar to that you actually use, this will include issues such as:-

- The type of equipment i.e. grinder
- The power sources (electric, pneumatic)
- The class of equipment
- Any built in anti vibration features
- The tasks the equipment is to be used for and the type of materials being worked on
- Any accessories being used.

The HSE guidance states a few typical vibration magnitudes which may be of assistance when starting the assessment.

Tool	Type	Vibration magnitude m/s^2
Road breaker	Typical	12
	Worst case	20
Hammer drill	Typical	9
	Worst	25
	Best in good operating conditions	6
Needle scalers	Modern	5-7
	Older	10 – 25
Angle grinder large	Modern	4
	Older	8
Chain saw	Typical	6
Orbital sander	Typical	7 – 10

There is not an automatic requirement to take vibration measurements, but where it is difficult to establish exposure and establish whether an action level is being exceeded then measurements may need to be taken. This is likely to be when:-

There is limited info to allow an accurate estimate of exposure
The need to check existing controls are actually effective
Use of vibration equipment for an unusual purpose where there is limit previous experience.

Once levels are assessed then the exposure periods needed to be estimated. Operators may often over estimate the time they are actually using a tool, as it is the “trigger time” or “contact time” not the time the job actually takes as there may be regular breaks and completion of other tasks which do not involve the tool.

Where use is continuous a stop watch or video may be used to observe for long periods. For intermittent use you may need to find out who many repetitions of a particular task are undertaken each day or week.

The daily exposure value is the daily exposure to vibration spread over a standard working day of 8 hours. (A(8) value) it is usually show as 5 m/s2 A(8) etc.

If worker works longer than 8 hours then if this is their estimated daily dose over eight hours their actual exposure will be higher.

The following table gives a range of vibration magnitudes together with corresponding times it would take to meet the exposure action value of (2.5 m/s2 A(8) and the exposure limit value of 5m/s2 A(8).

Vibration magnitude	**2.5**	**5**	**10**	**14**	**20**
Time to reach exposure action value in hours	8	2	.5	.25	8 mins
Time to reach exposure limit value	>24	8	2	1	.5 (30 mins)

b. Controlling the Risks

The risks of vibration must be assessed and steps taken to reduce and manage the risk which will include:-

- Providing suitable equipment – newer versions of equipment may vibrate less
- Maintaining and lubricating equipment
- Providing information to employees on the safe use and health risks involved
- Providing training to employees on the sources of hand arm vibration, the health effects, risk factors, how to recognise signs of injury and ways to minimise the risks.
- Providing health surveillance to those at greatest risk
- Minimise the time spent using high vibrating equipment – job rotation
- Design the job so it can be completed with good posture
- Replace vibration mounts before they are worn out
- Keep tools sharp
- Ensuring rotating parts are balanced on a regular basis
- Can extra anti-vibration mounts be fitted?
- Equipment with heated handles – to keep fingers warm and improve circulation
- Gloves to keep hands warm – helps to improve circulation

WHOLE BODY VIBRATION

Some machines which typically cause high levels of whole body vibration include:

- Mobile crushers
- Compactors
- Punching/hammering machines
- Construction vehicles
- Quarrying machinery
- Agricultural vehicles
- Forestry vehicles

There is likely to be a risk from WBV when one or more of the following occur;

- workers regularly drive off road
- the driver is jolted, shaken or lurches from side to side or backwards and forwards
- severe shocks or jolts are transmitted into the driving seat
- the manufacturer warns of WBV risks
- vehicles are used for work they were not designed for
- vehicle maintenance suggests that vehicle wear may be due to high levels of vibration or shock
- vehicles have damaged seats, or seat adjustments
- vehicles use unmade or poor quality roads for part of the journey or on worksites with poor surfaces
- workers sit or stand on a mobile or static machine when it is operating
- there is a history of back pain in the job
- employees report uncomfortable levels of vibration
- employees report pain in their lower back during and after exposure to WBV

Most exposure to whole body vibration at work is unlikely to cause back pain on its own unless there are very high levels of vibration or shocks over long periods of time on most working days. However, WBV exposure can aggravate back problems caused by other activities such as poor design of equipment, driver posture, bad driver technique, sitting for long periods, manual handling activities or climbing up and down into vehicle cabs.

Older people, those with back or neck problems, young people or pregnant women are more likely to be at risk of back pain and may be at higher risk from exposure to whole body vibration.

9.3 RADIATION

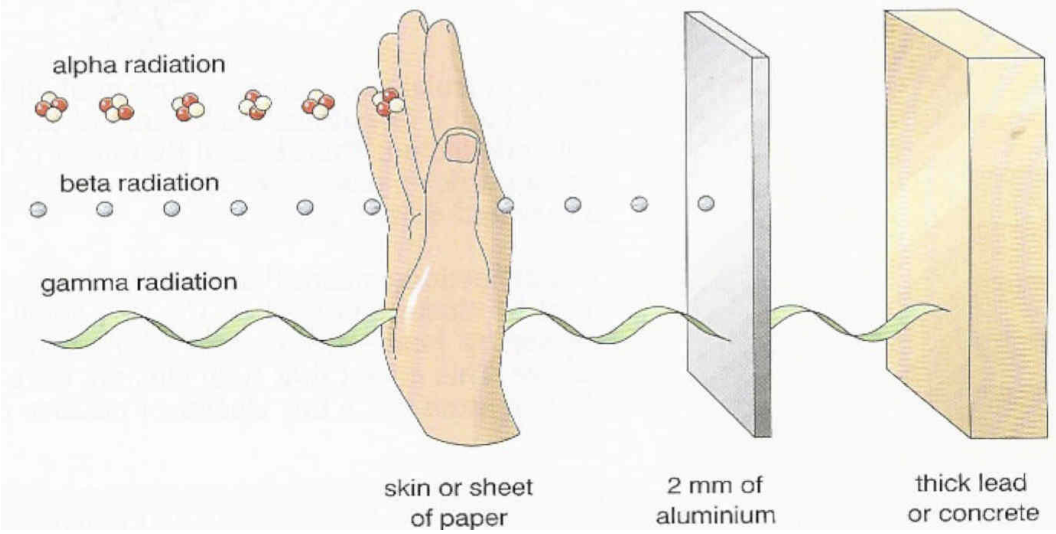
This is energy which is transmitted or emitted in wave or particle form, electromagnetic radiation. There are two main types: ionising and non ionising, with quite varying effects on living tissue.

Ionising is high power radiation which has the power to bring about changes in the very structure of matter, e.g. atoms. Radioactive isotopes are unstable and emit radiation. All ionising radiation has short wave lengths.

Non Ionising Radiation has long wavelengths and does not have the power to ionise matter.

a. IONISING RADIATION

Most elements are made up of stable atoms but there are some which are unstable, these are known as radioactive and they transform or decay to loose their energy. (e.g. uranium). During this process radiation can be emitted as either particles or waves. The smallest particle is the atom, this is made up of at least one Electron (-), Proton (+) & Neutron. The electrons orbit around the neutron and proton which are in the centre of the atom. Nuclear atoms are positively or negatively charged, stable atoms are neutral.



Alpha particles – these are relatively slow moving and can penetrate only into the surface of the skin. As such having skin protection can reduce the risk, however if these particles are inhaled or ingested into the body they can be harmful because their effects are more concentrated in one area.

Beta Particles – these are high speed electrons which can penetrate into the body to around 5mm in depth.

Gamma Rays – these are small packets of energy which are emitted in waves, they are high powered and can pass through a human body and most other materials. These are often used in non-destructive testing of components as they have the ability to penetrate through and identify whether there are any faults below the surface.

X rays – These rays are produced by high speed beta particles and can also penetrate through the body.

Radon Gas - Radon-222 is one of the decay products of uranium-238 which occurs naturally in many rocks and soils. Radon is a gas and high levels within the air in soil are possible, especially if the local **geology contains rocks** with higher levels of uranium. **Granite** tends to have high levels of uranium and so radon levels are particularly high in some granite areas within the UK.

Radon can seep out of the ground and build up in confined spaces. High concentrations can also be found in buildings because they are usually at slightly lower pressure than the surrounding atmosphere and so tend to suck in radon (from the soil) through cracks or gaps in the floor. Buildings with cellars and basements are at specific risk.

Most radon gas breathed in is immediately exhaled and presents little radiological hazard. However, the decay products of radon (radon daughters) are solid and are themselves radioactive. These decay products attach to atmospheric dust and water droplets which can become lodged in the lungs and airways when breathed in. They are thus likely to irradiate the respiratory tract. Some radon daughters are alpha emitters and will cause significant damage to the cells of the respiratory tract. Radon gas is measured in Becquerels per cubic metre, Bq/m 3 (i.e. air activity concentration).

Radon is now recognised to be the second largest cause of lung cancer after smoking and is estimated to cause 2,500 cancer related deaths in the UK every year. Radon contributes by far the largest component of background radiation dose received by the UK population.

Radon is a radioactive gas that comes from the natural decay of uranium found in nearly all soils. It typically moves up through the ground and into the air entering buildings through cracks and other holes in the foundations. Any home, workplace or school may have a radon problem including new or old, well-sealed or drafty homes or buildings with or without basements.

Radon gas from the soil produces the highest levels, however, in a limited number of cases radon can enter a building through the water supply.

Radon enters a building through:

- Cracks in solid floors
- Construction joints
- Cracks in walls
- Gaps in suspended floors
- Gaps around service pipes
- Cavities inside walls
- The water supply

It's estimated that nearly 1 out of every 17 buildings in Europe harbour elevated levels of radon gas. Whilst radon can be a particular problem in certain high risk areas elevated levels can be found in almost any building in almost any area.

ILL HEALTH EFFECTS

Ionising radiation can have varying effects on the individual exposed this can include nausea, vomiting, leukaemia, cell destruction, cancer and ultimately death.

Radiation also has the ability to effect an individual's offspring, high exposure can lead to damage to reproductive cells, change in sex ratio of off spring and an increased risk of miscarriage.

The amount of radiation absorbed into the body will depend on the distance from the source, its strength and the adequacy of any shielding or control measures. Although there is great concern about the risk of ionising radiation most people will receive a higher dose from medical treatment and natural sources (radon gas) than they will from the discharges from a nuclear power plant.

There are a range of different scales used to measure radiation, these include the Curie, Becqueral, Gray and Sievert.

OVERVIEW OF IONISING RADIATION REGULATIONS 2017

PRINCIPLES

- every practice must be justified
- all exposures as low as reasonably possible
- the sum of the dose must not exceed certain limits

Authorisation – This must be sought to carry out certain processes where ionising radiation will be used. E.g. medical treatment, processing of products

Notification - Except small low risk sources, in all instances of using Ionising radiation the employer must notify the HSE. (nature, source, strength). Any changes must also be notified.

Consents – these may be needed for mobile ionizing radiation sources.

Risk assessment – Before new activities begin – to prevent accidents, limit consequences and give sufficient information, instruction and training to staff.

Restrict exposure - All reasonably practicable steps to restrict employee exposure

Engineering controls :

- shielding
- containment
- minimise contamination
- systems of work
- ventilation
- safety features & warning devices
- PPE

Employees must take reasonable care & Use PPE provided.

Maintenance & Examination of engineering control and PPE.

No eating, drinking or smoking in controlled areas

Dose limitation - Dose Limits - 20 m Sv / Year (Other limits for lens of eyes, skin & abdomen, trainees, women of reproductive age and members of the public)

Co-operation between employers- where employees using radiation are from different organisations (i.e. several NHS trusts all sharing one X-Ray unit)

Designated Areas - Controlled Area more specific controls are required.

- Access to classified workers only
- Restrict access unless under written system

Key People

Classified worker – This is a person who may receive a dose of greater than 6 milli sieverts in a year or someone who may be subject to over 30% of any dose limit.

Radiation Protection Adviser – to oversee arrangements within the organisation

Radiation Protection Supervisors – for local areas/departments to co-ordinate safe working practices.

Construction Related Sources and Control of Ionising Radiation

1. Smoke Detectors

Where possible non-radioactive detectors should be used in preference to those containing radioactive material. Smoke detectors containing radium-226 must not be used. Where smoke detectors containing radium are discovered, the RPA should be consulted forthwith for advice on their removal and disposal.

Disposal of scrap smoke detectors

Where possible establishments should return scrap or defective smoke detectors to the manufacturer. Where this is not possible, advice on a suitable disposal route should be sought from the RPA.

Where smoke detectors are contained within an equipment they are to be removed before the equipment is disposed off. Smoke detectors units may be dismantled on the advice of the RPA, provided that the unit containing the radioactive source is not breached.

2. Radiation Safety Arrangements for Site Radiography

Many aspects of radiation safety are common to industrial radiography in enclosures and site radiography. Therefore, the following aspects of radiography should be considered:

1. Classification of personnel.
2. Personnel Monitoring.
3. Medical Surveillance.
4. Training and Instruction.
5. Radioactive sealed sources and their containers.
6. Maintenance of equipment.
7. Unexpected radiation events.
8. Loading and Unloading of radioactive sources.
9. Transport of sealed sources.
10. Disposal of sealed sources.

Prior to radiography the following information should be supplied by the person responsible for the non-destructive testing (NDT) team:

a. Prior notification and permission for the NDT source or x-ray machine to be bought on-site.
b. Name of the RPA/RPS and how they can be contacted on or off-site.
c. Places where work will be carried out including dates and description of work procedures/instructions.
d. Details of sources or X-ray to be used.
e. Description of monitoring procedure.
f. Risk assessments and contingency plans.
g. Health and Safety policy statement containing radiography local orders and procedures for the radiographers.

Where X-ray machines are used, the following requirements are to be fulfilled:

a. The beam filtration on the x-ray must be equivalent to at least 2mm of aluminium.
b. The leakage rate from the X-ray tube housing is not to exceed 2.5 mSv/h at 1 m from the focal spot at the maximum rated voltage and current, and for pulsed X-ray tubes at the maximum pulse rate.
c. The lengths of cables from the X-ray machines are to be long enough to enable the control panel, whenever practicable, to be outside the controlled area.
d. The X-ray set is to be provided with a means of collimation to restrict the radiation beam to the minimum size necessary for the work.
e. The equipment must be electrically safe.
f. The equipment is provided with a means of preventing unauthorised use (e.g. key operated switch).

Radioactive Sealed Sources

Radioactive sealed sources used are to be provided with a suitable means of collimation to restrict the extent of the radiation beam to a minimum necessary to undertake the work and a key operated switch to prevent unauthorised use.

Warning Signals

Adequate warning of the impending or actual presence of radiation is to be given to all persons within or approaching the marked off area during site radiography by appropriate visual or audible signals.

The duration of the pre-exposure warning alarm is to be sufficient for anyone within the controlled area to walk clear.

3. Portable Nuclear moisture/density gauges

Gauges usually have two radioactive sources – typically a Cs (317) gamma source and a Am/Be (241) neutron source. When the gauge is not in use, some shielding of the source is provided by the body of the gauge; however, the gamma source can be projected downwards out of the base of the gauge. The neutron source remains fixed within the body of the gauge.

Radiations levels around the gauge depend on:

- The type and activity of the sources.
- The mode of operation of the gauge, since the gamma source may be projected out from the base of the gauge.
- The amount of extra shielding.
- The direction the gauge is pointing.

Radiation levels are highest near the source and the base plate, and decrease with distance from the gauge. Damage to the gauge or poor work practices may lead to people receiving high radiation exposures, which can potentially cause harmful effects to their health. Nuclear density gauges have been involved in several incidents leading to an increased risk of radiation exposure for operators and other people. These have included gauges being crushed by site vehicles, loss or theft, or failure of shutters.

Notification and Consultation with RPA

There is a need to inform the HSE in writing 28 days in advance of the first time you work with ionising radiation, i.e. the gauge. The RPA needs to be consulted for assistance in addressing the issues relating to using the gauge.

Selection, Use and Maintenance of Portable Monitoring Instruments

IRR 17 requires equipment to be properly maintained so that it remains suitable for the purpose for which it was intended. All instruments have strengths and weaknesses and require reasonable care in use. Users should:

- Keep the instrument clean; repair minor damages as soon as possible; where appropriate keep the instrument in a well-fitting case.
- Regularly check switches, screw connections, cables, detector foils, and heads. Probes and their connecting cables are fragile and require careful handling.
- Check battery terminals and ensure adequate power to prevent false reading.
- Avoid temperatures extremes/rapid changes. Condensation can produce electronic failure, and ion chamber are particularly susceptible.
- Do not make any adjustments to instruments unless suitably qualified and trained.

The RPA should be consulted in all aspects of care, maintenance and testing of monitoring instruments.

B. TYPES OF NON IONISING RADIATION

ULTRA VIOLET

This form of radiation lies midway in the spectrum between non ionising and ionising radiation and as such has both capabilities. It is the radiation associated with the blue light seen from electric arc welding or sun lamps. The main parts of the body at risk are the eyes (retina, cornea & lens) and the skin.

Sources:

- Electric arc welding
- Sun light

- Mercury lamps

Injuries:

Cornea – photoketatitis – pains and spasms in the eye
Lens – cataracts
Retina – burns

INFRA RED

This is the heat given off from processes which can heat the body's temperature, the eye again is at risk as it does not have an effective way of cooling itself. Injuries include cataracts, retina damage and burns.

Sources:

- Sunlight
- Welding
- Glass blowing

Injuries: Lens – cataracts, Retina damage, Skin Burns, Heat exhaustion & Dehydration

LASERS

This is the "Light Amplification by the Stimulated Emission of Radiation" or laser for short. Lasers are a concentrated beam of light and can be produced from UV, IR and visible light. As such not all lasers are visible, these can be very dangerous if not controlled.

Lasers are classified according to the danger they present (BS7192). Low power lasers can damage the eye but blinking will give some protection, high power lasers will damage the eye and blinking affords little protection – as such lasers should never be set at eye level.

Sources - Surgery/ CD players/ Pointing devices / Printers

Injuries: Burns to skin and eyes

RADIO WAVES AND MICRO WAVES

These are waves which have the ability to heat tissue, they can also cause cataracts and tissue damage.

Sources - Radio Transmitters/ RADAR / Industrial Plastics sealing/ Cooking

GENERAL CONTROLS FOR NON IONISING RADIATION

- Personal Protective Equipment – goggles with suitable filters, face shields, gloves, sun block
- Reduce exposure times
- Contain source – maintenance of seals
- Shielding and non reflective surfaces
- Increase distance from source
- Signs – lasers in particular

- Limit access

Radiation Exercise Answer

Radiation Type	Sources	Possible injuries	Controls
Alpha / beta particles	Radio active waste – nuclear power	Cell destruction, radiation sickness, diarrhoea, cancer, leukaemia	Minimise source strength, safe systems, limit access, reduce exposure time, PPE, training, sealed sources
Gamma Rays	Medical photography Testing of metal components	"	"
X Rays	Radiography, Dentists	"	Lead aprons, training, isolation, monitor exposure, PPE
Ultra Violet	Mercury lamps Sun lamps The sun Electric Arc Welding	Skin cancer Cornea damage Arc Eye Premature aging of skin	Photo electric monitors, film badges, PPE, protective cream, reduce exposure time, Goggles, visors.
Infra red	Molten glass Oxyacetylene welding Furnaces Sunlight	Retina damage Cataracts Burns Heat exhaustion Dehydration	PPE – body protection Increase distance Work Breaks Ventilation
LASERS	Medical processes, cutting	Burns Eye damage	PPE, Limit access, Safety signs No lasers at eye level, PPE
Radio waves	Radio & TV transmitters Radar Telecom Cookers	Heating of tissue Cataracts Nervous system damage Tissue damage	Isolate Testing of equipment Training PPE Increase distance

9.4 DEALING WITH THE RISKS OF STRESS

Stress is becoming the biggest cause for concern due to the millions of days lost from work being recorded every year. Stress is in fact not an illness but a reaction to certain situations. Different people can accept different amounts of stress, what one person may find stressful another may readily accept as part of their role. Stress is a normal reaction to a situation, however, adverse levels of stress can affect human performance and health.

Job factors can contribute towards stress levels, these can include poor working conditions, working long hours or doing repetitive work. If the person is not clear about their role, its aims and objectives, this can make completing a task to the accepted standard difficult. Pressure outside work can also prove stressful, issues such as changing jobs, moving house and Christmas can be some of the most stressful activities people find themselves involved in.

a. What is stress?

The stress response is a package of physiological changes which have the general effect of preparing us for action. The package is only harmful if it continues for too long. What makes an individual a bad stress risk is not so much the size of their initial response to stress as the fact that their nervous system is slow to return to its resting, unstressed state.

b. What causes stress?

Anything and everything which forces us to adapt, react or make any significant adjustment is a stressor i.e. a source of stress, according to the definition used by doctors and psychologists. Thus a horror film is a stressor and so is a passionate kiss, so is a sudden change of outside temperature and a visit to the dentist. 'Stress' is just about the most imprecise, general term in medicine.

c. Is stress always bad for us?

Not in small doses, when it can serve to gee us up and give us an edge; for example, when we have to speak in public.

d. Who is at risk?

First the bad news. In 1983, Britain overtook Finland as the country with the highest rate of death from heart disease. The number of heart disease related deaths has been increasing since the 1970's. Since coronary heart disease (CHD) is a stress related condition, being born in this country clearly isn't a recipe for a stress-free existence.

This is probably partly to do with our eating habits. But psychologists believe it is also partly the result of the way we organise work in this country. Certain approaches to work increase the potential of work to act as a stressor - whether they result from an individual's own personality or are imposed by management attitudes. Work environments which are excessively competitive and/or time conscious are the most dangerous.

e. Recognising the symptoms of stress

Your own body functions as an effective early-warning system. The most important physical warning signs are: chest pains, diarrhoea persisting for more than a few days, headaches, indigestion, insomnia, palpitations and tiredness.

There are also mental signs that the pressure is too great: inability to relax properly at any time, irritability and short-temper, inability to concentrate, impulsive behaviour, inability to finish tasks which you have started, uncontrollable emotions, for example crying, over-reacting to small things.

f. What can be done about stress?

It's not easy to change your essential personality. And with jobs so scarce, even a stressful one may be better (and less stressful) than no job at all. But that doesn't mean there's nothing to be done about the stress in your life. If you are experiencing problems at work then you need to ensure that you report them in some way to your employer, your employer can only takes steps to support you if they are aware of the situation. There have been civil claims taken to court by injured employees which have failed because they have not reported any problems to their employer, the employer can only take reasonable steps to protect employees but to do this the onus must be on the employee to report the situation.

g. Here are six psychologically approved steps you can take to improve the situation:

- Set goals and priorities. There isn't time to do absolutely everything you'd like to do. Do the essentials which only you can do, delegate as much as you can, then force yourself not to think about the things which aren't going to get done. Making lists is often a simple way to reduce pressure.

- Do only one thing at a time.

- Don't expect perfection - from yourself or from other people. It's an impossible dream which will only make you feel frustrated and resentful.

- Make yourself take breaks, even when you're working to a deadline.

- Spend some time by yourself each day doing nothing, even if it's only for five minutes.

- Fight stress by taking exercise, relaxing, laughing and doing anything you actively enjoy.

h. The HSE have published a number of publications designed to assist employers in managing these risks, a number of stress standards have been developed to give guidance on specific areas such as:-

- Workload & demands
- Control & support
- Relationships
- Clarify role
- Organisational change
- Recruitment & selection
- Work related training
- STRESS awareness
- Rehabilitation
- Counselling/employee assistance

WORKLOAD & DEMANDS

Includes issues like workload, work patterns, and the work environment
The standard is that:

- Employees indicate that they are able to cope with the demands of their jobs; and systems are in place locally to respond to any individual concerns.

What should be happening / states to be achieved:

- The organisation provides employees with adequate and achievable demands in relation to the agreed hours of work
- People's skills and abilities are matched to the job demands
- Jobs are designed to be within the capabilities of employees and
- Employees' concerns about their work environment are addressed

CONTROL

How much say the person has in the way they do their work. The standard is that:

- Employees indicate that they are able to have a say about the way they do their work and
- Systems are in place locally to respond to any individual concerns

What should be happening / states to be achieved:

- Where possible, employees have control over their pace of work
- Employees are encouraged to use their skills and initiative to do their work
- Where possible, employees are encouraged to develop new skills to help them undertake new and challenging pieces of work
- The organisation encourages employees to develop their skills
- Employees have a say over when breaks can be taken; and
- Employees are consulted over their work patterns

SUPPORT

Includes the encouragement, sponsorship and resources provided by the organisation, line management and colleagues

The standard is that:

- Employees indicate that they receive adequate information and support from their colleagues and superiors and
- Systems are in place locally to respond to any individual concerns

What should be happening / states to be achieved:

- The organisation has policies and procedures to adequately support employees
- Systems are in place to enable and encourage managers to support their staff
- Systems are in place to enable and encourage employees to support their colleagues
- Employees know what support is available and how and when to access it
- Employees know how to access the required resources to do their job and they receive regular and constructive feedback

RELATIONSHIPS

Includes promoting positive working to avoid conflict and dealing with unacceptable behaviour.

The standard is that:

- Employees indicate that they are not subjected to unacceptable behaviours, e.g. bullying at work and
- Systems are in place locally to respond to any individual concerns
  What should be happening / states to be achieved
- The organisation promotes positive behaviours at work to avoid conflict and ensure fairness
- Employees share information relevant to their work
- The organisation has agreed policies and procedures to prevent or resolve unacceptable behaviour
- Systems are in place to enable and encourage managers to deal with unacceptable behaviour and
- Systems are in place to enable and encourage employees to report unacceptable behaviour

ROLE

Whether employees understand their role within the organisation and whether the organisation ensures that the worker does not have conflicting roles.

The standard is that:

- Employees indicate that they understand their role and responsibilities
- Systems are in place locally to respond to any individual concerns

What should be happening / states to be achieved:

- The organisation ensures that, as far as possible, the different requirements it places upon employees are compatible
- The organisation provides information to enable employees to understand their role and responsibilities

- The organisation ensures that, as far as possible, the requirements it places upon employees are clear and
- Systems are in place to enable employees to raise concerns about any uncertainties or conflicts they have in their role and responsibilities

CHANGE

How organisational change (large or small) is managed and communicated in the organisation.

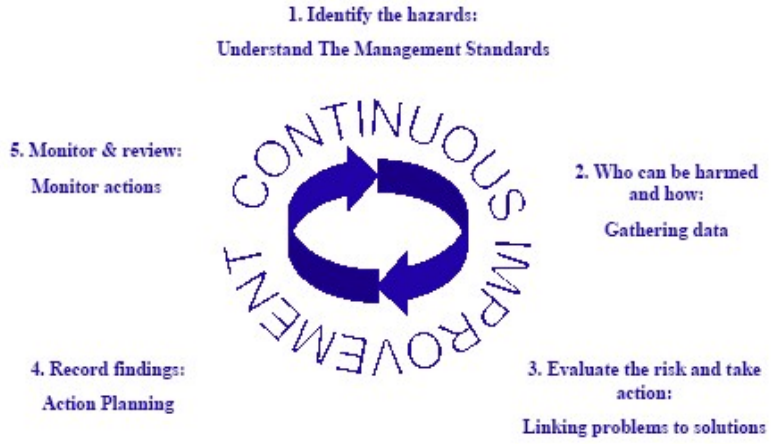
The standard is that:

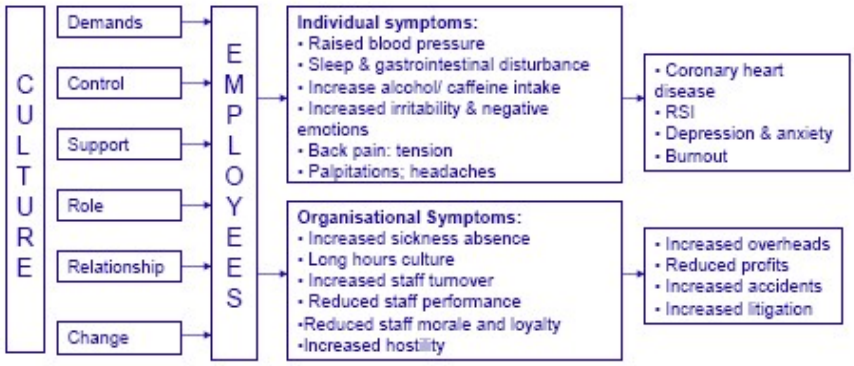
- Employees indicate that the organisation engages them frequently when undergoing an organisational change and
- Systems are in place locally to respond to any individual concerns

What should be happening / states to be achieved:

- The organisation provides employees with timely information to enable them to understand the reasons for proposed changes
- The organisation ensures adequate employee consultation on changes and provides opportunities for employees to influence proposals
- Employees are aware of the probable impact of any changes to their jobs. If necessary, employees are given training to support any changes in their jobs
- Employees are aware of timetables for changes
- Employees have access to relevant support during changes

Information Sources: HSE guidance and standards.





Palmer, Cooper & Thomas (2004)