Document no.

This document was produced ahead of the major procurement of Crossrail works and is not intended to be revised. The general principles remain but some legislation has now changed (notably CDM 2015 replacing CDM 2007).

Healthy By Design

A Guide for Crossrail Design Teams

A STATE OF MIND

Contents

1. Introduction

1.1 This guide will aid healthy design choices enabling designers to meet legal responsibilities, work in accordance with Crossrail Ltd policies and ethical codes of conduct as required by bodies such as RIBA, ICE, etc.

1.2 The guide aims to be a practical tool as well as providing detailed background information. For these reasons the document is divided in to a summarised practical section, supported by more in depth information.

1.3 Section Three of this guide contains specially designed toolkits to assist designers in the risk management process and is a valuable resource for the designer.

1.4 The document is divided as follows:

- Section Two: Quick Guide: Key messages for each topic section.
- Section Three: Designers' Toolkit: Practical aids to assist in Design Risk Assessment.
- Section Four: Additional information: Detailed background information for each section topic, including web resources.

2.0 Quick Guide

2.1 Designing out risks – why bother?

Key messages

It is a legal requirement

Failure may involve a fine and a criminal record and in the worst cases, prison. The designer has duties under the:

- Health and Safety at Work etc. Act 1974, and;
- The Construction (Design & Management) Regulations 2007.

CDM specifies the following duties for designers for all projects:

- Eliminate hazards and risks through design;
- Provide information about residual risks.

Where projects are notifiable to the Health and Safety Executive (HSE) (projects lasting more than 30 days or utilise more than 500 person days of construction work), designers must also:

- Check that the client is aware of their duties and that a CDM co-coordinator has been appointed; and
- Provide information needed for the health and safety file which is passed-on to the client at the end of such a project.

It's the right thing to do

Lives should not be lost or ruined through earning a living. Designers are also bound by the relevant code of ethics in relation to the chartered bodies to which they belong (i.e. RIBA, ICE).

It will save you money

From the employer running a business to the taxpayer's public purse, good health (and safety) management saves money. Accidents, ill health and disease cost businesses and the taxpayer £ millions each year.

It will make the project more efficient

Efficiency is a by-product of good design. As well as reducing the chance of an accident or ill health, consideration of health (and safety) can enhance and improve efficiency to a point where people will often wonder why it was not completed in this way in the past. For example, the Elliot Method for piling.

It's Crossrail Ltd policy to apply best practice to reduce ill health through design for all of the reasons above.

In 2008/9 1.2 million people were suffering from an illness they believed was caused or made worse by their work.

It is estimated that 47% of accidents that have occurred in the construction industry in recent years could have been prevented by design.

Essential web links:

http://www.hse.gov.uk/construction/healthrisks/index.htm

http://www.hse.gov.uk/construction/cdm responsibilities.htm

http://www.hse.gov.uk/construction/cdm/designers.htm

2.2 Designers Dilemma – Cost vs Risk

Key messages

Designers' earliest decisions fundamentally affect the health and safety of construction work.

Consideration has to be given to those involved in construction, maintenance, repair, cleaning, refurbishment and future demolition of all or part of a structure as well as the health and safety of the future users of the workplaces they have designed.

Based on the information available when the design is prepared or modified, designers must (so far as is reasonably practicable and taking into account other design considerations) eliminate hazards where possible, and reduce foreseeable risks arising from hazards that cannot be eliminated. **The greater the risk, the greater the weight that must be applied to eliminating or reducing it.**

CDM does not require zero risk designs as this is impossible, but designs should be able to be constructed, maintained, used or demolished safely.

Where significant risks still remain, designers should provide information with the design to ensure that the CDM Co-ordinator, other designers and contractors are aware of these risks and can take account of them.

Reducing risk to a degree which is as low as is reasonably practicable ('ALARP') is a common phrase. This requires employers or those in control to make considered judgements to balance operational risk against the cost of management. The completion of a risk assessment is required to achieve this aim. Refer to Toolkit in section three and Additional Information in section four for advice on this topic.

Designers can decide upon appropriate control measures based upon the following basic hierarchy:

Eliminate
(first choice)

Reduce

Isolate

Control
(last resort)

The HSE will test the overall management of the project as well as individual design decisions when considering whether risks have been reduced to the lowest level reasonably practicable.

2.3 The Unique Challenge of Health

Key messages

Ill health

- **1.2 million** people who worked during the last year were suffering from an illness (long standing as well as new cases) they believed was caused or made worse by their current or past work. **551,000** of these were new cases.

Working days lost

- **29.3 million** days were lost overall (1.24 days per worker), 24.6 million due to work-related ill health and 4.7 million due to workplace injury.

Source:
http://www.hse.gov.uk/statistics/overpic.htm

There is a greater loss of life and more debilitation caused by occupational disease than from accident or injury.

- The total number of mesothelioma deaths has increased from 153 in 1968 to 2156 in 2007.

- The number of cancer registrations in total from the six kinds of cancer which are attributable to occupational causes is estimated to be around 13,300 in 2003 (15% among women).

Occupational disease remains prevalent in the global community because it is seen to be difficult to manage. This is true of UK industry and commerce, and even more so in the construction sector. There are a number of reasons for this:

- Occupational 'health' has traditionally been seen as the domain of doctors and nurses: rather than a management prevention issue;
- Occupational diseases often have a long latency period – that is – the ill health occurs a long time after the exposure to hazardous substances, noise, vibration or repetitive actions;
- Interventions to prevent exposure are not immediately obvious;
- The 'dangers' can go undetected. For example, harmful silica dust that is produced when cutting or grinding stone and concrete cannot be seen by the naked eye;
- Employers are not always well informed when selecting suitable control measures and;
- Employers are often unaware of the specialist advice required (or who to contact for the advice) to carry out suitable and sufficient risk assessments.

With these challenges present in the construction sector, there are huge numbers of people who are forced to leave their trade due to ill-health or die prematurely due to disease. As an illustration of this, it is estimated that **10% of skilled bricklayers leave the industry every year due to dermatitis** caused by working with cement.

2.4 Health Hazards in Construction

Key messages

There are four key health hazards addressed in the guide:

2.4.1 Hazardous Substances
Ilness and disease caused by exposure to hazardous materials and biological agents:

2.4.2 Noise
Noise-induced hearing loss and tinnitus:

2.4.3 Vibration
Hand-arm vibration syndrome (HAVS), Vibration White Finger (VWF) caused by exposure to hand-arm and musculo-skeletal injuries caused by exposure to whole-body vibration;

2.4.4 Manual Handling
Musculo-skeletal injuries caused by manual handling and repetitive tasks.

In order to design out health risks relating to exposure to these hazards, a designer must be able to:

- **Recognise** hazards
- **Evaluate** risk levels
- **Eliminate** sources of danger
- **Control** residual risks

At the start of the design process it is vital that potential hazards are recognised. Designers need to have a basic understanding of what hazards are present and how to do an assessment of risk. Once health related risks associated with the construction work have been assessed designers should look to design out these risks by eliminating them where possible. Not all risk can be eliminated however the level of risk should be controlled to an acceptable level. (Refer to section three Designers' Toolkit and section four Additional Information of this guide).

When it is not possible to eliminate the hazards, it is essential that this is communicated to the contractor and others involved in the project. Designers must supply relevant information on residual hazards. This can be communicated through meetings, notes on drawings and must be included in the Health and Safety Plan. In accordance with the Construction Design and Management (CDM) Regulations 2007 the Principal Contractor has to produce a construction phase plan outlining the key arrangements to ensure that the work is carried out safely.

2.4.1 Hazardous Substances

Hazard And Risk

Hazard is the potential for a substance or process to cause harm:

- Hazard data for the substance and classification of the substance (e.g. harmful, toxic, corrosive).

Risk is the likelihood and severity of harm occurring:

- Quantity involved;
- Method of application (hand applying, spraying, remote pumping);
- Duration of exposure;
- Work environment (enclosed area, outside, etc); and
- Exposure prevention controls in place (for example, Local Exhaust Ventilation (LEV), Personal Protective Equipment (PPE), good hygiene practices (hand & face washing facilities).

Hazardous substances:

Substances that are hazardous to health take many forms, from proprietary chemicals to by-products such as dusts and vapours.

2.4.2 Noise

Noise-induced Hearing Loss (NIHL) and Tinnitus

Regular, frequent exposure to loud noise can permanently damage a person's hearing. This is most likely if high noise exposure is a regular part of the job.

Noise can also be a safety hazard at work, interfering with communication and making warnings harder to hear.

Hearing loss, can be temporary or permanent.

People often experience temporary deafness after leaving a noisy place. Hearing usually recovers within a couple of hours but temporary deafness should not be ignored it is a sign that continued exposure to loud noise could permanently damage your hearing.

2.4.3 Vibration

Hand-Arm Vibration (HAV)

Hand-Arm vibration is vibration transmitted from a work activity into someone's hands and arms. This occurs when:

- Operating hand-held power tools, e.g. power drills;
- Using hand-guided equipment, e.g. a vibrating compactor; or
- Holding materials being processed by a machine.
- Regular and frequent exposure to hand-arm vibration can lead to permanent ill health. This is most likely if contact with a vibrating tool or work piece is a regular part of someone's job. Occasional or low-level exposure is unlikely to cause ill health. The effects of Hand-Arm Vibration can mean that even the simplest of jobs (tying shoelaces, buttoning clothes) can be almost impossible to accomplish unaided.

2.4.4 Manual Handling

Musculo-Skeletal Disorders

The term musculoskeletal disorder (or 'MSD') refers to an injury that affects the muscles, joints, tendons or spinal discs. Such injuries are most likely to affect the back, shoulders and neck, and legs. Symptoms may include pain, aching, discomfort, numbness, tingling and swelling.

Workers who suffer from MSDs may have a reduced ability to do a task, as well as pain or discomfort, and the most serious cases can result in permanent disability. An ache or discomfort can, unless spotted and dealt with effectively, turn into a long-term or 'chronic' injury.

3.0 Designers Toolkits

3.1 Four Stages of Design

3.1.1 The Design Process

Occupational health (as well as safety) should be an integral part of the design process. Remember to take a 'whole-life' approach when assessing risks - think about the maintenance, use and eventual demolition of the structure.

The competent designer should:

- Identify significant occupational health risks that arise from a design;
- Eliminate the hazards so far as is reasonably practicable;
- Adjust designs, where practicable to minimise health risks ;
- Prioritise and assess health risks, and reduce them where possible; and
- Provide adequate information about any significant risks associated with the design

3.1.2 Identify Health Hazards

To identify hazards effectively, designers need to know about the materials and processes that are likely to be used in the construction, maintenance, use and eventual demolition of a structure.

If you don't have enough knowledge or experience of how to deal with a health hazard, you will need to consult others.

As well as considering the properties of a material, designers also need to know how it is likely to be used. For example, a hazardous substance or heavy component may pose a greater risk if it is handled or used in an enclosed area. Some health risks can be managed more effectively if a material or component is assembled in a factory environment, rather than on site. Off-site assembly can also improve quality.

Sometimes it makes sense to specify a material with a relatively high application risk due to the lower risks of maintaining the product over its lifespan - designers should take a 'whole-life' approach to risk management and design.

3.1.3 Eliminate Health Hazards and Assess Risks

Eliminating health hazards should be an integral part of the design process.

At routine design reviews, designers should confirm that health hazards have been properly addressed.

http://www.architecture.com/Files/RIBAProfessionalServices/Practice/OutlinePlanofWork(revised).pdf

Make sure that when eliminating one health hazard new and possibly more significant hazards are not created.

Risk assessments should be systematic and structured, and solutions should be selected on the basis of the risk control hierarchy as defined in the Management of Health and Safety at Work Regulations 1999.

Management Of Health And Safety At Work Regulations 1999

Schedule 1

Regulation 4

Where an employer implements any preventive and protective measures he shall do so on the basis of the principles specified in Schedule 1

General Principles Of Prevention

(This Schedule specifies the general principles of prevention set out in Article 6(2) of Council Directive 89/391/EEC)[24]

a) Avoiding risks;

b) Evaluating the risks which cannot be avoided;

c) Combating the risks at source;

d) 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;

e) Adapting to technical progress;

f) Replacing the dangerous by the non-dangerous or the less dangerous;

g) 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;

h) Giving collective protective measures priority over individual protective measures; and

i) Giving appropriate instructions to employees.

Red-Amber-Green Lists Can Help Designers Identify and Eliminate Hazards, and Control Risks

RED:
Hazardous products, processes and procedures to be eliminated from the project:

- Make sure that asbestos is removed if it is likely to be disturbed by work on existing/derelict structures;
- Avoid the need to scabble concrete;
- Design piles to enable cropping by a method other than manual breaker;
- Avoid processes that create dust;
- Avoid spraying harmful substances on site.

AMBER:
Products, processes and procedures to be eliminated or reduced as far as reasonably practicable and only specified if there is no other option. The designer should provide information about these risks, and the reason for their selection:

- Avoid specifying heavy building blocks (e.g. weighing >20 kg);
- Avoid specifying large/heavy glass panels, unless they can be installed using mechanical handling methods;
- Avoid specifying heavy lintels unless it is possible to transport and install the components using a mechanical handling solution;
- Design structures to receive services, instead of chasing out concrete later; and
- Avoid specifying solvent-based paints and thinners, or isocyanates, particularly inside buildings and basements.

GREEN:
Products, processes and procedures to be positively encouraged:

Design the layout of plant rooms so that mechanical lifting aids can be used when carrying out maintenance and replacing components;

- Specify precast concrete products that incorporate integral fixings to avoid drilling;
- Specify half-size plasterboard sheets for easier handling; and
- Treat timber off site if hazardous preservatives need to be used.

3.1.4 Inform

Designers should provide adequate information about significant risks associated with the design.

They must provide information that other project team members are likely to need to identify and manage the remaining health (and safety) risks. This should be project specific, and concentrate on significant risks which may not be obvious to those who use the design.

Designers also need to provide information about aspects of the design that could create significant risks during future construction work or maintenance.

Significant risks are not necessarily those that involve the greatest risks, but are those that are:

- Not likely to be obvious to a competent contractor or other designers;
- Unusual; or
- Likely to be difficult to manage effectively.

Information should be brief, clear, precise and in a form suitable for the users. For example by the use of:

- Notes on drawings (preferred - as the information is immediately available. The notes can refer to other documents if more detail is needed);
- Written information provided with the design (project specific and only containing information which will be useful to those constructing or maintaining the structure);
- Suggested construction sequences (where this is not obvious - contractors may then adopt this method or develop their own approach); and
- Large volumes of paperwork listing generic hazards and risks, most of which are well known to contractors and others who use the design are positively harmful, and suggest a lack of competence on the part of the designer.

Industry Guidance for Designers – Construction Skills publication 2007

http://www.cskills.org/uploads/CDM_Designers4web_07_tcm17-4643.pdf

3.2 Human Factors in Design

The design of control rooms, plant and equipment can have a large impact on human performance. Designing tasks, equipment and work stations to suit the user can reduce human error, accidents and ill-health. Failure to observe ergonomic principles can have serious consequences for individuals and for the whole organisation. Effective use of ergonomics will make work safer, healthier and more productive.

The earlier that consideration is given to human factors and ergonomics in the design process, the better the results are likely to be. However, it's important to use human factors and ergonomics expertise appropriately by involving people with knowledge of the working processes involved and the end user. For that reason, user involvement is key to designing operable and maintainable plant and systems.

Poor design contributes to work-related ill-health and has been found to be a root cause of accidents including major accidents e.g. Texas City, Herald of Free Enterprise and Ladbroke Grove.

The application of human factors to the design and development of systems and services is often called Human Factors Engineering or Human Factors Integration.

3.2.1 Key Principles In Design

- Equipment should be designed in accordance with key ergonomics standards including EN614 Parts 1 and 2;
- Control rooms should be designed in accordance with key ergonomics standards including EN11064, EEMUA 191 and EEMUA 201;
- Users, where practicable, should be involved in the design process. This should include different types of users including operatives, maintenance and systems support personnel;
- Consideration should be give to operator characteristics including body size, strength and mental capability;
- Plant and processes should be designed for operability and maintainability and other elements of the life cycle such as decommissioning;
- Consideration should be given to all foreseeable operating conditions including upsets and emergencies; and
- Consideration should be given to the interface between the end user and the system.

3.2.2 Information on Design for human factors is contained in the following publications:

- Reducing error and influencing behaviour (HSG48) contains a good summary of key design issues;
- Improving maintenance – a guide to reducing human error (HSE Books, ISBN 0 7176 1818 8. 9) discuss designing plant and equipment for maintenance;
- Human factors integration: Implementation in the onshore and offshore industries (RR001) Gives an overview of best practice on how to build human factors into design.
- Key standards in Applied Ergonomics This British Standards website lists the published standards in the area of applied ergonomics. (https://ecommittees.bsi-global.com/bsi/controller/pubstds?livelinkDataID=951718&XMLQUERY_commid=951718)
- Ergonomic principles in the design of work systems (BS EN ISO 6385:2004)

3.2.3 Ergonomic Design Of Control Centres

Parts 1-7, ISO 11064. Covers design principles, control room arrangements and layout, workstations, displays, controls, interactions, temperature, lighting, acoustics, ventilation, and evaluation. Designers should be following this standard for new control rooms, and it can usefully be referred to for upgrades and modifications especially where there are known problems.

3.3 Tables and Advice for Achieving ALARP

Achieving What Is 'Reasonable'

Decisions should be based upon predicted likelihood and severity based upon fair and foreseeable judgement which is not bogged-down in trivia. In reality this means that the designer has to:

1. Identify all tasks;
2. Identify all health (safety and environment) hazards;
3. Consider everyone who may be affected;
4. Identify risks arising from the hazards (likelihood of incidents and potential severity); and then
5. Decide upon appropriate control measures based upon the following basic hierarchy which is suitable for design work:-

   Eliminate (first choice)

   Reduce

   Isolate
   Control (last resort)

   The provision of a safe place to work takes preference over making a person safe as an individual, as it protects everyone.

   In addition, information provided should be appropriate, relevant and in sufficient detail to help those executing the design to make sensible decisions on construction methods and controls – specifically for those risks that the contractor may not be familiar with.

6. Review and revise as necessary.

3.3.2 Designers Risk Assessment (DRA), Hazard Analysis Records and Residual Risk Management Log, etc.

There is no specific legal requirement for the development of a DRA. However, as CDM requires designers to eliminate and reduce hazards and to pass on information about residual hazards Crossrail require a DRA to be completed. An alternative is for the designer to produce 'Hazard Elimination and Management Lists/Log', for use by members of the design team as the job progresses.

This documentation assists Designers in discharging their responsibilities for health (and safety) hazard identification, elimination/reduction and provides an audit trail for the management of residual risks. In addition, it establishes a record of the actions taken to apply the principles of prevention and protection, a method of communication for any residual risk information to the contractor, and a mechanism for the contractor to ensure that the residual risk information is incorporated into safe systems of work.

The following tables give an indication of possible solutions to hazards identified within BS 6164, 'Safety in Tunnelling', applying the hierarchy of control for use in tunnelling works. The chosen solution must be suitable for the specific situation and sufficient to control or eliminate the risk as intended (in other words, these tables are indicative only and not necessarily the best solution):

Hazard	Occurrence	Possible symptoms and/or consequences	Possible design solutions – requires assessment against other health hazards and control hierarchy (ERIC)
Physical			
Noise	Prolonged exposure to high noise levels. Pneumatic tools such as clay spades or rock drills. Machinery.	Long-term irreversible hearing loss.	E Specify low noise methods such as silent piling techniques. R Specify suitable job rotation, isolate equipment from employees. I Enclose noise source and provide adequate information of residual risks. C P.C. to identify additional control methods for any residual risk.
Manual Handling (lifting, carrying, pushing/pulling)	Hand excavation techniques. Erection of lining by hand. Use of heavy, awkward, slippery, sharp tools.	Pain including low back pain and restricted body movements that can lead to permanent disability. Prolapsed disc. Muscle/tendon damage.	E Specify materials which meet structural needs but are low in weight – e.g. concrete blocks which weigh less than 20kg. Adapt design so that mechanical assistance can be employed. R Consider site layout and ensure that suitable drop off points exist to minimise distances between this location and the work area. I Identify equipment that can be employed whereby personal intervention is removed. C P.C. to identify additional control methods for any residual risk.
	Repetitive, frequent or prolonged operations requiring force, gripping, squeezing of hands, rotation of wrists. Awkward posture	Work-related upper limb disorders. Pain numbness and restricted body movement which can lead to permanent disability.	E Adapt design so that mechanical assistance can be employed. R Consider site layout and ensure that suitable drop off points exist to minimise distances between this location and the work area. I Consider design to identify areas where work positioning may be difficult and identify in information provided. C P.C. to identify additional control methods for any residual risk.

Hazard	Occurrence	Possible symptoms and/or consequences	Possible design solutions – requires assessment against other health hazards and control hierarchy (ERIC)
Physical			
Vibration	Prolonged exposure to high vibration hand-held tools. Concrete/rock breakers. Clay spades. Percussive drills.	Hand-arm vibration syndrome. Tingling or pins and needles in the fingers and numbness. Whiteness at the fingertips when exposed to the cold. Finger paleness followed by rapid red hand flush, plus finger throbbing. More frequent attacks causing hand pain and reduced dexterity. Eventually blue-black appearance of fingers.	E Specify methods which will enable mechanical assistance to be employed R Consider opportunities to utilise low vibration solutions such as the Elliott Method. I Identify residual risks to assist P.C. in selecting suitable controls. C P.C. to identify additional control methods for any residual risk.
Heat	Hand excavation in conditions of high temperatures, high humidity, or low rate of air movement. Exacerbated by working in compressed air	Heat stress and strain. Exhaustion. Increased heart rate and body temperature and sweating, dehydration and salt imbalance. Fainting.	E Identify mechanical methods with in-built operator cooling / ventilation. R Incorporate cooling methods with specified plant designs. I Ensure suitable identification of potential is flagged-up to contractor for action C P.C. to identify additional control methods for any residual risk.
	Tunnelling / work in tunnels.	Heat stress and strain. Exhaustion. Increased heart rate and body temperature and sweating, dehydration and salt imbalance. Fainting.	See above
Hyperbaric atmosphere	Work in compressed air.	Decompression illness. Signs and symptoms can include: Acute: Limb joint pains, skin rashes, itching, mottling, numbness, tingling, weakness, paralysis, visual disturbance, unconsciousness and convulsions. Chronic: Bone necrosis.	E Specify non-pressurised methods where ground conditions / strata and project need allows. R Identify machinery where those exposed to pressurised environment is kept to a minimum. I Ensure suitable identification of potential is flagged-up to contractor for action C P.C. to identify additional control methods for any residual risk.

Hazard	Occurrence	Possible symptoms and/or consequences	Possible design solutions – requires assessment against other health hazards and control hierarchy (ERIC)
Chemical			
Cementitious materials, additives, epoxy resins.	Prolonged direct skin contamination of hands forearms, legs from converting, grouting, slurries, rock bolting. Application of sprayed concrete.	Redness, itching, scaling, blistering, cracking and bleeding of exposed skin causing irritant or allergic dermatitis.	E Specify non-hazardous materials. R Identify less hazardous product through assessment and selection of suitable alternative. I Identify type, location and quantities of hazardous product and ensure physical barriers are used such as containment. C P.C. to identify additional control methods for any residual risk.
Respirable crystalline silica	Machine cutting or rock. Application of sprayed concrete, drilling, breaking, crushing, conveying, cutting, loading of rock.	Increasing breathlessness, heart failure, acute silicosis, accelerated silicosis, lung fibrosis.	E Specify non-silica materials. R Utilise methods in design where dust generation is kept to a minimum and specify suitable mist suppression system and / or ventilation. I Identify where silica may exist throughout stages of the project and ensure physical barriers are used such as containment. C P.C. to identify additional control methods for any residual risk.
Other respirable dusts	Machine cutting of rock. Application of sprayed concrete, drilling and blasting.	Irritation of respiratory tract. Accumulation of dust in the lungs.	E Specify materials which are non-hazardous in nature. Design-out high dust methodologies. R Utilise methods in design where dust generation and those exposed is kept to a minimum (mechanical means and closed cab, etc). Specify suitable mist suppression system and / or ventilation. I Identify where silica may exist throughout stages of the project and ensure physical barriers are used such as containment. C P.C. to identify additional control methods for any residual risk.

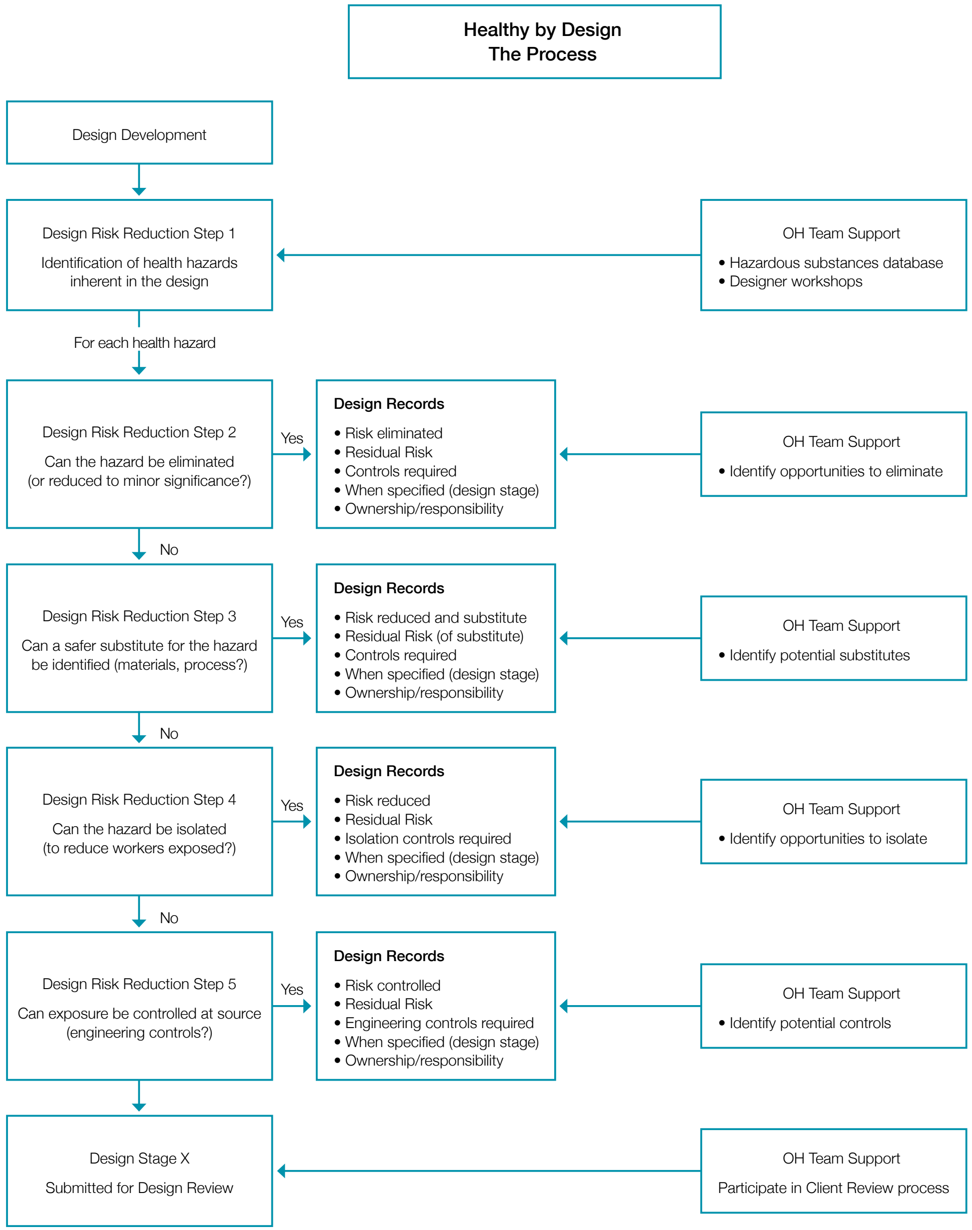
Hazard	Occurrence	Possible symptoms and/or consequences	Possible design solutions – requires assessment against other health hazards and control hierarchy (ERIC)
Chemical			
Solvents	Skin contact, contamination of tunnel atmosphere. Contaminated land.	Principally skin irritation including dermatitis. Nausea and giddiness.	E Specify non-hazardous materials. R Identify less hazardous product through assessment and selection of suitable alternative. I Identify type, location and quantities of hazardous product and potential explosive / flammable atmospheres. Ensure physical barriers are used such as containment, utilise personal protective equipment, etc. C P.C. to identify additional control methods for any residual risk.
Hydrocarbons	Particulates from diesel engine exhaust emissions.	Irritation of eyes and respiratory tract. Might be a link with cancer (cause unclear).	E Eliminate substances which are hydrocarbon based. Consider R Sources and replace with less hazardous alternative. I Identify hydrocarbon based materials and ensure physical barriers are used such as containment, utilise personal protective equipment, etc. C P.C. to identify additional control methods for any residual risk.
Biological			
Contaminated water or soil	Infection through poor hygiene practices, skin cuts and abrasions or rubbing eyes when working in contaminated land or water sewage.	Weils Disease (Leptospirosis) – a bacterial infection carried in contaminated water and soil. Early symptoms include sudden high temperature, loss of kidney function, influenza like illness, joint and muscle pains. Conjunctivitis and jaundice can occur.	E Eliminate need for human interaction with contaminants. R Reduce activity which requires interactivity and specify cleaning / washing technology. I Clearly identify areas of contamination, cordon off and ensure the results of sampling show substances involved. C P.C. to identify additional control methods for any residual risk.

3.4 Responsibility Chart, Option Evaluation Chart and Best Practice

3.4.1 Responsibility Charts:

Describing who does what, when in relation to identification and management of health risk. These promote understanding of roles and responsibilities and assist in team integration. Benefits include:

- Discipline – health risks are identified, dealt with or correctly handed on either to the next stage of design or to another team;
- Management at the interface – health risk is neither left behind nor "parked" to a stage in the process where designing out risk becomes too onerous and resource intensive; and
- Avoidance of conflict - team members understand the role they can usefully play in eliminating health hazards and mitigating residual risk and time is not wasted.



3.4.2 Option Evaluation Charts:

- Summarise considerations in decision making and ensure the capture of relevant information with regard to pros and cons;
- Act as an audit trial showing that "reasonably practicable" decisions have been made regarding the health aspects of the design;
- Act as a convenient, standardised communication tool summarising key decisions and showing ownership and handover information; and
- Will avoid duplication of effort, sending mixed messages, inappropriate challenge and loss of key information.

The health hazard	Design Stage	Design option	Decision	Action	Owner	Hand over
	Stage 1	Elimination	Yes	Record with justification that decision is RP		
			No	Move to next option with justification that decision is RP		
	Stage 2	Substitution	Yes	Record substitute Use process the manage residual risk		
			No	Move to next option with justification that decision is RP		
	Stage 3	Isolation	Yes	Record with justification that decision is RP		
			No	Move to next option with justification that decision is RP		
	Stage 4	Engineering control	Yes	Record with justification that decision is RP		
			No	Move to next option with justification that decision is RP		
	Stage 5	Administrative control	Yes	Record with justification that decision is RP		
			No	Move to next option with justification that decision is RP		

Note: RP: Reasonably Practicable

3.4.3 Best Practice

Attendance at HAZID Workshops and other relevant workshops: ensuring that health is covered as an agenda item at Hazard Identification workshops facilitated by a specialist in ill-health prevention; this will focus the design teams' minds leading to a collaborative culture with shared ownership. In this way, ground breaking healthy design solutions will be created as a legacy from this project.

Health Information within Design Drawings: engaging with ill-health prevention experts will ensure that key health information is including on the detailed design drawing used by contractors. This is a simple communication tool that helps by either:

- Ensuring that solutions chosen early in the design process are neither lost nor changed through lack of knowledge and information as the design evolves; or
- Triggering an investigation into what effects a design change during the construction phase could have on the health aspects of the job such as introducing new risks or exacerbating existing ones.

RAG lists: these are a well established tool to embed new innovations, techniques and technology into design activities. Generic lists are useful but the more specific to sector and type of work, the better they will be at influencing design decisions;

Risk Registers: these are a well established as a control tool into which healthy design decision making can be usefully integrated;

Health checklists signposts in the gateway process: alignment of health milestones with CDM and other milestones at a strategic level can be achieved using simple checklists and signposts. These will ensure that health is integrated within the project and communicates that addressing health issues is integral to the process;

- **Checklists:** act as a prompt ensuring that all issues have been identified and sensible, proportionate decisions have been made;
    - **Signposts:** can indicate the start of a high risk work (e.g. demolition of an asbestos containing building, enabling works in contaminated ground), or the need to complete a key activity such as a health risk assessment or intrusive investigation.

Keeping a Best practice database: useful in sharing best practice methods of eliminating and controlling residual risk. Incentivising design teams to use an Achievement Log and celebrating "innovation of the month" as well as building duties and responsibilities into the assurance programme will ensure that the database becomes a useful tool used across all packages and potentially, the wider industry.

Best practice assistance: making use of tried and tested tools such as those listed below will ensure that the design teams are not burdened with excessive additional work when meeting Crossrail's aspirations regarding healthy design interventions.

- Some examples that will be made available through Sypol as a part of their contract with Crossrail:

1. Hazardous materials: CMS hazardous substance and database, risk rating tool and COSHH assessment compiler.
2. Noise: HSE Noise Ready Reckoner.
3. Vibration: HSE Whole Body Vibration (WBV) tool, HSE Hand arm Vibration (HAV) ready reckoner, OPERC and HAVTEC which are databases of Vibration outputs.
4. Manual handling and repetitive tasks: MAC tool, ergonomic best practice HSE best practice case study examples for each hazard aligned with each design stage.
5. Pressure and Fatigue: HSE stress management standards, CIPD managers competency tool.

3.5 Red Amber Green Lists

3.5.1 Red List examples:

- Use of hazardous materials where other less or non-hazardous material alternatives exist;
- Scabbling of concrete ('stop ends', etc);
- Demolition by hand-held breakers of the top sections of concrete piles (pile cropping techniques are available);
- Other works likely to generate loud noise or require vibrating tools;
- Fragile roof-lights and roofing assemblies or other frangible surfaces;
- Processes giving rise to large quantities of dust (dry cutting, blasting etc.);
- On-site spraying of harmful particulates;
- The specification of structural steelwork which is not purposely designed to accommodate safety nets;
- Designing roof mounted services requiring access (for maintenance, etc), without provision for safe access e.g. barriers; and
- Use of processes that may contaminate environmental media (soil, water or air).

3.5.2 Amber List examples:

- Erection or other execution sequences which require personnel to work at height, exposed to leading edge risk of falls;
- Inadequate external or internal illumination;
- Internal manholes in circulation areas;
- External manholes in heavily used vehicle access zones;
- The specification of "lip" details (i.e. trip hazards) at the tops of pre-cast concrete staircases;
- The specification of shallow steps (i.e. risers) in external paved areas;
- The specification of heavy building blocks i.e. those weighing > 20kgs;
- Large and heavy glass panels;
- The chasing out of concrete / brick / block work walls or floors for the installation of services;
- The specification of heavy lintels (the use of slim metal or concrete lintels being preferred);
- The specification of solvent-based paints and thinners, or isocyanates, particularly for use in confined areas;
- Specification of curtain wall or panel systems without provision for the tying of scaffolds for construction and/or maintenance;
- Specification of block work walls >3.5 metres high and retarded mortar mixes; and
- Formaldehyde-containing materials which compromise indoor air quality.

3.5.3 Green List examples:

- Off-site fabrication, and ground-level fabrication and assembly, so that work may be carried out as far as possible in a "manufacturing environment" vis-à-vis HS&E controls, and working at height may be minimised by pre-assembly and craneage of finished/semi-finished components;
- Adequate access for construction vehicles to minimise reversing requirements (one-way systems and turning radii);
- Concrete products with pre-cast fixings to avoid drilling;
- Half board sizes for plasterboard sheets to make handling easier;
- Demolition of the top sections of concrete piles by pile cropping techniques;
- Low volatile organic compound materials, e.g., water-based paint coatings, adhesives, etc;

- Structural steelwork purposely designed to accommodate safety net fixings and/or suitable harness anchorages;
    - Timber from sustainable sources;
    - Early installation of permanent means of access, and prefabricated staircases with hand rails;
    - The provision of edge protection at permanent works where there is a foreseeable risk of falls after handover;
    - Practical and safe methods of window cleaning (e.g. from the inside) and other normal maintenance and cleaning activities;
    - Thoughtful location of mechanical/electrical equipment, light fittings, security devices etc. to facilitate access and away from crowded areas;
    - Provision of adequate access and headroom for maintenance in plant rooms, and adequate provision for replacing heavy components; and
    - Off-site timber treatment of PPA- and CCA-based preservatives (boron or copper salts used for cut ends on site) – delivered dry and cured to site;

Note: For ease of reference some examples relating to safety considerations are also included in the above lists.

3.6 Healthy Design Solutions

3.6.1 Ergonomics

- Specify blocks <20kg in weight;
- Design rebar cages for lifting;
- Specify couplers in place of long laps, to aid steel fixing;
- Adapt design for the use of mechanical aids;
- Specify lighter alternatives e.g. slim metal or concrete lintels;
- Design for ease of access;
- Design in adequate space for access, e.g. services in voids, fixing rebar;
- Specify spliced beams;
- Specify built in ducting;
- Use re-enforcing mesh;
- Design for the use of mechanical excavators; and
- Design for machine laying paving.

3.6.2 Vibration

- Specifying surface finishes that don't require scabbling;
- Design piles so that mechanical pile cropping is possible;
- Specify concrete products with pre-cast fixings;
- Specify built in ducting;
- Specify retarding and washing off the joint interface;
- Specify cast in joint formers;
- Designing the position of construction joints etc, to limit the size of concrete pours to what can be achieved in two hours; and
- Design for the use of remote control compaction.

3.6.3 Noise

- Specify hydraulic piling;
- Specify self compacting concrete;
- Specify crack-inducers;
- Cast in brick ties, instead of shot-firing;
- Specify concrete products with pre-cast fixings;
- Specify built in ducting;
- Specify dry lean concrete;
- Design for the use of tools with noise attenuation fittings; and
- Design for the use of remote control compaction.

3.6.4 Hazardous Substances

- Specify low chrome cement;
- Design to use bulk supply pumped concrete;
- Plan enabling works with welfare facilities installed at project start;
- Specify adhesives that have non-volatile solvents;
- Specify concrete products with pre-cast fixings;
- Off-site timber treatment;
- Specify a contamination survey for refurb or demolition work;
- Specify built in ducting;
- Specify the correct size for reinforcing mesh.

Work Practices which should not be considered

3.6.5 Ergonomics

- Blocks >20kg;
- The specification of heavy lintels.

3.6.6 Vibration

- The chasing out of concrete / brick / block work walls or floors;
- Hand tunnelling;
- Hand drilling.

3.6.7 Noise

- The chasing out of concrete / brick / block work walls or floors;

3.6.8 Hazardous Substances

- Dry cutting of concrete / brick / block work walls or floors;
- The chasing out of concrete / brick / block work walls or floors;
- Specification of isocyanate based paints;
- On site use of PPA- and CCA-based preservatives;
- Spraying of solvent based coatings.

3.6.9 Examples Of Risk Control Measures for Health Hazards

Activity	Health Risk	Possible Control Measure
Laying block paving	WRULD	Design for machine laying: space, component size, etc.
Brick laying	WRULD	Design to reduce long duration repetition.
Tying reinforcement	WRULD Back injury	Use welded mesh; detail to allow prefabrication and lifting in.
Block laying	Back injury	Use lighter blocks.
Materials Handling	Back injury	Adequate space for available machines; Specify low weight packages.
Working in small or awkward spaces	Back injury & Other MSIs	Dimension: height, width, to fit modules of the work environment. Size rc components to minimise pushing/pulling while fixing re-bar.
Use of hand tools, e.g. a) in rc work b) compaction	HAVS	Design for: a) use of crack-inducers; or non-scabbled joints; b) Remote compaction.
Pile cropping	HAVS	Design spacing and pile re-bar for machine Cropping.
Cutting, e.g. a) chases b) joints in rc c) blocks, etc	HAVS	a) Provide ducts, detail box-outs, b) Use crack inducers, c) minimise number of cuts.

Note: WRULD work-related upper limb disorder.

HAVs hand arm vibration syndrome.

Source: Safety in Design

View Safety In Design website at: www.safetyindesign.org

3.7 Hazardous Substances: Key Health Risks

Substance	Example	Health Effects	Construction Applications
Gas	Carbon Monoxide	Toxic by inhalation – causes acute hypoxia and possible death (deprivation of oxygen supply) by binding to red blood cells. Can also cause chronic damage to the central nervous and renal system and has an adverse effect on foetal development.	Carbon monoxide (CO) is produced by poorly combusted fuels – badly maintained gas boilers, generators, petrol or diesel fuelled tools and equipment in poorly ventilated areas.
	Chlorine	Toxic by inhalation and a primary irritant. – converted to corrosive hydrochloric and hypochlorous acid in contact with moisture in the lungs, eyes and skin causing permanent lung damage and reversible skin rashes and strong eye irritation.	Can be produced by mixing chlorine based products such as bleach or sodium hypochlorite with acidic materials.
Liquid	Mercury	Very toxic by inhalation and possesses reprotoxic effects. – causes severe neurotoxic and developmental effects that are often irreversible and may lead to death.	Can be found in contaminated ground, especially old gas work sites. Will rarely be encountered in elemental form as free mercury will react with the environment to form solid and liquid mercury organic & inorganic compounds.
	Epoxy resin	Irritating to eyes and skin and a skin sensitiser – causes reversible skin rashes, strong eye irritation and possible development of occupational allergic reactions (e.g. dermatitis) to epoxy based products.	Epoxys are found in adhesives, paints and hard setting resins.
	Acids	Corrosive or irritant – can cause acute chemical burns, tissue destruction or irritation to eyes and skin when dilute. Some acids are also irritating to the respiratory tract and others can also display acute or chronic toxic effects.	Acid-based cleaners, paint-strippers, batteries, brick cleaners.
	Alkalis	Corrosive or irritant – can cause acute chemical burns, tissue destruction or irritation to eyes and skin when dilute. Some acids are also irritating to the respiratory tract and others can also display acute or chronic toxic effects.	Cement is an alkaline liquid and can cause severe burns. Some people have lost limbs as a result of cement burns. Bleaches and certain degreasers are also strongly alkaline materials.

Substance	Example	Health Effects	Construction Applications
	Solvents	Acute inhalation toxicity can cause narcosis (feeling of being drunk), headaches, nausea and unconsciousness. Repeated and prolonged exposure can lead to brain, central nervous system (CNS), liver or kidney damage. Skin contact can lead to dermatitis, permanent skin damage or direct absorption in to the blood stream causing kidney, liver or brain or CNS damage.	Paint strippers, paint thinners, solvent-based paints and coatings, curing agents.
Vapour	Solvents	Acute inhalation toxicity can cause narcosis (feeling of being drunk), headaches, nausea and unconsciousness. Repeated and prolonged exposure can lead to brain, central nervous system (CNS), liver or kidney damage.	Vapours released from paint strippers, paint thinners, solvent-based paints and coatings, curing agents.
Mist	Oil mist, acid mist	Mineral oil mists generated from cutting fluids can cause lung disease and infections. Acids when heated create a mist which can cause damage to the respiratory tract and lungs when inhaled.	Cutting fluids, brick cleaners.
Solid	Metals, mineral / ceramic fibres	Mineral fibres – can cause severe lung damage and irritation to the skin.	Insulating materials, thermal protection materials.
Dust	Wood, soil, silica	Wood dusts can cause occupational asthma – hard wood dusts can cause nasal cancer. Silica is produced when concrete / stone is cut or blasted. Exposure to respirable silica can cause lung disease caused silicosis and is an HSE priority area for disease reduction. Soil – exposure to contaminated soil can cause ill health.	Carpentry / joinery tasks. Stone / concrete cutting, grinding and blasting. Contaminated land sites.

Substance	Example	Health Effects	Construction Applications
Fume	Welding, soldering	Fumes are solid particles in air generated when materials are heated, mainly in welding or soldering. Some fumes are more harmful than others – they can cause lung diseases, including occupational asthma.	Welding and soldering, metal cutting.
Biological Agent	Legionella, leptospirosis, anthrax	Legionella – causes Legionnaire's Disease Leptospirosis – causes Weil's Disease Other bacteria and viruses may be present in contamination, some of which may cause potentially severe human diseases.	Legionella – cooling water systems, showers Leptospirosis – water courses, water contaminated with rats urine (standing water). Anthrax – found in old horse-hair plaster, or contaminated ground (old tannery sites, animal graveyards)

3.8 Noise, Vibration and Manual Handling Key Risks

3.8.1 Work groups at risk from noise:

- Workers who use power tools, such as:
  - concrete breakers, pokers and compactors;
  - sanders, grinders and disc cutters;
  - hammer drills;
  - chipping hammers;
  - chainsaws;
  - cartridge-operated tools; and
  - scabblers or needle guns.
- Workers who operate heavy plant or control machines on site, and anyone in close proximity to them.

3.8.2 Work Groups at risk from hand-arm vibration

Tradesmen who work with hand-held or hand-guided power-tools and machines, such as:

- concrete breakers, pokers and compactors;
- sanders, grinders and disc cutters;
- hammer drills;
- chipping hammers;
- chainsaws; and
- scabblers or needle guns.

3.8.3 Musculoskeletal Disorders

The construction industry has one of the highest rates of MSDs. The biggest cause of injury is manual handling, which includes lifting, lowering, pushing, pulling and carrying. However, handling heavy objects is not the only cause of injury - MSDs can also result from doing a task repetitively, even if the load is relatively light (e.g. bricklaying), or where the person's body position is less than ideal (e.g. tying rebar). Other common tasks associated with MSDs include:

- block laying;
- handling pipework;
- laying kerbs and paving slabs;
- moving and installing plasterboard; and
- installing M&E (mechanical and electrical equipment)

Musculoskeletal injuries are common in the construction industry. They typically arise from work that involves:

- Lifting, lowering and carrying heavy materials (e.g. roof tiles);
- Pushing and pulling objects and equipment (e.g. barrows);
- Bending and twisting (e.g. plastering);
- Repetitive movements (e.g. tying rebar);
- Working too long without breaks;
- Awkward working positions (e.g. bending or crouching) or restricted space (e.g. working in a roof void); and
- High job demands or time pressure, which may mean that workers resort to brute force rather than using a mechanical handling solution.

3.9 Hazardous Substances

Crossrail has access to CMS from Sypol, which facilitates successful management of hazardous substances in the workplace, and compliance with the COSHH regulations. The CMS software package contains comprehensive COSHH risk assessments for thousands of materials, and is available to designers by contacting Melodie.gilbert@sypol.com

Designers can search the database for COSHH assessments for materials they are using, and also use the 'safer substitute tool' which can assist in eliminating high hazard materials at the design stage.

Web address: www.sypolcmsonline.com/cms7

4.0 Additional Information

4.1 Designing Out Risk Why Bother?

4.1.1 Legal requirements

There are a number of legal obligations on all people who are at work – so if you are an employer; employee; are self employed; a volunteer; a contractor; a supplier; manufacturer or visitor to a work place there are duties to ensure you act safely and that your health, safety and welfare are safeguarded from harm. These duties and responsibilities are established by the Health and Safety at Work etc Act 1974 (HASWA).

Health and safety law is enforced by both local authority Environmental Health Officers (EHOs) and primarily the Health and Safety Executive (HSE), the regulatory body instigated through the HASWA. The HSE also provides free guidance and advice on all aspects of health and safety at work.

For more information log on to www.hse.gov.uk

The HASWA itself is statute law, which means that failure is punishable as a crime in the criminal courts. Breaking this law can lead to company, group or individual being prosecuted. A successful prosecution can result in the guilty party being imprisoned or fined and left with a criminal record. Magistrates' courts can impose maximum fines of £20,000 for each offence and up to 12 months in prison, depending upon the offence. A Crown court has the power of unlimited fines and specifying up to 2 years in prison. Both also have the powers to serve Court Orders which will result in enforced changes in approach, system and / or a way or working. Finally, Directors can be banned from holding such a position for up to 15 years. Additionally, enforcement officers (EHOs and HSE) have the power to issue Improvement Notices requiring changes in working arrangements, or Prohibition Notices stopping certain work until such measures are in place.

The HASWA sets out minimum health and safety standards and expectations through the identification of general duties, and as there are so many different hazards in the workplace; the HASWA also enables regulations to be made that cover specific topics such as controlling noise, chemicals, using computers etc. A breach of a regulation can also lead to a criminal prosecution.

Designers have a specific legal duty under the HASWA to ensure that their influence on articles and substances provided for use at work will ensure that they are safe when properly used. This will require the provision of a sound specification in terms of the materials used, the capability intended and the information provided to future users.

4.1.2 Moral and Ethical Obligations

Putting aside what the law has to say, it is a human right for people to have safe, healthy workplaces with basic welfare needs met. An employer has to ensure that this is the case for their workforce. If you engage in work activity you are responsible to play your part, whether this is keeping your work environment clean and tidy or in the developing of new structures.

The methods of work and materials used in the realisation of designs can have massive future implications: it could be a life or death decision.

The economics involved in accidents/ ll health at work are both far reaching and varied in impact. Typically, about 10% of the 'cost' of an accident can be recovered via insurance. This will include the cost involved in a civil claim, for example.

Other 'costs' include prosecution, bad publicity, lost orders and ill feeling in industry, court and legal costs, payment for overtime and temporary workers to make-up work planned to be completed by those off sick or injured, and so on. These costs are not recoverable through insurance, so the employer has to utilise existing funds to cover them.

Management of ill health (and safety) in design can reduce the risk to employees and others affected by employer activities and therefore the resulting costs involved in absence for what ever reason. This guide gives a range of examples where design can be enhanced to provide this obvious business benefit.

4.1.3 Examples of practical design solutions

Laying Kerb stones

Laying kerb stones has a legacy of years of injury, hard-work and long hours have been replaced with a quicker and more efficient method of completing the same task virtually risk free. This has been enabled through the introduction of vacuum lifters attached to plant and the re-design of kerbs to reduce material weight and density, but not at the detriment of performance.

The Elliot Method

Traditionally, excess concrete at the top of each pile is trimmed away to the final cut-off level using hand power tools, but this has proved to be a time consuming, costly and messy process. It involves a great deal of noise, vibration and dust exposure for the operators. The Elliot method, by contrast, is kinder to the both the user and the environment and simple in design.

Apart from the obvious cost savings, another important benefit is reduction of hazards. “Exposure to hand-arm vibration is reduced by 90-95% compared to conventional methods”, according to Elliot M.D., Bob Merritt. As well as that, slipping, tripping and falling are the most common causes of accidents on construction sites, and this becomes a serious hazard when the working space is littered with lumps of broken concrete. Because the pile top is removed in one piece, the Elliot method greatly reduces this hazard.

Before pile cages are installed, foam rubber sleeves, similar to pipe lagging, are placed over the reinforcing bars above cut-off level. This prevents them from bonding with the concrete. At cut-down, when the pile is finally exposed, a 50cm diameter horizontal hole is drilled into the concrete at the cut-off level and to a depth just over half the diameter of the pile. A standard hydraulic splitter is then inserted into the hole and triggered, causing the pile to split neatly, and in a controlled fashion at exactly the right level.

The unwanted top of the pile can be lifted away using a lifting eye cast into the top surface of the pile. The pile top comes away quickly and easily thanks to the foam rubber sleeves, and the excess concrete can be crushed and recycled if necessary. The reinforcing bars are left straight and undamaged and are immediately ready for joining to the pile cap or foundation slab.

The entire process takes on average 10 minutes per pile, so it is possible for a two-man crew plus a crane to do in one hour what it would normally take 10 men many days to do. At one site near Gloucester, a contiguous wall of 25 bored piles each 1200 mm diameter was removed in a single day by two workers.

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View: http://www.youtube.com/watch?v=ZB5nuSytKR8

The McGovern Lever

It was recognised during the project planning of a building refurbishing job that the demand on the workers could lead to trouble. During a U.S. project where it was learnt that 19,000 holes had to be drilled into a concrete ceiling, the issue was raised at a project planning meeting, challenging planners to reduce the shoulder strain to the workers who would have to do the drilling. The result was the McGovern Lever.

Working overhead contributes to the development of neck and shoulder injuries, especially when using a heavy tool. It is also difficult to maintain a productive work pace while applying force with both arms rose up to the ceiling.

The McGovern Lever which uses an adjustable seesaw attached to scaffolding to serve as a lift for a drill fastened to a post. When pressed down with your foot; the seesaw lifts the post, thus applying upward pressure for the drill to do its job overhead.

View: http://www.elcosh.org/en/document/591/d000569/bright-ideas-%25238%253A-mcgovern-lever.html

4.1.4 National Statistics – Health Performance in Construction

According to national statistics compiled by the HSE:

- Data for 2006-2007, indicates a higher incidence rate of work-related illness in construction than across all industries;
- Data indicates the rate of work-related musculoskeletal disorders was higher in construction than other industries, and has above all-industry average rates for asbestos-related diseases, and HAVS (formerly vibration white finger).

View: www.hse.gov.uk/statistics/industry/construction/

4.2 Designers’ Dilemma Cost vs Risk

These decisions influence later design and construction choices, efforts and costs, and considerable work may be required if improvements or corrections are required at a later date. It is therefore vital to address health (and safety) from the earliest opportunity. This includes consideration of the Workplace (Health, Safety and Welfare) Regulations 1992.

For most designers, buildability considerations and ensuring that the structure can be easily maintained and repaired will be part of their normal work, and thinking about the health (and safety) of those who do this work should not be an onerous duty.

Designers have to weigh-up many factors in their work. Health and safety considerations have to be weighed alongside other issues including cost, fitness for purpose, aesthetics, buildability, maintainability and environmental impact. CDM requires designers to take due account of other relevant design considerations. The regulations do not prescribe design outcomes, but they do require designers to balance these various factors and reach reasoned, professional decisions.

Based on the information available when the design is prepared or modified, designers must (so far as is reasonably practicable and taking into account other design considerations) eliminate hazards where possible, and reduce foreseeable risks arising from hazards that cannot be eliminated. The greater the risk, the greater the weight that must be applied to eliminating or reducing it. CDM does not require zero risk designs because this is impossible, but designs should be able to be constructed, maintained, used or demolished safely.

Where significant risks still remain, designers should provide information with the design to ensure that the CDM Co-ordinator, other designers and contractors are aware of these risks and can take account of them. Dissemination of information may include annotated HSE information boxes on drawings (in simple situations) or design hazard logs in more detailed cases.

4.2.1 So what is 'Reasonably practicable'?

Reducing risk to a degree which is as low as is reasonably practicable ('ALARP') is a common phrase. This requires employers or those in control to make considered judgements to balance operational risk against the cost of management. In essence, the completion of a risk assessment is required to achieve this aim.

'Risk' is the likelihood of incidents occurring quantified against the potential outcome, or seriousness of that incident. Cost involves time, effort, sacrifice, and money. The costs which should be considered are those which are necessary and sufficient to implement the measures to reduce risk.

There is no standard answer to what is reasonable under all circumstances. It is for those in control to decide. The courts have presided over a number of cases throughout the years and have concluded in various judgements that:

"In every case, it is the risk that has to be weighed against the measures necessary to eliminate the risk. The greater the risk, no doubt, the less will be the weight to be given to the factor of cost."

And

"'Reasonably practicable' is a narrower term than 'physically possible' and seems to imply that a computation must be made by the owner in which the quantum of risk is placed on one scale and the sacrifice involved in the measures necessary for averting the risk (whether in money, time or trouble) is placed in the other, and that, if it be shown that there is a gross disproportion between them - the risk being insignificant in relation to the sacrifice - the defendants discharge the onus on them."

It should be remembered that risk is a part of daily life but the aim of risk assessment is to reduce foreseeable risk to the lowest reasonable level via a hierarchy of options, each with justification of non-applicability or inappropriateness before the next is considered. Hazard removal via elimination or substitution is preferable to the specification of control measures which may have weak links. For example, eliminating the need to cut concrete blocks is better than specifying wet cutting or face masks.

In the context of health, materials that are known to be hazardous in some way (irritant or flammable, for example) may be substituted for a non-hazardous alternative. The same should be attempted for processes. For example, one process may generate excessive amounts of dust, noise and vibration whereas an alternative may be available which removes one if not all of these potential health issues.

4.2.2 The Enforcers View

It is recognised that designers have a range of issues to contend with from appearance and structural integrity through to compatibility with other designs and the specification In addition, these considerations vary between design disciplines and the element of cost affects them all.

The current regulatory view is that a hazard must be eliminated (or the remaining risk reduced) unless, in comparison to the risk, it is grossly disproportionate in terms of time, cost and effort to do so.

In addition it is expected that a new facility or installation would not give rise to a risk level greater than that achieved by the best of existing practice for comparable functions.

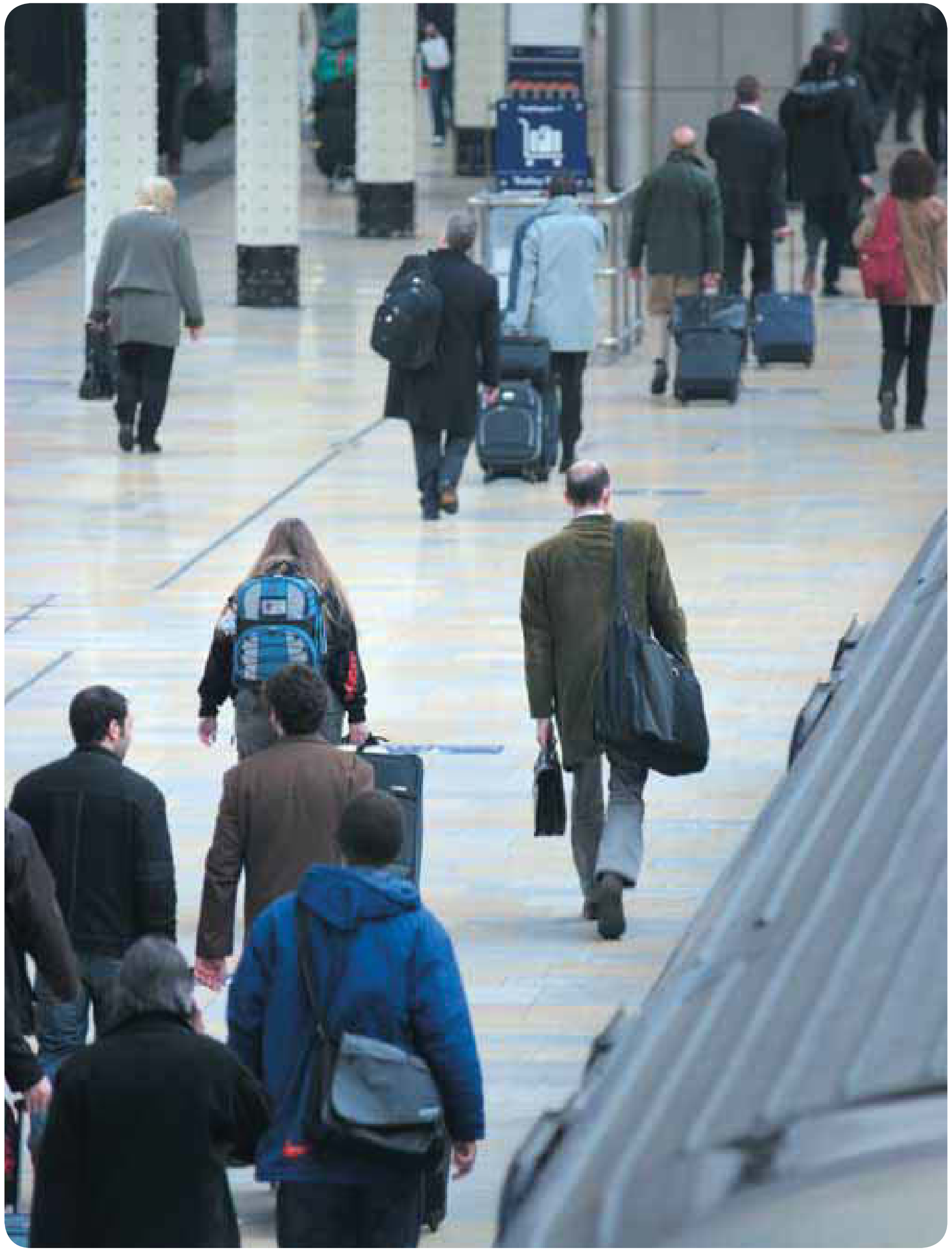
In other words – current best practice should be the minimum benchmark for design solutions. Falling below these standards is likely to be seen as sub-standard and unprofessional. Institutional codes and ethics, best practice recognised within specialist disciplines and due diligence will be relevant in ensuring that the necessary standards are met.

A holistic approach is important in order to ensure that adopted risk-reduction measures do not address one hazard and disproportionately increase risks due to other hazards, or compromise the associated risk control measures. Where appropriate, consideration should also be given to the balance of risk between workers and the public.

Standard industry practice may not necessarily be good practice or reduce risks to the lowest level possible. The HSE will continually review good practice since it may cease to be relevant over time. New legislation may change the requirements; new technology may make a higher standard reasonably practicable. In addition, HSE expects duty-holders to keep relevant good practice under review.

The majority of judgments made by the HSE involves comparison of duty-holders' actual or proposed practice against relevant good practice which provides generic advice on controlling the risk from a hazard. In so far as they can adopt relevant good practice, this relieves duty-holders such as designers of the need (but not the legal duty) to take explicit account of individual risk, costs, technical feasibility and the acceptability of residual risk, since these will also have been considered when the good practice was established.

The HSE have the right to test the overall management of the project as well as individual design decisions when considering whether risks have been reduced to the lowest level reasonably practicable. In doing this, a feel for both the appropriateness of a solution in comparison to risk and the ability of the project to implement these solutions will be assessed. Professional ethics, standards, specialist knowledge also have a bearing on this and are taken into account when reviewing judgments and decisions taken.



Project stage	Elements in demonstration that risks are as low as is reasonably practicable
Choosing between options or concepts	• Risk assessment and management according to good design principles. • Demonstration that duty-holder's design safety principles meet legal requirements. • Demonstration that chosen option is the lowest risk or justification if not. • Comparison of option with best practice, and confirmation that residual risks are no greater than the best of existing installations for comparable functions. Risk considered over life of facility and all affected groups considered. • Societal concerns met, if required to consider.
Detailed design	• Risk assessment and management according to good design principles. • Risk considered over life of facility and all affected groups considered. • Use of appropriate standards, codes, good practice etc. and any deviations justified. • Identification of practicable risk reduction measures and their implementation unless demonstrated not reasonably practicable.

Source: HSE Website - http://www.hse.gov.uk/risk/theory/alarp3.htm

Designers are not required to design out or reduce the risk of hazards which only become known at a later stage in the project. As there is a duty on designers to seek the co-operation of others involved in the project, they will need to take steps to find out that information. The effort required will vary from project to project.

Undertaking hazard elimination and risk reduction as an 'up-front' integrated part of the design process (as opposed to a retrospective activity) is a key element to good risk management and compliant design.

4.2.3 What Is an Acceptable Level of Risk?

There are numerous considerations to be made when selecting control measures to bring down the level of risk to acceptable levels.

In the first instance legal requirements should be met. For example, there are legal limits regarding the levels of exposure to hazardous substances, noise and vibration.

Further considerations should be made to any specific Crossrail policies or standards and in addition industry good or best practice standards that have been committed to.

The client, design team and specialist advisors such as occupational hygienists or health and safety advisors would need to collaborate at the hazard identification and risk assessment stage to agree what the acceptable level of risk should be.

In some cases, European directives or other international measures adopt a risk control standard different from "reasonably practicable" (i.e. ALARP).

View: www.hse.gov.uk/risk/theory/alarpglance.htm for more details about ALARP

4.2.4 Risk Transfer

Introduction of a health and safety measure to control a hazard may transfer risk to other employees or members of the public.

If the transferred risk arises from the same hazard, then it should be offset against the benefit from the measure under consideration. For example, the introduction of mechanical exhaust ventilation may transfer the risk from the employee to the general public as the fumes are pumped outside the workplace. The added risk to the public should be offset against the benefits the measure otherwise brings to employees – and here the dilution effect would need to be taken into account.

If the transferred risk arises from a different hazard, it should be treated as a separate matter for which control measures should be introduced. For example, providing scaffold fans to protect members of the public from being struck by falling objects will transfer some of the risk from the public to the scaffolders involved in erecting the fans. Since a different hazard is involved (i.e. scaffolders falling from a height), the fans should be provided to reduce the risks to the public, but at the same time, the duty holder must ensure that the risks of the scaffolders' working methods are also reduced to the lowest level possible. However, if the risks from the health and safety measure to be introduced (in this example, scaffolding fans) when properly controlled are still greater than the risks which it is sought to prevent (injury to members of the public) when properly controlled, the measure should not be introduced.

4.2.5 Cost Benefit Analysis (CBA)

Where relevant good practice is a good fit to the circumstances, then decisions on risk reduction action are straightforward. Where this is not the case or the situation is complex and the relevance of available guidance is questionable (e.g. the combination of discrete hazards is not foreseen in the good practice documents), the decision-making process on risk reduction is less straightforward. CBA helps by giving monetary values to the costs and benefits to enable a comparison of different options to be made.

The analysis can help make an informed choice between risk reduction options.

But it cannot form the sole argument of a reasonably practicable decision nor can it be used to undermine existing standards and good practice.

In undertaking a CBA, all relevant costs which accrue from the design inputs into a health (and/or safety) intervention should be identified and costed. Inputs are defined as any additional human, physical and financial resources that are used to undertake the intervention.

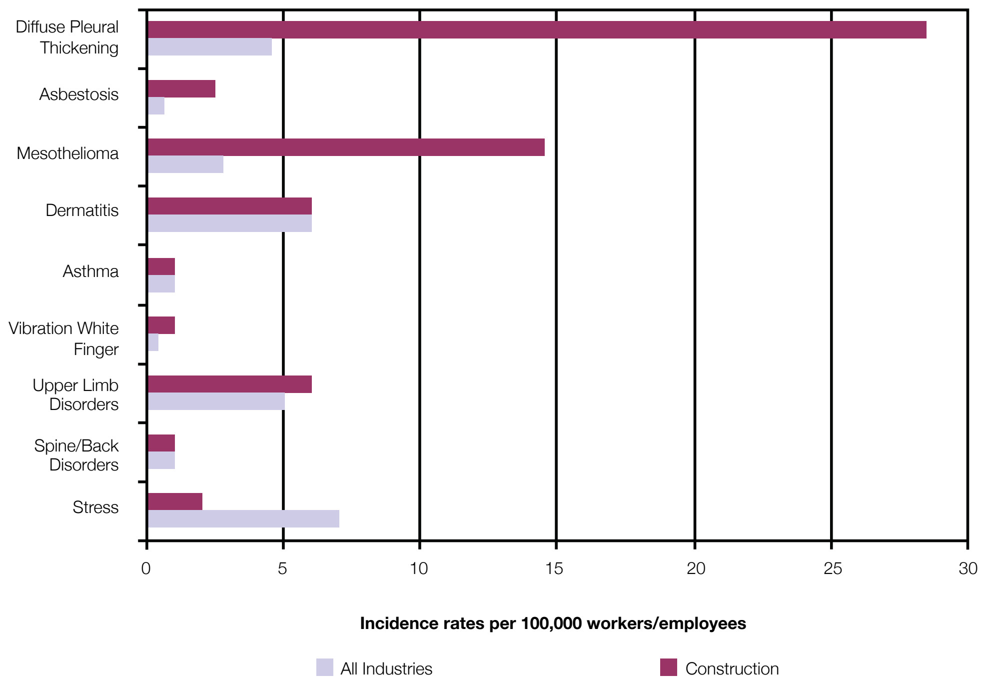
4.3 The Unique Challenge of Health

Walk around any construction site and you can see dangers including people working at height, lifting operations and a range of plant and machinery. It's obvious that a fall or collision could cause considerable harm or damage. It's well documented in HSE statistics that many people are killed every year due to accidents at work, one a week on average on construction sites. What is not necessarily obvious is that there are more fatalities and disabilities caused by occupational diseases than accidents.

4.3.1 Key Annual Figures 2008/09 (HSE)

- **2.1 million** People were suffering from an illness they believed was caused or made worse by their current or past work.
- **1.2 million** of these cases were suffered by people working during the year, of which 551 000 were new cases.
- **2156** people died of mesothelioma (2007), and thousands more from other occupational cancers and lung diseases.
- **180** workers were killed at work, a rate of 0.6 per 100 000 workers.
- **29.3 million** days were lost overall (1.24 days per worker), **24.6 million due to work-related ill health** and 4.7 million due to workplace injury.

Annual average incidence rates of occupational diseases seen by disease specialist doctors 2005-2007



Note: Diffuse pleural thickening is a disease associated with exposure to asbestos.

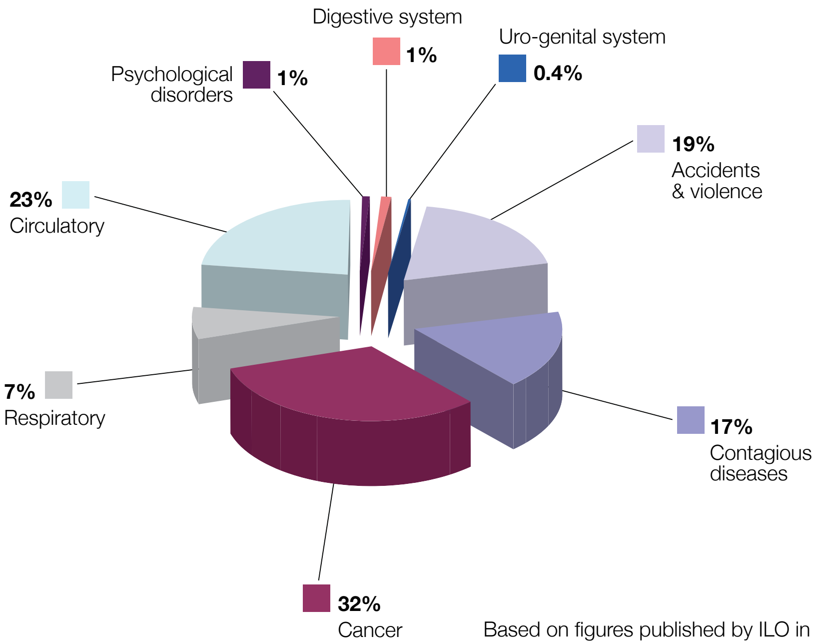
The incidence rate of work-related ill-health within construction in 2007/08 was higher than the average across all industries.

For more details view: www.hse.gov.uk/statistics/industry/construction/ill-health.htm

The International Labour Organisation (ILO), of which the UK is a member, estimates that each year world-wide about 2.3 million men and women die from work-related accidents and diseases including close to 360,000 fatal accidents and an estimated 1.95 million fatal work-related diseases.

The chart below shows the breakdown of work-related fatalities:

Extent of the problem



Based on figures published by ILO in 2005

1 DEATH EVERY 10 MINUTES

Industry Kills just short of 1.8 million people yearly through work related ill health

Occupational disease remains prevalent in the global community because it is seen to be difficult to manage. This is true of UK industry and commerce, and even more so in the construction sector. There are a number of reasons for this:

1. Occupational 'health' has traditionally been seen as the domain of doctors and nurses – not as a management prevention issue. As a result, managing health risks in the workforce has been under-resourced by employers. Skilled professionals such as Occupational Hygienists and competent Health and Safety Advisors are critical resources for managing exposure to health risks at the sharp end.
2. Occupational diseases often have a long latency period – that is – the ill health occurs a long time after the exposure to hazardous substances, noise, vibration or repetitive actions. For example, exposure to asbestos fibres can lead to cancer, but mesothelioma can occur up to 60 years after the fibres are inhaled.
3. Interventions to prevent exposure are not immediately obvious. If you see a dangerous situation on a site – for example – someone about to fall, you can prevent it and see that no accident has occurred. By controlling dusts, you cannot immediately see the health benefit.
4. The 'dangers' can go undetected. For example, harmful silica dust that is produced when cutting or grinding stone and concrete cannot be seen by the naked eye.
5. Employers are not always well informed when selecting suitable control measures. There can be an over-reliance on personal protective equipment (PPE) – this should never be the main source of protection for a planned operation, although for emergency or maintenance work it may be appropriate. Reliance on PPE is problematic for a number of reasons:
   - Selecting the most suitable type requires specialist knowledge: hearing protection should protect against the actual sound level and frequency that causes harm – there is no 'one size fits all'. It's the same with respiratory protective equipment (RPE) commonly known as dust masks. RPE must be appropriate to the type of substance (dust or vapour) and to the exposure levels (quantity that can be breathed in). Gloves used to protect against chemicals must be the correct type – a rubber glove will offer little protection against solvents.

   Use the Sypol CMS database to get more information. http://sypol.com
6. Employers are often unaware of the specialist advice required (or who to contact for the advice) to carry out suitable and sufficient risk assessments for exposures to hazardous substances (dusts, vapours, chemicals) and physical agents (noise, vibration, radiation) and psycho-social risks (stress, violence, aggression), manual handling and repetitive actions.

With these challenges present in the construction sector, there are huge numbers of people who are forced to leave their trade due to ill-health or die prematurely due to disease. It is estimated that 10% of skilled bricklayers leave the industry every year due to dermatitis caused by working with cement. Many more suffer from musculo-skeletal disorders (MSDs) caused by heavy lifting or repetitive actions such as continual bending or stretching.

4.4 Health Hazards in Construction

Main Legislation

- The Control of Substances Hazardous to Health Regulation 2002 (as amended) **(COSHH)**;
- The Control of Asbestos Regulations 2006 **(CAR)**;
- The Control of Lead at Work Regulations 2002 **(CLAW)**;
- The Control of Noise at Work Regulations 2005;
- The Control of Vibration at Work Regulations 2005; and
- The Manual Handling Operations Regulations 1992 (as amended).

4.4.1 Hazardous Substances

In terms of hazardous substances, there are two strands to risk: one is the physical properties of chemicals that could lead to fire, explosion or asphyxiation. These risks are covered by other regulations other than COSHH for example, the Dangerous Substances and Explosive Atmospheres Regulations (DSEAR). The other element to risk is the health effects that exposure to some substances can lead to. It is these risks that this guide focuses on, although there may be some circumstances where these regulations will impact upon each other.

View http://www.hse.gov.uk/fireandexplosion/index.htm for further reading on fire and explosion risks

4.4.2 COSHH

The Control of Substances Hazardous to Health Regulations (COSHH) 2002 (as amended) requires an employer to:

- Undertake risk assessments to determine risk of exposure to substances by employees and other parties who may be affected by the work;
- Eliminate substances or find safer substitutes;
- and a to follow a strict hierarchy when controlling residual risk;
- to undertake health surveillance and / or personal exposure monitoring when using the most dangerous substances;
- Provide training on the health risks and how to work safely; and
- Establish emergency procedures.

4.4.3 Respiratory Disease

Work-related respiratory disease covers a range of illnesses that are caused or made worse by breathing in hazardous substances that damage the lungs. In the construction industry the most prevalent of these diseases are chronic obstructive pulmonary disease (COPD) and asthma and silicosis.

4.4.4 Chronic Obstructive Pulmonary Disease (COPD)

COPD is characterised by airflow obstruction that is not fully reversible. The condition is usually progressive and is associated with inflammatory responses of the lungs to hazardous substances. Symptoms include a chronic cough, sputum production, and shortness of breath. COPD often develops slowly and becomes symptomatic in midlife.

The main cause of COPD is cigarette smoking, but exposure to harmful dust, fume and gases at work can also contribute to the development of the disease. Construction workers have higher levels of this disease than the general population.

4.4.5 Occupational Asthma

Occupational asthma is an allergic reaction that occurs in some people when they are exposed to substances in the workplace, e.g. wood dust. These substances are called ‘respiratory sensitisers’, or asthmagens. They can cause a change in people’s airways, known as the ‘hypersensitive state’.

Not everyone who becomes sensitised goes on to develop asthma, but once the lungs become hypersensitive, further exposure to the substance, even at quite low levels, may trigger an attack.

Work-related asthma can be triggered by exposure to substances in the workplace. Individuals with asthma are more likely to be sensitive to these respiratory sensitisers.

Construction tasks that involve a risk of developing asthma include:

- laying epoxy floors; and
- carpentry.

4.4.6 Silicosis

Silicosis is an irreversible lung disease that can take years to develop. Fine particles of respirable crystalline silica (RCS) cause damage and inflammation in the lungs. Over time, this leads to the formation of scar tissue (fibrosis), which shows up on chest X-rays. The main symptoms are breathing difficulties and a chronic cough which may not appear before retirement. Silicosis can be extremely disabling and lead to early death.

Exposures to freshly cut surfaces of RCS occur in many common industrial tasks found in construction such as cutting, blasting, drilling and grinding. It doesn’t matter whether the parent material is granite, sandstone, slate, or a manufactured product such as brick or concrete.

Examples where RCS exposure can be high include:

- Cutting kerbstones;
- Stonemasonry;
- Scabbling and surface grinding;
- Tunneling;
- Crushing and screening demolition material;
- Clearing and removing rubble; and
- Chasing out mortar before repointing.

4.4.7 Skin Disease

Contact dermatitis is inflammation of the skin that can arise from contact with a range of materials. The main signs and symptoms are dryness, redness, itching, swelling, flaking, cracking and blistering, and it can be very painful. Work-related dermatitis is caused or made worse by work.

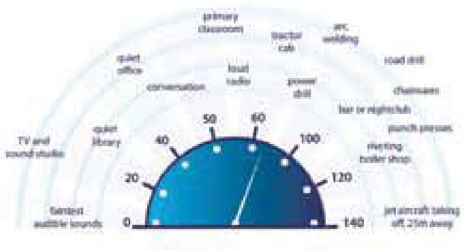
In construction, the substances that cause most skin health problems are:

- Wet cement;
- Epoxy resins and hardeners;
- Acrylic sealants;
- Bitumen or asphalt;
- Solvents used in paints, glues or other surface coatings;
- Petrol, diesel, oils and greases; and
- Degreasers, descalers and detergents.

All construction workers, but in particular bricklayers, roofers, road builders and painters, who have frequent contact with harmful substances are at risk of contracting dermatitis.

4.4.8 Noise

Some examples of typical noise levels are shown in the figure below:



(HSE, 2009)

Hearing loss caused by exposure to noise at work continues to be a significant occupational disease. Some 170,000 people in the UK suffer deafness, tinnitus or other ear conditions as a result of exposure to excessive noise at work.

Full compliance with the Control of Noise at Work Regulations 2005 will eventually eliminate occupational noise-induced hearing loss. HSE aims that by 2030 there should be no new cases of noise-induced hearing loss through noise at work. (Safety In Design, 2009)

Visit the HSE website to hear the effects of noise-induced hearing loss

Visit http://www.hse.gov.uk/noise/demonstration.htm

Hearing loss can make it difficult to understand speech, but this is not the only problem. Some people develop tinnitus (ringing, whistling, buzzing or humming in the ears) which is a distressing condition that can disturb sleep.

Remember:

- Young workers can be damaged as easily as older ones;
- Workers with damaged hearing need even greater protection.

Useful web links

http://www.rnid.org.uk/information_resources/aboutdeafness/

http://www.tinnitus.org.uk

4.4.8.1 Noise Risk Assessment

Noise is measured in decibels (dB). An 'A-weighting sometimes written as 'dB(A)', is used to measure average noise levels, and a 'C-weighting' or 'dB(C)', to measure peak, impact or explosive noises. You might just notice a 3 dB change in noise level, because of the way our ears work. Yet every 3 dB doubles the noise, so what might seem like small differences in the numbers can be quite significant.

Some typical noise levels for a range of construction-related processes. Actual levels can vary and may increase if the process takes place where there are 'reflective' surfaces, e.g. the basement of a building are shown in the table below:

Process		Noise Level
Working with concrete: chipping, drilling, floor finishing, grinding etc	Typical	85-90 dB
Labouring	General work	84 dB
	Shuttering	91 dB
	Shovelling hardcore	94 dB
	Concrete pour	97 dB
	Digging/ scabbling	100 dB
Driving machines or vehicles	Typical	85-90 dB
Carpentry	Typical	92 dB
Angle grinding/ cutting	Typical	90-110 dB
Piling	Machine operator	85 dB
	Piling worker	100 dB

View HSE assessment tool for assessing exposure to noise at: http://www.hse.gov.uk/noise/calculator.htm

4.4.8.2 Eliminating and Controlling Risks from noise

Safety in Design best practice

What designers should do

1. Designers should give consideration to measures, which either remove the hazard of noise or lessen its cumulative effects

2. Although exposure to noise in construction is inevitable with much of the state-of-the-art plant that is available, there are some construction processes, which are no longer necessary. In these cases, designers should not specify work, which requires such processes to be carried out. For example:

a) Scabbling "green" concrete to achieve a bonding surface is not always necessary. Instead, designers should specify;

i) retarding and washing off the joint interface;
ii) cast in proprietary joint formers;

b) Saw-cutting joints in concrete should be avoided and cast in crack inducers specified instead;

c) Chasing walls for services should not be necessary:

i) in new buildings, built-in ducting should be specified;
ii) in existing buildings, consider overcoating existing plaster if it is sound enough to do so and build ducts in;

d) Build proprietary ties into masonry joints instead of specifying site shot-firing;

e) Avoid site drilling wherever possible, e.g.: specify cast-in anchors instead of the drill-and-fix type;

f) Site grinding, cutting, etc should be kept to a minimum. For example by:

i) Detailing mesh reinforcement to suit designed bay sizes rather than cut to suit on site;
ii) specifying non-standard concrete blocks as specials, to be cut off site under controlled conditions;

g) Specify road and slab bases, which do not require the use of noisy rollers, e.g., dry-lean concrete;

h) Avoiding vibro-compaction of ground.

3. The health risks associated with exposure to noise can be lessened, by reducing a workers continuous exposure to noise. Designers may be able to affect either the duration of exposure by specifying processes that are of short duration or the level of exposure by designing for and specifying quieter methods. Examples include:

a) Designing the position of construction joints, etc, to limit the size of concrete pours to what can be achieved in two hours;

b) Designing for and specifying the quieter methods of driving piles, which are available.

4. In addition, to lessen the risk of increasing the intensity, designers should, if it is possible to do so, limit the number of noisy operations that need to be carried out in enclosed spaces with hard surroundings. Situations in which the intensity can be increased include:

a) Inside of box-girders – grinding welds, using power tools;

b) The inside of concrete structures – usually, but not exclusively, a problem associated with refurbishment work;

c) In sewers, box-culverts and manholes;

d) In cofferdams.

5. Some plant has been designed with noise reduction attachments. Designers should find out about these items and, where it is possible to do so, modify their designs to suit their use, if it is necessary to do so.

View Safety In Design technical guidance on noise at:
http://www.safetyindesign.org/images/stories/design-guides-pdfs/H%2020.002%20Noise.pdf

4.4.8.3 HSE Guidance on Noise Reduction

Alternative Work Methods

Look for alternative work methods that eliminate or reduce exposure to noise. Your trade association, industry contacts, equipment suppliers and trade journals may help to identify good practice in your industry.

Mechanise or automate work so that the operator is removed from the noisy environment (e.g. excavator cab).

4.4.8.4 Equipment Selection

Make sure that equipment is suitable and can do the work efficiently. Equipment that is unsuitable, too small or not powerful enough is likely to take longer to complete the task and increase exposure to noise.

Select tools that produce the least noise.

Limit the use of high-noise tools wherever possible.

Example: To cut large holes in brickwork, use a diamond-tipped hole-cutter with a rotary action rather than a tungsten-tipped bit, which requires rotary and hammer action. This reduces both vibration and noise exposure.

Example: Use vibration-dampened stone-cutting saw blades. Construction processes that lead to high levels of hand-arm vibration are often high-noise processes too.

SOUND solutions

For case studies on design related noise reduction techniques view:
http://www.hse.gov.uk/noise/casestudies/soundsolutions/index.htm

4.4.8.5 Hearing Protection

Assuming that noise cannot be eliminated, the most efficient and effective way of controlling noise is by technical and organisational means that protect workers at source, e.g. changes in process, reducing vibration (damping) and reducing time spent in noisy areas.

The level at which employers must provide hearing protection and hearing protection zones is now 85 decibels (daily or weekly average exposure) and the level at which employers must assess the risk to workers' health and provide them with information and training is now 80 decibels. There is also an exposure limit value of 87 decibels, taking account of any reduction in exposure provided by hearing protection, above which workers must not be exposed.

4.4.9 Vibration

Hand-arm vibration can cause a range of conditions called hand-arm vibration syndrome (HAVS). The best known is vibration white finger (VWF), but vibration also links to specific diseases such as carpal tunnel syndrome.

For some people symptoms appear after only a few months of exposure but for others it may take years. The symptoms are likely to get worse with repeated exposure and can lead to permanent damage and disfigurement. They can severely limit the jobs that someone is able to do, as well as affect family and social activities.

The symptoms include any combination of:

- Tingling and numbness in the fingers;
- Not being able to feel things properly;
- Loss of strength in the hands; and/or
- Fingers going white (blanching) and becoming red and painful on recovery (particularly in the cold and wet, and probably only in the tips at first).

The effects of these symptoms on people include:

- Pain, distress and disturbed sleep;
- Inability to do fine work (e.g. assembling small components) or everyday tasks (e.g. fastening buttons);
- Reduced ability to work in cold or damp conditions (i.e. most outdoor construction work), which is likely to trigger a painful finger blanching attack; and
- Reduced grip strength, which might affect the ability to work safely.

4.4.9.1 HSE Guidance On How To Reduce Exposure To Vibration

The Table on the next page shows alternative processes to avoid/reduce use of vibrating equipment.

This table identifies alternative methods for specified high risk activities or processes; and links to further information and case studies.

Activity or process	Alternative methods	Further information (links)
Tunnelling by hand with clay spade or jigger pick.	Mechanised tunnelling methods, to eliminate hand digging. This is expected for all but the smallest tunnelling jobs.	British Tunnelling Society, preparing a code of practice http://www.hse.gov.uk/vibration/hav/campaign/construction/tunnelling.htm Tunnelling and Pipe jacking Guidance for Designers www.hse.gov.uk/construction/pdf/pjaguidance.pdf
Breaking concrete, asphalt, etc. with hand-operated breakers in ground work, road	Plan construction work (e.g. casting-in ducts, detail box-outs) to minimise breaking through new concrete/masonry. Use alternative method/equipment as appropriate: • machine-mounted hydraulic breakers • floor saws • directional drilling/pipe jacking to avoid trenching • hydraulic crushers • hydraulic bursters • diamond core drilling • diamond wire cutting • hydro-demolition (UHP water jetting)	http://www.hse.gov.uk/vibration/hav/campaign/construction/cicguidance.htm http://www.hse.gov.uk/vibration/hav/campaign/construction/mountedroadbreaker.htm http://www.hse.gov.uk/vibration/hav/campaign/construction/directionaldrilling.htm http://www.hse.gov.uk/vibration/hav/campaign/construction/crushingconcrete.htm http://www.hse.gov.uk/vibration/hav/campaign/construction/burstingconcrete.htm http://www.hse.gov.uk/vibration/hav/campaign/construction/diamondwire.htm http://www.hse.gov.uk/vibration/hav/campaign/construction/waterjetting.htm http://www.hse.gov.uk/vibration/hav/campaign/construction/codeofpractice.htm
Pile cropping using hand-held hammers/breakers	Pile cap removal using hand-operated breakers is not acceptable. Use alternative method as appropriate: • Elliott method • Recipieux method • suspended hydraulic pile cropper • the above alternatives to hand-operated breakers, especially machine-mounted breakers • design pile spacing and pile re-bar for mechanised cropping • Note: some dressing using hand-operated tools may still be required	http://www.hse.gov.uk/vibration/hav/campaign/construction/pilecrop.htm http://www.lboro.ac.uk/research/design4health/public_area/press_rel/pile_case/pile_case.html
Scabbling using: Needle scalers Hammer type scabblers Pole type scabblers	Scabbling purely for architectural aesthetic effect is not acceptable. Specify finishes that do not require scabbling. (Some finishes can be designed into shuttering using special moulds or chemical retardants and water jetting.) Surface preparation to ensure a good concrete bond. Use alternative methods where technically appropriate: • grit blasting (wet or dry) • use of chemical retarders and pressure washing • cast in proprietary joint formers e.g. mesh formwork • UHP water blasting (refer to CoP for safety guidance)	http://www.hse.gov.uk/vibration/hav/campaign/construction/gritblasting.htm http://www.hse.gov.uk/vibration/hav/campaign/construction/paintonmaterial.htm http://www.hse.gov.uk/vibration/hav/campaign/construction/specialformwork.htm http://www.hse.gov.uk/vibration/hav/campaign/construction/waterjetting.htm
Wall chasing using hand-held breakers	• in new buildings, specify built-in ducting • in existing buildings, consider over coating existing plaster and building in the ducts	http://www.hse.gov.uk/vibration/hav/campaign/construction/cicguidance.htm
Drilling masonry/concrete using: Electric hammer drills or "combihammers"	Design and plan to avoid unnecessary drilling. Use, where appropriate: • jig-mounted drilling • diamond core drilling (clamped in rig) • cast-in anchors and channels for wall fixings instead of drill-and-fix types • use of direct fastening tools	

Note 1: changes of process to eliminate or reduce vibration may introduce other hazards to health (e.g. noise, dust) or safety which must be addressed and managed (e.g. hazards associated with lifting operations in some mechanised methods for pile cap removal).

The table below shows examples of how contractors may have to manage HAV risks where use of vibrating equipment has not been designed-out or is unavoidable.

Issue	Expectation	References and related guidance
Selection of work equipment	Tool selection can make a substantial difference to the vibration level but the tool must be suitable for the task and used correctly. Employers should demonstrate a sound procurement policy for power tools and hand-guided machines, showing they have considered the following: • There is no reasonably practicable alternative method with no (or less) vibration exposure (see Table 1) • Equipment is generally suitable for the job (safety, size, power, efficiency, ergonomics, cost, user acceptability, etc.) • Reduced vibration designs are selected provided the tools are otherwise suitable (e.g. breakers with handle suspension) • Declared vibration emission is not high compared with competing machines of similar capacity to do the job • Information on likely vibration emission in use (e.g. from manufacturer, hire company, databases) • Available information from the manufacturer or elsewhere on control of vibration risks through: • maintenance (e.g. servicing grinders, sharpening drills and chisels) • Selection of consumables (abrasive discs, chisels, drills, etc.) • correct operation and operator training (see below) • maximum daily trigger times or maximum daily work done with the tool.	http://www.hse.gov.uk/vibration/hav/campaign/construction/selectingequipment.htm
Limiting daily exposure time	Restricting exposure time ("finger-on-trigger" time) may be required to bring exposures below the ELV, even after all reasonably practicable measures to reduce vibration levels are in place. Maximum times can be determined using the exposure points system or supplier's "traffic lights" tool categories, but these should be derived from sound "real use" vibration emission values. Note: Employers tend to ask "How long can we use this tool?" The exposure must be reduced to the lowest level that is reasonably practicable (Reg 6(2)), so the ELV should not be used as a target, if a lower exposure is reasonably practicable.	http://www.hse.gov.uk/vibration/hav/campaign/construction/exposureperiod.htm http://www.hse.gov.uk/vibration/hav/readyreckoner.htm
Other risk controls	Control of HAVS risk by means other than reducing vibration exposure: • Ergonomic aids support weight of tool and reduce forces applied by operator • Suitable workplace temperature or provision of warm clothing and gloves • Regular breaks from work involving vibration and encourage operators to exercise fingers	http://www.hse.gov.uk/vibration/hav/campaign/construction/warmclothing.htm http://www.hse.gov.uk/vibration/hav/campaign/construction/othermeasures.htm
Information, instruction and training	Employees at risk from vibration should have received information on: • the risks from HAV and how to help reduce them (see above) • arrangements for health surveillance and their duty to cooperate. Look for evidence that tools are being used correctly, as recommended by the manufacturer. This may require operators to receive specified training – are operators and their supervisors aware of the need? In particular, breakers with suspended (sprung) handles designed to absorb vibration must be used correctly, and with appropriate force, or the potential reduction in vibration will not be achieved.	http://www.hse.gov.uk/vibration/hav/campaign/construction/informationandtraining.htm http://www.hse.gov.uk/vibration/hav/campaign/construction/operatortraining.htm
Health surveillance	Required where the EAV is likely to be exceeded. Expect to see, as a minimum: • use of a periodic health screening questionnaire – ideally annually and for new employees • arrangements for referral of relevant cases to an occupational health provider with HAVS expertise for diagnosis and on-going monitoring • arrangements to receive medical advice on management of affected employees • arrangements for RIDDOR reporting of HAVS cases • arrangements to receive anonymised information to demonstrate effectiveness of controls although this may not be meaningful for casual/short-term workers • In construction, short-term employment presents difficulties for managing health surveillance; cooperation between employers should be encouraged.	http://www.hse.gov.uk/vibration/hav/advicetoemployers/healthsurveillance.htm

Source: http://www.hse.gov.uk/vibration/hav/campaign/construction.htm

4.4.9.2 Risk Assessment Tools

The HSE has developed tools that will assist in undertaking risk assessments for activities involving exposure to hand-arm vibration and can be found using the link below:

www.hse.gov.uk/vibration/hav/advicetoemployers/assessrisks.htm

4.4.10 Manual Handling

Assessing Health Risks

Musculoskeletal injuries are common in the construction industry. They typically arise from work that involves:

- Lifting, lowering and carrying heavy materials (e.g. roof tiles);
- Pushing and pulling objects and equipment (e.g. barrows);
- Bending and twisting (e.g. plastering);
- Repetitive movements (e.g. tying rebar);
- Working too long without breaks;
- Awkward working positions (e.g. bending or crouching) or restricted space (e.g. working in a roof void); and
- High job demands or time pressure, which may mean that workers resort to brute force rather than using a mechanical handling solution.

Injuries are often caused by a combination of:

- The work itself (e.g. the weight of a load or the force that needs to be applied);
- The work environment, including weather conditions; and
- A worker's physical capability.

HSE has developed the Manual Handling Assessment Chart (MAC) to help you to identify and prioritise activities that involve a risk of MSD. You may also find it useful to talk to workers about the tasks they do at work and how they are actually done. Ask if any of them have experienced MSD problems or back pain.

Some activities you may need to consider include:

- Asbestos removal;
- Block laying;
- Ceiling fixing;
- Cladding/sheeting;
- Curtain wall installation;
- Diamond drilling/sawing;
- Dry lining;
- Ductwork installation;
- Ground works;
- Mechanical and electrical work;
- Piling operations;
- Plant operation;
- Plastering;
- Pre-cast concrete installation;
- Roads and paving;
- Scaffolding;
- Structural steel work;
- Tunneling; and
- Window installation.

If you do not have information (including weight) about products you intend to use, contact the supplier - they have to provide customers with relevant health and safety information.

Access the HSE MAC tool using this link
http://www.hse.gov.uk/msd/mac/

Safety In Design – Best Practice Advice For Musculo-Skeletal Injuries (MSI)

Controlling The Hazard By Design

At the design stage, designers should assess the risks to hea th introduced by their requirements and change the details if necessary. In certain circumstances it may be possible to discuss, with a contractor, the construction methods likely to be employed. If not, designers will need to consider how the work is likely to be constructed.

Generally, overall design concepts should, as far as possible, reduce the need for long duration repetitive or strenuous activ ty.

Generally, designers should consider details, which avoid these operations. For example, designers should consider:

a) Eliminating the need for manhandling heavy components, e.g., high density block

b) Designing to allow use of plant for materials handling and processing rather than manual methods, i.e.:

i) by using layouts, which provide sufficient space for mechanical plant, and
ii) by detailing, components so that their sizes are compatible with machines currently available;

c) Not specifying operations, which require

i) hand-held tools, which vibrate, e.g., needle guns, power saws, etc, or
ii) tools, which are heavy or awkward to use, e.g., concrete drills, pneumatic breakers; because they are likely to contribute to MSI;

d) Not specifying operations, which will require people to work in awkward or cramped conditions. Information on anthropomorphic (human body) measurements is widely available;

e) Detail the works to allow for maximum off-site prefabrication, e.g.:

i) using reinforcing mesh instead of individual bars wherever possible,
ii) detailing reinforcement to allow fabrication in a more accessible situation;

f) Dimension the works to allow the use of non-hand held tools for cutting, excavation and compaction. For example:

i) Trench widths should be sized to allow remotely controlled compaction,
ii) Trench widths should not be narrower than minimum excavator bucket sizes,
iii) Detail reinforcing mesh so that it arrives on site at the correct size, rather than to be cut on site;

Layouts, dimensions of buildings and structures and clearances should allow good access for building and maintenance tasks, for example:

a) Heights of work should fit with module sizes of temporary works equipment

b) Corridor widths should allow use of mobile TWE;

c) Service runs could be designed to be at heights, which fit in with TWE module sizes;

d) Service runs should be detailed with enough space around them, so that they can be grasped properly;

Controlling Hazards by Information

When t is not possible to eliminate the hazards, it is essential that this is communicated to the contractor and others involved in the project. Designers must supply relevant information on residual hazards. This can be communicated through meetings, noted on drawings and must be included in the Construction Phase Plan.

Some examples of how the designer might be able to help are given in Table 1. Note that this table is not exhaustive and is for guidance only. It is for the designer to identify the risks and to set out appropriate control methods.

Table 1 Examples of Risk Control Measures

Activity	Health Risk	Possible Control Measure
Laying block paving	WRULD	Design for machine laying: space, component size, etc.
Brick laying	WRULD	Design to reduce long duration repetition.
Tying reinforcement	WRULD Back injury	Use welded mesh; detail to allow prefabrication and lifting in.
Block laying	Back injury	Use lighter blocks.
Materials Handling	Back injury	Adequate space for available machines; Specify low weight packages.
Working in small or awkward spaces	Back injury &Other MSIs	Dimension: height, width, to fit modules of TWE; Size rc components to minimise pushing /pulling while fixing re-bar.
Use of hand tools, e.g. a) in rc work, b) compaction	HAVS	Design for: a) use of crack-inducers; or non-scabbled joints; b) Remote compaction.
Pile cropping	HAVS	Design spacing and pile re-bar for machine Cropping.
Cutting, e.g., a) chases, b) joints in rc, c) blocks, etc	HAVS	a) Provide ducts, detail box-outs, b) Use crack inducers, c) minimise number of cuts.

Note: WRULD work-related upper limb disorder.

HAVs hand arm vibration syndrome.

MSI musculo-skeletal injury.

Construction operations in which workers are particularly exposed to MSI include:

a) Bricklaying – high density blocks;

b) Glazing – installing heavy windows;

c) Manoeuvring heavy components while laying paving and kerbstones;

d) Working while bent over, e.g.:

i) Concrete work requiring – hand spreading, vibrating, hand floating large areas of concrete and cutting joints;
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iii) pressure washing;
iv) compacting equipment;

g) Using hand held diggers and breakers;

Common types of MSI and the activities, which can cause them, may be summarised as follows:

a) Back injury: caused by lifting and carrying of plant and materials or working in awkward conditions;

b) Work- related upper limb disorder [WRULD]: caused by carrying out repetitive tasks over long periods;

c) Hand arm vibration syndrome [HAVs]: caused by exposure to vibrations from plant and machinery.

The situation is exacerbated by:

a) Workers who often do not recognise that carrying out tasks in a particular way may result in long-term ill-health. Their working methods are frequently based on ‘how it has always been done’; and

b) Contractors work methods, which are usually driven by site, planning, time or financial constraints;

c) Sometimes thoughtless design creates the problem.

View Safety In Design Website and find other technical information
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Example: Risk assessment for MSDs

Step	Action	Example
1	Identify the hazards	32 kg trench blocks are to be used at ground level on a supermarket site.
2	Decide who might be harmed and how	Bricklayers moving and laying the blocks.
3	Evaluate the risks and decide on precautions	The bricklayers will be at significant risk from distributing the heavy blocks and the frequent lifting, bending, carrying and twisting involved while laying them. The risk will be managed by discussing with the designer to see if the foundations can be constructed using an alternative method, e.g., trench fill, concrete or piling. If this is not possible: • uses lighter blocks (or bigger blocks and handle them mechanically). Discuss the selection of these with the designer (via principal contractor); • investigate the use of a lifting equipment to avoid or reduce manual handling; • use plant to deliver the blocks to the to the point of use to reduce carrying; • investigate whether access in the trench can be improved, e.g. by specifying a wider excavation or using in-trench boarding; • provide gloves to improve grip and protect hands from cuts, abrasion and the blocks drying the skin. Arrange training or refresher training in manual handling skills.
4	Implement the findings and record them	Meet the bricklayers to: • make them aware of the MSD risk; • discuss the issue; • make sure that they understand what is required of them; and Check they have the correct equipment and personal protective equipment (PPE).
5	Review your risk assessment and update if necessary	This part of the work is due to take three weeks. A further meeting to be held with the bricklayers after one week to check above measures working or change if needed.

Sample solutions (HSE, 2009):

If you usually	Consider
Base the substructure on a strip foundation	Other solutions, e.g. trench fill
Lay a block wall	Changing the design to a panel wall system
Lay heavy blocks over 20 kg	Lighter blocks
Lay kerbs and flags	A different product or construction process, or use vacuum/mechanical handling equipment
Distribute materials by hand	A self-erecting crane - get maximum benefit by erecting it at an early stage of the build
Carry or haul materials up onto a scaffold	An electric chain hoist
Carry plasterboard up a stairwell	Planning ahead so that materials are lifted into the building and distributed by pallet truck while plant such as cranes and tele-handlers still has access
Mix mortar on site	Pre-mixed mortar or a batch mix silo
Load up roof tiles by hand	A ladder hoist
Install heavy mechanical and electrical pipes at height	Making sure that the powered access platform is fitted with suitable hydraulic lifting equipment
Install cladding from a scissor lift	Hiring proprietary handling equipment
Turn and distribute composite roof sheets	Providing a suitable lifting accessory or beam

Poor manual handling techniques can result in injuries to muscles and joints.

For more information visit
http://www.hse.gov.uk/construction/healthrisks/

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Appendix One

Glossary Of Abbreviations

ABB	DEFINITION	USEFUL WEB LINK
ALARP	As low as reasonably practicable	http://www.hse.gov.uk/risk/theory/alarp.htm
BOHS	British Occupational Hygiene Society	www.bohs.org
CAR	Control of Asbestos Regulations	http://www.hse.gov.uk/asbestos/index.htm
CDM	Construction (Design & Management) Regulations	http://www.hse.gov.uk/construction/cdm.htm
CLAW	Control of Lead at Work Regulations	http://www.hse.gov.uk/lead/index.htm
CNS	Central Nervous System	
COPD	Chronic Obstructive Pulmonary Disorder	http://www.hse.gov.uk/construction/healthrisks/respiratory.htm
COSHH	Control of Substances Hazardous to Health	www.sypol.com http://www.hse.gov.uk/coshh/index.htm
DSEAR	Dangerous Substances and Explosive Atmosphere Regulations	http://www.hse.gov.uk/fireandexplosion/dsear.htm
ERIC	Eliminate, Reduce, Isolate, Control	Risk management framework Contact Sypol Limited www.sypol.com
HASWA	Health and Safety at Work etc Act 1974	http://www.hse.gov.uk/legislation/hswa.htm
HAV	Hand-arm vibration	http://www.hse.gov.uk/vibration/index.htm
HAVS	Hand-arm Vibration Syndrome	http://www.hse.gov.uk/vibration/index.htm
HSE	Health and Safety Executive	www.hse.gov.uk
ILO	International Labour Organisation	http://www.ilo.org/global/lang--en/index.htm
LEV	Local Exhaust Ventilation	http://www.hse.gov.uk/lev/index.htm
MSD	Musculo-skeletal disorder	http://www.hse.gov.uk/msd/index.htm
NIHL	Noise-induced hearing loss	http://www.hse.gov.uk/noise/index.htm
PPE	Personal Protective Equipment	www.sypol.com
REACH	Registration, Evaluation & Assessment of Chemical Hazards	http://www.hse.gov.uk/reach/index.htm
TWE	Temporary Works Equipment	
RPE	Respiratory Protective Equipment	www.sypol.com
WBV	Whole-body vibration	http://www.hse.gov.uk/vibration/index.htm
MSI	Musculoskeletal injuries	www.safetyindesign.org

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