ACKNOWLEDGEMENTS

RenewableUK acknowledges the time, effort, experience and expertise of all those who contributed to this document.

This document was prepared for RenewableUK by SgurrEnergy Ltd.

STATUS OF THIS DOCUMENT

RenewableUK Health and Safety Guidelines are intended to provide information on a particular technical, legal or policy issue relevant to the core membership base of RenewableUK. Their objective is to provide industry-specific advice or guidance, for example where current information could be considered absent or incomplete. Health and safety guidelines are likely to be subject to review and updating and so the latest version of the guidelines must be referred to. Attention is also drawn to the disclaimer below.

DISCLAIMER

The contents of these guidelines are intended for information and general guidance only, do not constitute advice, are not exhaustive and do not indicate any specific course of action. Detailed professional advice should be obtained before taking or refraining from action in relation to any of the contents of this guide, or the relevance or applicability of the information herein.

RenewableUK is not responsible for the content of external websites included in these guidelines and where applicable the inclusion of a link to an external website should not be understood to be an endorsement of that website or the site's owners (or their products / services). The lists of links and references are also not exhaustive.

LINKS AND UPDATES

All reasonable care has been taken to ensure that the references and links included in the guidance are accurate and effective at the date of publication. However should you identify any references or links that appear to be out of date or compromised, RenewableUK would welcome these being brought to our attention. Please e-mail any comments or concerns to: healthandsafety@RenewableUK.com.

CHANGES IN LEGISLATION AND STANDARDS

These guidelines reflect legislation, standards and other published guidance such as industry rules, at the date of publication. It is recognised that some key reference publications are currently being reviewed; these guidelines are therefore subject to periodic revision, to take account of such changes.

Many of the Approved Codes of Practice and Guidance documents endorsed by the HSE and referenced in this publication are currently under review. This may mean that links from this document no longer reach the target document, and that previously referenced guidance is no longer available.

VERSION

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Note: This document is recommended to be viewed as a pdf; this enables all headings to be used as bookmarks for ease of navigation:
Introduction

The publication of the Onshore Wind Health & Safety Guidelines represents a further key milestone for the renewable energy sector. They support the strategic vision of RenewableUK:

“to continue to be a leading enabler in the delivery of an expanding UK wind, wave and tidal sector free of fatalities, injuries, work related ill-health and environmental incidents.”

The guidelines support our commitment to championing health & safety and environmental protection for the benefit of everyone in the wind, wave & tidal industry thereby:

- Continuing to make the UK a leader as a safe and responsible jurisdiction in which to do business; and
- Ensuring that Health & Safety and Environmental Protection remain as a top priority throughout all sectors of the industry.

STATUS OF THE GUIDELINES

The guidelines do not define or mandate any new industry standards or requirements. They have been developed by taking account of existing and emerging industry good practice within the framework of UK health and safety legislation. Specifically, the guidelines consider the occupational health and safety of employees and others who may be exposed to risks as set out under the Health and Safety at Work etc. Act 1974 and the applicable subordinate regulations.

The guidelines do not aim to influence or direct any specific risk management, operational, technical or other solution. Duty holders throughout the lifecycle of a wind energy project continue to be responsible for ensuring compliance with regulatory and contractual obligations, and so must make their own assessment of the relevance and suitability of any guidance provided. However, while no new standards are set out, the guidelines collectively are likely to be regarded as representing the current industry state of knowledge for the issues addressed.

TARGET AUDIENCE OF THE GUIDELINES

The guidelines are primarily written from the perspective of the developer or client in relation to projects designed, constructed, operated and maintained in the United Kingdom. However, they are likely to also provide a useful reference source for:

- Designers and Manufacturers – of wind turbine generators (WTGs), balance of plant and associated project infrastructure;
- Contractors – including Principal Contractors and other contracting and supply chain parties; and
- Professional advisers – including nominated health and safety competent persons, CDM Co-ordinators, inspection and certification companies and other occupational health and safety advisers.

SCOPE AND CONTENT OF THE GUIDELINES


For the purpose of this guidance:

- Onshore wind projects, referred to as “wind farms” in this document, are considered to relate to:

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1 Including the associated balance of plant and project infrastructure.
WTGs as defined by:
- BS EN 61400-1:2005+A1:2010 – Wind turbines - Design requirements; and
- BS EN 61400-2:2014 - Wind turbines. Design requirements for small wind turbines; together with

The associated balance of plant and project infrastructure.

The guidance also takes account of small and where applicable medium WTGs supported under the Feed-in Tariff (FIT) in Great Britain and subject to the Microgeneration Certification Scheme (MCS).

The guidelines acknowledge a collective responsibility for health and safety in the industry, and so support a strategic objective to enhance the overall health and safety performance of the sector.

However, the guidelines cannot cover every relevant issue or every possible risk associated with the lifecycle of wind energy projects. For example, the guidelines do not address the relationship between health and safety law and employment law, which can sometimes be at odds.

STRATEGIC HEALTH AND SAFETY CONTEXT

The strategic importance and business benefits³ of good health and safety management are recognised by all responsible organisations. Good practice in health and safety makes sound business sense and can help to:

- Protect people from the suffering caused by accidents and ill health;
- Reduce absences and sick leave;
- Retain staff;
- Maintain an organisation's reputation;
- Improve productivity and profits; and
- Reduce insurance premiums and legal costs.

While these broad outcomes are all relevant to the sector, good health and safety management can also offer specific benefits, including:

- Supporting and enhancing the overall improvement in health and safety performance for onshore wind projects;
- Adding value and reducing costs and uncertainty, by supporting the timely, effective, safe and sustainable delivery and operation of assets throughout their lifecycle;
- Contributing to the reduction of both direct and indirect health and safety related risks within the sector;
- Addressing complex or contentious issues that are unique or have a particular sector-specific dimension; and
- Protecting and enhancing the reputation of the UK renewable energy industry.

RenewableUK’s Health, Safety & Environmental Vision, Mission and Strategy and supporting work plan enables organisations to show their commitment to:

- Clear and visible leadership on health and safety;
- Being part of a responsible industry that is fully engaged in self-regulation, by confronting its key health and safety challenges; and
- Taking a proactive stance on health and safety, to eliminate hazards and reduce risks.

Examples of how companies can take account of this in the strategic goals and priorities of their business include:

- Recognising that good health and safety is an integral part of the safe delivery and operation of onshore wind projects;
- Adopting lifecycle thinking, and a lifecycle approach to managing health and safety risks, with particular emphasis on health and safety considerations influencing the project concept and design;
- Ensuring direct and indirect health and safety and commercial benefits, through the development of effective partnerships and alliances when managing health and safety risks;
- Applying an iterative risk management approach that takes account of the rapidly changing state of knowledge within the sector;
- A commitment to monitoring performance and sharing good practice, to enable lessons to be learnt, and good industry practice to be widely communicated;
- Ensuring effective co-operation and co-ordination of all contracting parties, including setting out clearly defined roles and responsibilities; and
- Recognising the need to develop and maintain individual and organisational health and safety competencies relevant to the risks concerned.

**STRUCTURE OF THE GUIDELINES**

Although the guidelines are published as a single document, they are designed to be accessed and used as an initial reference source on a wide range of topics, providing clear signposting of key supporting health and safety information on the topic concerned. Where possible, references are provided as links to other related sections of the guidelines, or external reference sources. For these reasons, while the document can be printed, it will be most effective if used as an electronic document, using bookmarks to section headings within the document, and hyperlinks to access supporting guidance on the internet.

The guidelines are structured as follows:

**Part A:** Health and Safety Management;

**Part B:** The Project Lifecycle;

**Part C:** Key Hazards and Activities; and

**Part D:** References and Glossary.

**Part A** sets the context for health and safety management in wind farm development. It considers:

- The **legal frameworks** that apply to activities;
- The importance of **leadership** and the establishment of a positive health and safety culture including effective workforce engagement, human factors and occupational health, and the minimisation of collective risk through the development of shared values;
- Health and safety **management systems** and **risk management** including their role in developing competence and safe systems of work;
- The significance of **stakeholder engagement** and **supply chain management**, including the management of change, and **strategic planning**; and
- Approaches for **emergency response and preparedness** and **first aid** provision.

**Part B** sets out a generic lifecycle framework in order to identify, assess and manage the main health and safety hazards and risks that could reasonably arise in wind farm development. It also aims to put in context the potential critical timelines and decision points to enable suitable and effective health and safety precautions to be identified and put into effect. It considers:
- The relevance and importance of a **lifecycle approach** to the management of health and safety;
- The **project definition** and **project design** phases, and how they will affect subsequent lifecycle phases; and
- The significant phases creating a direct occupational health & safety risk exposure including **construction & commissioning, operations & maintenance** and **decommissioning**;
- Major supporting activities that span the above phases.

**Part C** aims to consider the most significant health and safety hazards and activities relevant to onshore wind projects. It considers:

- **Access, driving, transport** and **logistics** issues;
- **Construction** and **infrastructure** risks;
- Safety risks including **confined spaces, electricity** and **fire** as well as **remote / lone working, lifting** and **working at height**;
- Health and related risks including **hazardous substances, noise, vibration, ergonomics** and **welfare** as well as the health and safety issues in **waste and spillage** management; and

Within Part C, these topics are arranged in the alphabetical order of their titles.

**Part D** includes a list of references and a glossary of terms and abbreviations used in the guidelines.
Part A Health and Safety Management

INTRODUCTION
This part of the guidance sets the context for health and safety management in wind farm development, and considers:

- The role of leaders, and the establishment of a positive health and safety culture;
- The regulatory frameworks that apply to work activities;
  - The focus is on the frameworks relating to occupational health and safety risk arising over the lifecycle of a wind farm;
  - Regulatory requirements in relation to specific activities and hazards are covered in Part C;
- Health and safety management arrangements in relation to:
  - The organisation itself, including the management of risk, the health of the workforce, and the operation of safe systems of work; and
- Commonly applied techniques for managing planned and emergency situations.

This guidance provides an overview in each of these areas, with links to more detailed guidance documents, which can help in addressing specific issues.

The interactions between health and safety issues, over the different phases in the whole lifecycle of a wind farm, are addressed in Part B.
A.1 LEGAL FRAMEWORK

The Health and Safety at Work etc. Act 1974 (HSWA) modernised the legal framework for health and safety in Great Britain (GB), replacing numerous industry-specific regulations, with non-prescriptive general duties under the Act; more prescriptive regulations are made to address specific activities and hazards, rather than industrial sectors. The effect of this approach is that, even though there are no regulations that specifically address renewable energy, the relevant activities and hazards are already subject to existing regulations and the general duties under the HSWA.

This section outlines the principal acts and regulations that address the overall framework for health and safety management in onshore wind projects; regulations pertaining to specific activities and hazards are covered in the relevant sections of Part C.

The Health and Safety at Work (Northern Ireland) Order 1978 established matching provisions for Northern Ireland (NI), and a matching set of regulations is in force, therefore unless otherwise stated, these guidelines describe the regulatory requirements for the whole of the UK, even though they are implemented by different statutory instruments in GB and NI.

A.1.1 HEALTH AND SAFETY AT WORK ETC. ACT 1974

The HSWA imposes general duties upon:

- Employers, employees and the self-employed;
- Those who have control of workplaces; and
- Designers, manufacturers, importers and suppliers of articles and substances for use at work;

...to ensure, so far as is reasonably practicable, the health and safety of those who may be affected by their actions or omissions, whether they be employees, users of equipment or premises, or members of the public; employers have an additional duty to ensure the welfare of their employees at work.

A fundamental principle of the Act is to make those who create risks, in the course of work activity, responsible for protecting workers and the public from the consequences of their activities. The HSE requires duty-holders to identify and address “hazards which are a reasonably foreseeable cause of harm, taking account of reasonably foreseeable events and behaviour”.

The Act also establishes:

- The Health and Safety Executive (HSE) as the regulator;
- A framework for regulations to be made under the Act, which also provides a means for EU directives to be adopted as UK regulations;
- The legal status of Approved Codes of Practice (ACOP) published by the HSE;
- The system of enforcement of regulations, including the powers of inspectors, and the issue of improvement and prohibition notices;
- The arrangements for prosecution of offences, which allow for directors or other company officers to be prosecuted where they are responsible for an offence by a corporate body.

The Act and subsidiary regulations generally adopt a “goal-setting” approach, in that they set objectives, with broad applicability, and leave duty holders to determine the best way of achieving these objectives, rather than imposing particular approaches, standards or technical solutions. However, it must be noted that in some cases, regulations impose absolute duties, which are not qualified in any way and must be complied with.

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4 From HSE – Reducing Risks, Protecting People.
A.1.1.1 *Reasonably Practicable*

In essence, health and safety law in the UK seeks to ensure that duty holders reduce all material risks, “so far as is reasonably practicable” (SFAIRP), also expressed as “as low as reasonably practicable” (ALARP). Material risks are those that are more than fanciful, and are real. SFAIRP and ALARP are central to the general duties under the Act and its subsidiary regulations. There are very few cases in which regulations define an exact technical specification; in most cases, the duty holder will have to identify a specification or practice that will reduce risk ALARP.

When determining whether a risk has been reduced ALARP, both cost and risk reduction are considered; however, the decision is weighted in favour of health and safety: further risk reduction measures should be implemented unless the cost or effort of doing so would be grossly disproportionate to the resulting risk reduction. In the event of legal proceedings relating to this duty, it is for the duty-holder to demonstrate that they had reduced risk ALARP, rather than for the prosecution to show that they had failed to do so; this reverses the normal burden of proof.

When considering if a risk has been reduced ALARP, control measures can be compared against recognised and relevant good practices, including HSE ACOPs and Guidance; if these do not cover the full scope of activities, then recognised good practices should be followed as far as possible, and an assessment made of whether more can be done to reduce the risk. Note that the fact that a practice is universal in an industry does not necessarily mean that it is a good practice; established practices should be reviewed against current legislation, available technology, and relevant good practices that have been demonstrated elsewhere.

Note that it is neither possible, nor a regulatory requirement, to eliminate all risks; rather, the actions taken to reduce risk should be proportionate to the risk involved.

A.1.1.2 *Legal Status of ACOPs and Guidance*

Regulations are Statutory Instruments, made by government, and must be complied with. As legal documents, they define duties precisely, but more practical explanation is helpful in understanding their application, so the HSE publishes ACOPs and Guidance on regulations and other specific topics to assist in this. These are generally published in the same document, with formatting to ensure that the distinction between them is clear, given their different legal statuses.

ACOPs provide practical guidance on how to comply with the law, and have a special legal status:

- If a duty-holder follows the advice in the ACOP, then they will be deemed to be complying with those legal duties that it covers;
- If a duty-holder is prosecuted for a breach of health and safety law (i.e. the Act or a regulation), and it is shown that they did not follow the advice in the ACOP, then they will need to show that they have satisfied the legal duty in some other way, otherwise they will be found to be non-compliant.

Guidance also provides practical means of complying with the law, but does not have the same legal status; while it is seen as best practice, and following it will normally ensure compliance with relevant legal duties, duty-holders are free to take other action.

A.1.1.3 *Health and Safety Executive for Northern Ireland (HSENI)*

The Health and Safety at Work (Northern Ireland) Order 1978 establishes the HSENI, and provides for the making and enforcement of regulations in a similar manner to the arrangements in Great Britain; further details are available from the [HSENI website](https://www.hseni.com). In most cases, the HSENI has authorised GB ACOPs for use in NI, however there are some specific ACOPs and Guidance documents for NI.

A.1.1.4 *References*

A complete list of the regulations enforced by the HSE is available on the Statutory Instruments page of the HSE website.

HSENI publishes lists of **GB ACOPs approved for use in NI, NI ACOPs** and **NI Guidance**.
A.1.2 **EUROPEAN HEALTH AND SAFETY DIRECTIVES**

Many aspects of health and safety are subject to EU directives, the requirements of which are generally transposed into UK legislation in the form of Statutory Instruments (regulations) made and enforced under the HSWA. The EU Framework Directive on Safety and Health at Work, adopted in 1989, set out to guarantee minimum health and safety standards throughout Europe, while still allowing member states to maintain or establish more stringent conditions. Key EU health and safety directives, and the associated GB and NI regulations, are listed in Table 11 in the Appendix; note that only the most relevant regulations are listed, as each directive may affect multiple sets of regulations.

As EU directives are implemented in this manner, the general duties under the HSWA still apply, in particular the ALARP principle. There may also be substantive differences in requirements or application between the EU directive and the related UK regulations. These differences may mean that contractors and suppliers from other member states are used to different requirements and approaches, despite the regulations being of common origin.

In addition to health and safety directives, “New Approach” directives on the supply (rather than use) of products include extensive technical rules, many of which define health and safety requirements to be addressed in product design and manufacture, with the aim of ensuring that products have to conform to the same requirements across the EU. Member states cannot impose product safety requirements that differ from those set out in the relevant “New Approach” directive. A key example of this is the Machinery Directive, implemented in UK law as the Supply of Machinery (Safety) Regulations, which are made under the European Communities Act 1972, rather than the HSWA, but enforced by the HSE.
A.1.3 MANAGEMENT OF HEALTH AND SAFETY AT WORK REGULATIONS 1999 (MHSWR)

The MHSWR, also known as the Management regulations, are aimed mainly at improving health and safety management, by promoting a systematic approach. The regulations require employers, amongst other duties, to:

- Establish a health and safety policy;
- Assess the risks to the health and safety of their employees and others who may be affected by their work activities;
- Make arrangements for putting into practice the health and safety measures that the risk assessment shows to be necessary; these arrangements should cover planning, organisation, control, monitoring and review;
- Establish plans for the response to emergencies, considering both internal response and the involvement of emergency services;
- Ensure co-operation on health and safety measures between contractors and subcontractors;
- Ensure that they have access to competent health and safety advice;
- Provide suitable supervision; and
- Consult with employees regarding workplace risks and preventive and protective measures.

In organisations with five or more employees, the health and safety policy and risk assessments must be recorded.

Specific risk assessments that may be required under other regulations, such as COSHH or Manual Handling regulations, will partially fulfil the duty to carry out assessments under the MHSWR, and therefore do not need to be repeated or supplemented, provided that they remain valid and cover all significant risks.

The MHSWR further expand the general duties under the HSWA by requiring employers to take account of their employees’ capabilities, in relation to their health and safety, when giving them tasks to do; this could include the employee’s previous training, knowledge and experience. The employee’s competence will affect the level of supervision that is required in order for them to work in a safe manner.

A.1.3.1 REFERENCES

HSE HSG65 - Managing for health and safety.
A.1.4 CONSTRUCTION (DESIGN AND MANAGEMENT) REGULATIONS 2007 (CDM)

The CDM Regulations provide a framework for the management of construction projects. The key aims of CDM are to:

"integrate health and safety into the management of the project and to encourage everyone involved to work together to:

a) improve the planning and management of projects from the very start;

b) identify hazards early on, so that they can be eliminated or reduced at the design or planning stage, and the remaining risks can be properly managed;

c) target effort where it can do the most good in terms of health and safety; and

d) discourage unnecessary bureaucracy"\(^5\).

Managing a project in accordance with CDM will involve the production of certain documents for notifiable projects, namely Pre-Construction Information, a Construction Phase Plan, and a Project Health and Safety File, however, these documents only exist as a means to support effective communication and the safe management of a project, and are not of themselves the purpose of CDM.

A.1.4.1 RELEVANT ACTIVITIES

The regulations apply to construction work, the definition of which is given in CDM Regulation 2, and includes a wide range of activities, such as:

- Construction, on-site assembly / dismantling, fitting out, installation of services, commissioning, and decommissioning;

- Preparation of a site, including site investigation (intrusive investigations), but excluding non-intrusive survey activities; and

- Demolition and removal from site;

Certain other activities are specifically excluded from the definition of construction; the ACOP lists several categories of excluded activities, such as:

- General maintenance of fixed plant, unless it involves substantial dismantling or alteration of structures; and

- Off-site manufacture of items that will later be installed on site.

A.1.4.1.1 Notifiable Projects

Certain projects are notifiable to the HSE / HSENI, in which case additional duties apply; notifiable projects are those that are expected to involve more than:

- 30 days on which any construction work takes place on the site; or

- 500 person-days of construction work, over any period of time.

Development of most wind farms will involve a level of work that exceeds the thresholds for notification, and therefore require the appointment of a competent CDM Co-ordinator (CDMC) and Principal Contractor (PC). However, erection of a small number of small or medium WTGs on a site may not reach the above thresholds for notification, in which case the Client would not be required to appoint a CDMC and PC. While this may appear to simplify project execution, it also removes key resources from the project team, compared to the situation on a notifiable project, thereby increasing the Client’s role in ensuring that health and safety is given adequate consideration in the design, execution and handover of the project.

\(^5\) HSE _L144 - Managing health and safety in construction - Construction (Design and Management) Regulations 2007 Approved Code of Practice.
A.1.4.2 ROLES AND DUTIES UNDER CDM

CDM defines a number of key duty holders within a project:

- Client;
- CDM Co-ordinator;
- Designer(s);
- Principal Contractor; and
- Contractors.

Note that although the CDM regulations are the means by which the UK has implemented the EU Temporary and Mobile Construction Sites Directive, the approach taken in the UK to fulfilling the duties of Designer, CDM Co-ordinator and Principal Contractor differs from that of most other member states.

The duties held by each of these roles are summarised in Table 1 on page 19; additional explanation of key points is given in the sections below.

A.1.4.3 THE CLIENT

A Client is an organisation or individual for whom a construction project is carried out. The Client can be considered to be the entity to which the final project will be delivered; their actions will have a significant influence on the safety of the project, such as:

- Appointing key members of the project team;
- Determining the time and resources available to the project team;
- Establishing the culture and arrangements for co-operation and co-ordination of the activities of team members; and
- Providing Pre-Construction Information to the team.

The Pre-Construction Information package should concentrate on any significant project-related hazards that competent designers and contractors could not reasonably be expected to anticipate or identify; Appendix 2 of the ACOP provides a list of potential hazards, although these are not specific to wind industry activities.

In the case of a Joint Venture (JV), the steering committee must determine how the role of Client is to be fulfilled; either:

- An individual organisation within the JV formally accepts the role of Client, with the full written agreement of all of the other parties in the JV to entrust this one organisation with the full responsibilities and authority of the Client; or
- The steering committee of the JV undertakes the role of Client themselves.

Notwithstanding the above, the legal structures applied to JVs can differ from one project to another. Some JVs may be separate legal entities in their own right, while others may be unincorporated associations between various companies. To ensure all parties to a JV know exactly what their legal duties are with regard to health and safety, specialist advice should be taken.

A.1.4.4 THE CDM CO-ORDINATOR (CDMC)

The CDMC advises the Client on the management of health and safety risks in construction work, including:

- Assisting the Client to appoint competent contractors;
- Assessing the adequacy of health and safety management arrangements;
- Ensuring that health and safety aspects are properly co-ordinated in the design process;
- Facilitating communication and co-operation amongst project team members, for example between Designers and Contractors; and
• Preparing the project Health and Safety File, which hands over relevant information from the construction phase to assist health and safety management in subsequent lifecycle phases.

In order for the CDMC to fulfil these duties, they should be appointed before any significant design decisions are made on the project, and ideally have continuity throughout the project.

The CDMC should have sufficient independence from the Client to ensure that they can provide impartial advice with respect to health and safety throughout the project. This does not mean that the CDMC cannot be an employee of the Client organisation, but if so, the CDMC should be able to demonstrate true impartiality.

The CDMC is appointed by the Client, based on a robust assessment of their competence in relation to the nature of the project; guidance on assessing the competence of a CDMC is given in Appendix 5 of the CDM ACOP.

A prospective CDMC should be offered the role by the Client, in writing, and shall give a written acceptance of this. Included in this written acceptance is the confirmation that the CDMC considers that they are competent to fulfil the role for the specific project being undertaken.

In complex developments, the CDMC may also have an important role in interfacing with adjacent construction projects or operational sites.

On a non-notifiable project, there is no requirement to appoint a CDMC; in such cases, the Client may need to do more to ensure that health and safety is managed effectively throughout design and construction, and that the necessary information will be available to support safe operation.

A.1.4.5 THE DESIGNER(S)

Anyone who takes a design decision relating to a construction project is a Designer under CDM, and should be aware of their responsibilities as such, which include:

• Eliminating hazards and reducing risks in the design;
  o This will require a suitable risk assessment process to be applied as the design is developed; and

• Providing information about remaining risks;
  o The emphasis should be on risks that are unusual in some way, or not obvious to a competent contractor or another designer;
    ▪ The ACOP specifically cautions against producing lengthy lists of standard risks, which can obscure the most important and relevant risks;
  o If the safety of construction could be affected by the adoption of a particular sequence or method, then this information should also be provided; however
    ▪ Providing this information is not the same as instructing a contractor to adopt a particular approach.

This broad definition of a Designer can include many different parties on a project, such as:

• The project developer – who may also be the Client;
• External project development consultants (or companies); and
• Geotechnical, environmental or resource assessment consultants.

The Designer(s) is/are appointed by the Client. Early in the development lifecycle, the Designer may be an individual within a team that is developing the concept for the project, and will also be key to ensuring that the appropriate risk assessments are performed on the design as it evolves. As the project progresses, other Designers may be appointed, often with respect to a particular discipline or work package. Their appointment and design packages should be co-ordinated by a lead designer and/or the CDMC as appropriate; the CDMC has a specific duty to co-ordinate health and safety aspects of design work. The lead designer and CDMC should support the Client in assessing the competence and resources of all additional design contractors prior to appointing them to the project.
In cases where a design is prepared or modified outside Great Britain for use in construction work, then the Designer's duties will apply to:

- The person who commissions the design (if they are established within Great Britain); or
- If that person is not established within Great Britain, the Designer's duties revert to the Client.

Clients should be aware of this when placing contracts for work packages that include design work. In Northern Ireland, an equivalent duty exists, if designs are prepared or modified outside NI.

Exactly who would be held to be a Designer under CDM is not always obvious, and specialist advice should be sought. For example, it is arguable that the person who selects the WTG for a particular project could be held as a Designer under CDM. It is also arguable that where a bespoke product is designed for a project, then both the specifier of the product, and the manufacturer that develops the detailed design, are Designers. Much of course would depend upon the nature of the project, the specific circumstances in consideration and the extent of knowledge of the relevant person involved in the actual design.

**A.1.4.5.1 Designers of Standard Products**

In most situations, the manufacturer of a standard product, such as a WTG that can be used in any project, is not a Designer under CDM, although the Essential Health and Safety Requirements set out in Schedule 2 of the Supply of Machinery (Safety) Regulations (see Section **A.1.7**) impose some very similar duties, including:

- Machinery must be designed and constructed so that it is fitted for its function, and can be operated, adjusted and maintained without putting persons at risk when these operations are carried out under the conditions foreseen but also taking into account any reasonably foreseeable misuse thereof. The aim of measures taken must be to eliminate any risk throughout the foreseeable lifetime of the machinery including the phases of transport, assembly, dismantling, disabling and scrapping."

- Machinery and its components and fittings must be stable enough to avoid overturning, falling or uncontrolled movements during transportation, assembly, dismantling and any other action involving the machinery. If the shape of the machinery itself or its intended installation does not offer sufficient stability, appropriate means of anchorage must be incorporated and indicated in the instructions.

- Each instruction manual must contain, where applicable, at least the following information:
  (i) assembly, installation and connection instructions, including drawings, diagrams and the means of attachment and the designation of the chassis or installation on which the machinery is to be mounted;
  (l) information about the residual risks that remain despite the inherent safe design measures, safeguarding and complementary protective measures adopted;
  (m) instructions on the protective measures to be taken by the user, including, where appropriate, the personal protective equipment to be provided;

Any site-specific design would involve the duties of a Designer under CDM.

**A.1.4.6 THE PRINCIPAL CONTRACTOR (PC) AND CONTRACTORS**

The PC plans, manages and monitors the construction phase. Prior to the start of construction work, the PC will prepare the Construction Phase Plan, which will form the basis for the safe management of construction work. The PC also has responsibilities relating to the provision of welfare facilities, undertaking site inductions, assessing the competence of appointees and liaison with Designers.

The CDMC should support the Client to assess the competence and suitability of a potential PC, using Appendix 4 of the CDM ACOP as a guide. The PC can either be a suitable external construction organisation, or, if the Client is taking a multi-contractor approach to development, with the result that there will not be a main or managing contractor for the duration of the works,
and if the Client has the necessary competence, then it may be appropriate for the Client to take on the duties of the PC. Clients should always take care when taking on the role of PC.

Contractors, who may include the PC, subcontractors, and sometimes also Client personnel, have a range of duties, including:

- Managing their own work;
- Ensuring the competence of their own personnel and any subcontractors that they appoint; and
- Co-operating and co-ordinating with the PC and other contractors in order to support safe management of the work.

There can only be one PC for a project at any given time, however a large wind farm development could involve more than one project running in parallel, such as the wind farm construction itself, and construction of a grid connection, each with a separate PC, with a physical interface at the substation, and other potential interfaces such as the shared use of access routes. In situations where preliminary works such as geotechnical investigations are carried out in advance of the main construction package, it may be appropriate for a change of PC to occur between these phases. Any such change should be clearly recorded and communicated to all involved, particularly where it results in a change of safety management arrangements.

On a non-notifiable project, there is no requirement to appoint a PC; in such situations, Clients should consider how the functions that the PC would fulfil, in relation to managing the safe execution of construction works, will be undertaken; the approach will vary depending on the contracting structure on the project, and the competence of the different parties involved.

A.1.4.7 REFERENCES


HSE L144 - Managing health and safety in construction - Construction (Design and Management) Regulations 2007 Approved Code of Practice.
<table>
<thead>
<tr>
<th>Table 1: CDM Roles and Duties.</th>
<th>All construction projects (Part 2 of the Regulations)</th>
<th>Additional duties for notifiable projects (Part 3 of the Regulations)</th>
</tr>
</thead>
</table>
| **Clients (excluding domestic clients)** | • Check competence and resources of all appointees
• Ensure there are suitable management arrangements for the project welfare facilities
• Allow sufficient time and resources for all stages
• Provide pre-construction information to designers and contractors | • Appoint CDM co-ordinator*
• Appoint principal contractor*
• Make sure that the construction phase does not start unless there are suitable welfare facilities and a construction phase plan is in place.
• Provide information relating to the health and safety file to the CDM co-ordinator
• Retain and provide access to the health and safety file
• (* There must be a CDM co-ordinator and principal contractor until the end of the construction phase) |
| **CDM co-ordinators** | • Advise and assist the client with his/her duties
• Notify HSE
• Co-ordinate health and safety aspects of design work and co-operate with others involved with the project
• Facilitate good communication between client, designers and contractors
• Liaise with principal contractor regarding ongoing design
• Identify, collect and pass on pre-construction information
• Prepare/update health and safety file |
| **Designers** | • Eliminate hazards and reduce risks during design
• Provide information about remaining risks | • Check client is aware of duties and CDM co-ordinator has been appointed
• Provide any information needed for the health and safety file |
| **Principal contractors** | • Plan, manage and monitor construction phase in liaison with contractor
• Prepare, develop and implement a written plan and site rules (Initial plan completed before the construction phase begins)
• Give contractors relevant parts of the plan
• Make sure suitable welfare facilities are provided from the start and maintained throughout the construction phase
• Check competence of all appointees
• Ensure all workers have site inductions and any further information and training needed for the work
• Consult with the workers
• Liaise with CDM co-ordinator regarding ongoing design
• Secure the site |
| **Contractors** | • Plan, manage and monitor own work and that of workers
• Check competence of all their appointees and workers
• Train own employees
• Provide information to their workers
• Comply with the specific requirements in Part 4 of the Regulations
• Ensure there are adequate welfare facilities for their workers | • Check client is aware of duties and a CDM co-ordinator has been appointed and HSE notified before starting work
• Co-operate with principal contractor in planning and managing work, including reasonable directions and site rules
• Provide details to the principal contractor of any contractor whom he engages in connection with carrying out the work
• Provide any information needed for the health and safety file
• Inform principal contractor of problems with the plan
• Inform principal contractor of reportable accidents, diseases and dangerous occurrences |
| **Workers/ everyone** | • Check own competence
• Co-operate with others and co-ordinate work so as to ensure the health and safety of construction workers and others who may be affected by the work
• Report obvious risks | |

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A.1.5 REPORTING OF INJURIES DISEASES AND DANGEROUS OCCURRENCES REGULATIONS 2013 (RIDDOR)

RIDDOR places a duty on employers, the self-employed and those in control of premises, to report certain serious accidents, occupational diseases and dangerous occurrences, that “arise out of or in connection with work”, whether they affect employees or others, such as members of the public. The purposes of reporting are to:

- Enable the HSE / HSENI to respond rapidly and investigate serious incidents;
- Provide intelligence that allows the HSE / HSENI to target its interventions; and
- Provide data to enable trends and progress to be tracked at a national level; the reports generated from this data can assist businesses in targeting their health and safety management efforts.

The categories of incident that must be reported include:

- Deaths;
- Major injuries, defined as “specified injuries” in the regulations;
- Injuries that cause a person to be incapacitated for routine work for more than seven consecutive days;
  - Even though the reporting requirement applies after seven days, any injuries incapacitating a person from routine work for more than three days must still be recorded by the employer.
  - In Northern Ireland, the reporting requirement applies after three days.
- Occurrences of specified occupational diseases; and
- Specified dangerous occurrences.

The HSE provides clear guidance on which incidents should be reported, and the regulations specify the time limits for reporting different categories.

A.1.5.1 REFERENCES

HSE INDG453 - Reporting accidents and incidents at work - A brief guide to the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013 (RIDDOR) provides a clear overview of reporting requirements under RIDDOR. Helpful guidance is also given on the RIDDOR pages of the HSE website.

HSENI HSA31 - A guide to the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (Northern Ireland) 1997 provides guidance on the different requirements in NI.
A.1.6  **ELECTRICITY SAFETY, QUALITY AND CONTINUITY REGULATIONS (ESQCR) 2002**

These regulations specify technical and reporting requirements relating to the safety of electrical equipment, from generating plant, through transmission and distribution networks to consumers’ installations. Their scope therefore includes WTGs, substations, underground cables and overhead lines. The duty holder under these regulations is the operator of the equipment, such as the generator (wind farm owner) or Distribution Network Operator.

### A.1.6.1 SAFETY REQUIREMENTS

The regulations include specific duties relating to technical measures to ensure the safety of networks, including:

- Periodic inspection of networks;
- Protection and earthing of networks;
- Safety of substations;
- Specification, depth of burial, protection against damage, marking and mapping of underground cables;
- Ensuring that overhead lines are erected and maintained to exceed specified minimum clearances above the ground; and
- Provision of approved warning signage;

### A.1.6.2 REPORTING REQUIREMENTS

The ESQCR impose reporting requirements, which are in addition to those under RIDDOR:

- Events leading to the death or injury of an employee of the dutyholder are reportable to the HSE / HSENI under RIDDOR;
- Events leading to the death or injury of a person who is not an employee of the dutyholder are reportable to the HSE / HSENI under ESQCR;
- Other specified events, which give rise to a risk of injury or death, are also reportable to the HSE / HSENI under ESQCR; these include:
  - Damage to overhead lines or other equipment, which could lead to live parts being accessible to members of the public;
  - Partial or complete collapse of buildings or structures, which include WTGs;
  - Any fire, explosion or implosion that results in a significant risk of death or injury to the public;
  - Unauthorised access to high voltage (HV) systems, including substations;
  - Theft or attempted theft of components of a network;
  - Overhead lines having less than the specified minimum clearance; and
  - Damage to underground cables.

### A.1.6.3 REFERENCES

**HSE Website** -  *Electricity Safety, Quality and Continuity Regulations (ESQCR)*

**RenewableUK H&S Circular: ESQC Regulations**

In addition to the above statutory reporting requirements, the Energy Networks Association operates the subscription-based *National Equipment Defect Reporting Scheme (NEDeRS®)*, which is focused on electrical distribution network equipment, and contains notifications of dangerous incidents, equipment defects and changes in operational practices on safety grounds.
A.1.7 **SUPPLY OF MACHINERY (SAFETY) REGULATIONS AND HARMONISED STANDARDS**

The first EU Machinery Directive was adopted in 1989, and the current Directive (2006) has been implemented in UK law by means of the Supply of Machinery (Safety) Regulations 2008. The Directive aims to improve the safety of machinery, by adopting inherently safe designs that fulfil the Essential Health and Safety Requirements (EHSRs) of the Directive, and thereby enable the free movement of machinery in the course of trade within the EU. In order to achieve this, the Directive is supported by harmonised standards, and processes for conformity assessment and type examination, which together give the assurance that a satisfactory standard of safety has been achieved.

A.1.7.1 **GENERAL PRINCIPLES**

The EHSRs are to be applied in accordance with General Principles, defined in the directive and regulations, which can be summarised as:

- The responsible person (who will usually be the manufacturer, or their authorised representative) must ensure that a risk assessment is carried out; this should identify the hazards presented by the machinery, and thereby determine which EHSRs apply:
  - The design and construction of the machinery must address the outcomes of the risk assessment;
  - The responsible person must determine the limits of the machinery, considering both its intended use and any reasonably foreseeable misuse;
    - This considers situations such as mistakes being made by operators or technicians, or short cuts being taken in the execution of tasks;
    - Machinery is to be designed and constructed in such a way as to prevent abnormal use, if such use would give rise to a risk;

- The responsible person must apply an iterative process of risk assessment and risk reduction, according to the Principles of Safety Integration specified in the regulations, which define the hierarchy of risk reduction as:
  - “eliminate or reduce risks as far as possible (inherently safe machinery design and construction);”
  - “take the necessary protective measures in relation to risks that cannot be eliminated;” and then
  - “inform users of the residual risks due to any shortcomings of the protective measures adopted, indicate whether any particular training is required and specify any need to provide personal protective equipment.”

Annex 1 of the Directive (incorporated into Schedule 2 of the regulations) details the EHSRs, which are therefore mandatory. The only qualification to this is that if, considering the “state of the art”, it is not possible to satisfy the requirements in full, then the machinery must, as far as possible, approach the requirements. The state of the art can be summarised as the most effective technical means that is generally available on the market, at a reasonable cost, considering the type of machinery involved, and the risk reduction that is required.

The state of the art therefore evolves over time, so as improved solutions become available, manufacturers should review older designs that are still in production; the Directive does not impose any duty on users or owners of machinery to upgrade existing machines to the state of the art. (Note, however, that the outcomes of periodic risk assessment of work activities under health and safety regulations may identify improvements that are necessary in order to reduce risk ALARP.)

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A.1.7.2 THE ESSENTIAL HEALTH AND SAFETY REQUIREMENTS

The EHSRs, which are applicable to all machinery, address a wide range of issues, and apply to all phases from installation to decommissioning and disposal; some of the most relevant requirements are listed below:

- General requirements:
  - The materials of construction, and products (such as fluids and gases) used, including any filling / exchange operations required, must not endanger persons’ health and safety;
  - Lighting must be provided within machinery, in situations where ambient light alone will not be sufficient for the required tasks during operation and maintenance activities;
  - Machinery and components must be designed to facilitate handling, whether manually or by means of lifting equipment;
  - The design must minimise ergonomic risks to operators / maintainers of machinery; this includes ensuring that there is enough space for movements of the parts of the person’s body;

- Control systems:
  - Control systems must be designed and constructed in such a way as to prevent hazardous situations from arising, taking account of the operating conditions, and including ensuring that a fault in the hardware, software or logic of the control system, or reasonably foreseeable human error, does not lead to a hazardous situation;
    - The required Safety Integrity Level of the protective functions of a control system should be based on an assessment of the risk that a failure of the system could present;
  - There must be safe arrangements for stopping and starting machinery, including in situations where the machine can be controlled from more than one location, such as remote operation from a control centre, or where specific sequences must be followed;
  - The design must ensure that safety is maintained at all times, even where different control and operating modes can be selected; this includes features such as maintenance modes, or enabling operation with a protective device in a disabled state, which may affect the normal function of safety systems;
  - The machinery must remain safe in the event of an interruption to the power supply; in the case of a WTG, this would include behaviour relating to interruptions to the grid or auxiliary power supplies within the WTG;

- The design and construction of the machinery must protect against mechanical hazards including:
  - Loss of stability, such as overturning, falling or uncontrolled movements during transportation, assembly, dismantling and any other action involving the machinery;
  - Break-up of components during operation, including failure of rigid or flexible high pressure pipework, and taking account of failure modes such as fatigue and ageing;
  - Falling objects;
  - Sharp edges, surfaces or angles;
  - Moving parts;
  - Uncontrolled movements;

Where protection against mechanical hazards is to be by means of guards, the regulations specify detailed requirements.
The design and construction of the machinery must provide safety from a range of other hazards including:

- Electricity, including both electrical systems and static electricity;
- Other sources of energy;
- Errors of fitting;
- Extreme temperatures, which could harm people in contact;
- Fire or overheating;
- Noise and vibration;
- Slipping, tripping or falling from locations where people may stand or move around;
- Lightning;

The design must consider maintenance requirements, including providing:

- Safe access to adjustment and maintenance points, and the ability to carry out all necessary adjustments and maintenance while the machinery is stopped or otherwise made safe;
- Suitable isolations from all energy sources;

The responsible person must also provide information including:

- Information or warning pictograms and devices;
- Information devices such as SCADA screens; and
- Operating and maintenance instructions.

Machinery that satisfies all of the relevant EHSRs is in conformity with the Directive, and is therefore permitted to carry the CE mark; it is an offence to place any machinery on the market in the EU without this.

### A.1.7.3 Harmonised Standards

Harmonised (EN) standards provide methods and specifications to assist machinery manufacturers in achieving compliance with the Essential Requirements of an EU product supply directive. Unlike the Requirements themselves, the specifications laid down in harmonised standards are voluntary:

- Harmonised standards provide an indication of the state of the art at the time when they were adopted (or revised), and therefore provide a benchmark of the level of safety that was generally being achieved at that point in time;
- If a manufacturer chooses to adopt an alternative solution to those specified in the standards, then they must be able to demonstrate that their solution is in conformity to the EHSRs, taking account of the current state of the art, thereby achieving a level of safety that is at least equivalent to that which would be achieved by adopting the specifications of the relevant harmonised standard.

There are three types of harmonised standard under the Machinery Directive, as shown in Table 2 below; when an article is stated as being in conformity with a standard, it is important to understand the nature of that standard, as this determines the extent of conformity.
Table 2: Types of harmonised standard under the Machinery Directive.

<table>
<thead>
<tr>
<th>Type</th>
<th>Content</th>
<th>Application</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Basic concepts; Terminology; Design Principles</td>
<td>All categories of machinery</td>
<td>Essential framework for correct application of Machinery Directive; Not sufficient to ensure full conformity with relevant EHSRs.</td>
</tr>
<tr>
<td>B</td>
<td>Specific aspects of machinery safety; or Specific types of safeguard</td>
<td>Wide range of categories of machinery</td>
<td>Presumption of conformity with those EHSRs that the standard covers, if a C-type standard or the manufacturer’s risk assessment shows that the technical solution specified by the B-type standard is adequate.</td>
</tr>
<tr>
<td>C</td>
<td>Specifications</td>
<td>Specific category of machinery</td>
<td>Presumption of conformity with the EHSRs that the standard covers, when applied on the basis of the manufacturer’s risk assessment; May refer to A or B-type standards, but the requirements of the C-type standard take precedence.</td>
</tr>
</tbody>
</table>

A.1.7.4 REFERENCES

HSE INDG 270 - Supplying New Machinery.
HSE INDG271 - Buying new machinery.
The Supply of Machinery (Safety) Regulations 2008.

The European Commission Enterprise and Industry website contains a complete list of harmonised standards, by category. Examples of Category A, B, C standards are:

B: BS EN ISO 13849-1:2008: Safety of machinery. Safety-related parts of control systems. General principles for design
A.1.8 **PROVISION AND USE OF WORK EQUIPMENT REGULATIONS 1998 (PUWER)**

The aim of PUWER is to minimise the health and safety risk that work equipment of any kind, provided under any contractual arrangement, presents to users. There are two main ways in which the regulations seek to achieve this aim:

- Management arrangements, relating to the selection of work equipment, its ongoing inspection and maintenance, control of specific hazards, and provision of suitable information, instruction and training to users; and
- Physical requirements, ensuring that work equipment has appropriate safety features such as suitable guarding of dangerous parts, appropriate control and stopping systems, adequate stability, lighting and warnings to users.

PUWER applies to all work equipment, ranging from simple hand tools such as a spanner, powered tools such as grinders, portable generators and permanently-installed hoists. Many of the duties relating to the safety of machinery are applicable to WTGs. PUWER sets the framework for the provision and use of work equipment, and the majority of duties rest with the employer who provides the work equipment to their employee. Other more specific regulations apply to particular categories or components within work equipment, such as:

- Lifting equipment, where the more specific requirements of the Lifting Operations and Lifting Equipment Regulations (LOLER) also apply;
- Work equipment for use during work at height, which is subject to the Work at Height Regulations;
- Machines, the supply of which is subject to the Supply of Machinery (Safety) Regulations (SMSR), the Essential Health and Safety Requirements of which will help to fulfil many of the physical requirements of PUWER;
  - Note that PUWER applies to all work equipment, at the point of provision and use, irrespective of when it was placed on the market, or its ownership; and
  - The manufacturer or importer of a machine is subject to SMSR, whereas the employer of persons working with a machine holds the duties under PUWER.

As the MHSWR require the risks involved in any work activity to be assessed, this risk assessment should take account of the risks presented by work equipment; the requirements of PUWER should inform this risk assessment, particularly with respect to the management and physical measures to reduce risk to users of work equipment, but a separate risk assessment is not required to fulfil duties under PUWER.

During activities involved in wind farm construction and operations and maintenance (O&M), it is likely that employees of one employer will make use of work equipment owned by another organisation; in this situation, each employer retains the duty to ensure that any work equipment provided to their employees conforms to, and is used in accordance with, the requirements of PUWER. Where work is undertaken under CDM, the construction phase plan should address the arrangements for sharing equipment, so that there are clear responsibilities for co-ordination of equipment and reporting requirements, and that users understand relevant safe methods and limitations of use.

**A.1.8.1 REFERENCES**

A.1.9 PERSONAL PROTECTIVE EQUIPMENT AT WORK REGULATIONS 1992

The Personal Protective Equipment (PPE) regulations impose a range of duties on employers; these include:

- Suitable PPE must be provided, without charge, to employees. The suitability of PPE should be assessed in relation to the task(s) for which it will be used, the conditions in the working environment, and the characteristics of the user;
  - While the employer is the duty-holder, a meaningful assessment of the suitability of PPE will generally need the involvement of the end user, possibly also involving field trials to assess the practical performance of items before widespread adoption;
    - As the function of PPE is often affected by how it fits the user, it may be necessary to provide a range of types and sizes of PPE, including carrying out formal tests of the correct fitting of items such as respirators;
  - Many tasks will require the use of more than one item of PPE, in which case the employer must ensure that the different items are compatible. For example, if working in a high noise area on a construction site, ear defenders and safety helmets must be compatible with each other;

- PPE must be maintained and replaced as necessary, to ensure that it functions efficiently. Suitable storage facilities are also required, and will assist in keeping the PPE in good condition; drying facilities may also be necessary; and

- Information, instruction and training must be provided to users; the extent of this should reflect the complexity of the equipment involved, and will be particularly rigorous for items such as specialised PPE for work at height.

Other duties apply both to employers and employees:

- The employer has duty to ensure that the PPE is properly used, usually by means of training, supervision and auditing of use, while employees have a duty to use PPE in accordance with the instructions and training that they have received;
  - Use of procedures such as “buddy checks” of each other’s PPE prior to commencement of a task can help to fulfil this duty;
- The employer must make arrangements to enable employees to report any defects in PPE, and for it to be repaired or replaced as required, while employees have a duty to take reasonable care of PPE provided, and to report any loss or obvious defects.

A.1.9.1 CE MARKING

PPE should always carry a CE mark, with the declaration of conformity confirming that the CE mark relates to the requirements of the PPE Directive and relevant harmonised standards. However, certain items of safety-related equipment, such as rescue lifting devices to EN 1496:2006, are not classified as PPE, and are outside the scope of other product supply directives. In these cases, there is no harmonised standard, and no directive under which a CE mark could be obtained, so while such items may conform to the relevant product standard, and be safe to use, they cannot carry the CE mark.

A.1.9.2 AVOIDANCE OF COUNTERFEIT PPE

People can be put at risk by counterfeit PPE, some of which carries the CE mark, despite not conforming to the relevant standards, and which may also be accompanied by fraudulent declarations of conformity. While some counterfeit products are easily spotted, others appear almost identical to the genuine articles, but do not provide the same level of protection; the British Safety Industry Federation has introduced the Registered Safety Supplier Scheme to provide audited assurance that suppliers in this scheme are sourcing genuine PPE.

A.1.9.3 COMMON APPROACHES

PPE should be used to provide protection against residual risks, therefore requirements for the types of PPE to be used, and when it should be worn, should be based on the outcomes of risk
assessments. Typical PPE for common roles on a wind farm are outlined in Table 3 and Table 4 below, as examples.

**Table 3: Typical minimum PPE to be worn when working on wind farms**

<table>
<thead>
<tr>
<th>Item</th>
<th>Relevant standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety footwear</td>
<td>BS EN ISO 20345, with appropriate rating for the work being undertaken</td>
</tr>
<tr>
<td>High-visibility clothing</td>
<td>BS EN 471, with the class of clothing according to the workplace risks</td>
</tr>
<tr>
<td>Head Protection – Safety helmet</td>
<td>BS EN 397 (not necessarily suitable for climbing)</td>
</tr>
<tr>
<td></td>
<td>BS EN 14052 (suitable for site use and climbing)</td>
</tr>
<tr>
<td>Eye protection</td>
<td>BS EN 166, which includes a wide range of types of eye protection, but does not cover welding filters.</td>
</tr>
<tr>
<td>Hearing protection</td>
<td>BS EN 352</td>
</tr>
<tr>
<td>Hand protection (gloves)</td>
<td>BS EN 420 defines general requirements; BS EN 388 covers protection from mechanical risks; BS EN 374 covers protection from chemicals.</td>
</tr>
</tbody>
</table>

**Table 4: Typical additional PPE to be worn for work at height**

<table>
<thead>
<tr>
<th>Item</th>
<th>Relevant standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full body harness</td>
<td>BS EN 361</td>
</tr>
<tr>
<td>Work positioning belt and lanyard</td>
<td>BS EN 358</td>
</tr>
<tr>
<td>Energy-absorbing lanyards</td>
<td>BS EN 355</td>
</tr>
<tr>
<td>Head Protection – Safety helmet</td>
<td>BS EN 397 (only suitable for climbing if without a peak and fitted with a chin strap)</td>
</tr>
<tr>
<td></td>
<td>BS EN 14052 (suitable for site use and climbing)</td>
</tr>
<tr>
<td></td>
<td>BS EN 12492 (suitable for climbing, but not designed for use with other PPE such as ear defenders, face visors etc.)</td>
</tr>
</tbody>
</table>

**A.1.9.4 REFERENCES**

HSE L25 - *Personal protective equipment at work (second edition) – Personal Protective Equipment at Work Regulations 1992 (as amended) - Guidance on Regulations.*

British Safety Industry Federation – *PPE Checklist* provides guidance on checks that may help to spot counterfeit PPE. The BSIF also provides a useful list of *Safety Product Standards.*

A *list of harmonised EN standards for PPE* is available on the European Commission website.
A.1.10 WORKPLACE (HEALTH, SAFETY AND WELFARE) REGULATIONS 1992

The Workplace regulations apply to all non-domestic premises (or parts of premises) to which a person has access while at work, including the means of access to or egress from a place of work (other than access along a public road.) They therefore apply to wind farms, including WTGs, site buildings, roads and paths.

A.1.10.1 REQUIREMENTS

The regulations include requirements relating to the design and maintenance of workplaces:

- The design should ensure that the workplace is stable and provides sufficient space to work;
- The working environment should be suitable, considering temperature, ventilation, lighting, cleanliness;
- Floors and traffic routes should minimise the risk of slips, trips, falls, dropped loads or instability / loss of control of a vehicle;
- Traffic routes for pedestrians and vehicles should be organised in a safe manner, usually involving separation, apart from designated crossing points; and
- Amenity facilities, such as sanitary conveniences, washing facilities, drinking water, clothing accommodation, changing facilities and facilities for rest and eating meals are to be provided, in accordance with details defined in the ACOP

A.1.10.2 EXCLUSIONS

There are several exclusions from the regulations:

- They do not apply to:
  - Construction sites (including site offices), where CDM applies; or
  - Vehicles;
- Certain provisions of the regulations are limited:
  - On temporary work sites, which are only used infrequently or for short periods, the requirements for amenity facilities apply so far as reasonably practicable.

Clearly many wind farms will be temporary work sites, so the developer will have to determine the level of provision that is reasonably practicable, taking account of how often and how many people are expected to be on the site, and the value of the development. Various solutions can be adopted, such as:

- Provision of a toilet and handwashing facilities at a substation / store building;
- Deployment of mobile amenity facilities to a site when work is planned;
- Agreement with others, such as the site landlord or a neighbouring business, to allow wind farm personnel to use their facilities;
  - If off-site welfare facilities are to be used, then they should be within a reasonable distance of the site, and site personnel should be allowed sufficient time to use them.

A.1.10.3 REFERENCES

A.1.11 Regulators, Investigation and Enforcing Authorities

The law relating to Health and Safety in the UK essentially consists of statutory duties set out in legislation, either Acts of Parliament or subordinate regulations, and duties created by judicial precedent over many years (often referred to as common law). There is both State enforcement of the duties, through the criminal courts and other enforcement methods available to State regulators, and private enforcement by way of private civil actions. Both systems exist side by side, and the common law and legislative duties often overlap.

The different regulatory and enforcing authorities, their responsibilities and jurisdictions are listed in Table 5 below.

Table 5: Summary of Regulatory and Investigative Authorities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Lead Regulator / Investigator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulation of work under the HSWA and subsidiary</td>
<td>HSE (Great Britain)</td>
</tr>
<tr>
<td>regulations, and investigation of accidents</td>
<td>HSENI (Northern Ireland)</td>
</tr>
<tr>
<td>occurring during such work</td>
<td></td>
</tr>
<tr>
<td>Prosecution of offences under the HSWA</td>
<td>HSE (England and Wales)</td>
</tr>
<tr>
<td></td>
<td>Procurator Fiscal (Scotland)</td>
</tr>
<tr>
<td></td>
<td>HSENI (Northern Ireland)</td>
</tr>
<tr>
<td>Investigation of fatality or life-threatening</td>
<td>Police have jurisdiction, in addition to the above regulators</td>
</tr>
<tr>
<td>injury</td>
<td></td>
</tr>
<tr>
<td>Aviation regulation</td>
<td>Civil Aviation Authority</td>
</tr>
<tr>
<td>Aviation accident investigation</td>
<td>Air Accidents Investigation Branch (Part of the Department for Transport)</td>
</tr>
</tbody>
</table>

A.1.11.1 HSE

The HSE’s functions include the development of regulations and standards, carrying out research, providing information and advice, and enforcing health and safety law. The jurisdiction of the HSE covers Great Britain, while the Health and Safety Executive for Northern Ireland (HSENI) covers Northern Ireland.

The HSE’s Field Operations Directorate:

- Provides advice and guidance on how to comply with the law;
- Inspects workplaces, installations and facilities;
- Investigates accidents and complaints; and
- Takes enforcement action where necessary.

HSE inspections can be carried out without prior notice, to audit compliance of operations at sites, or to examine corporate systems at company offices. In the event of deficiencies being found, the HSE’s response aims to be proportionate to the severity of the problems, and ranges from:

- Verbal or written guidance on necessary improvements;
- A written Notification of Contravention;
- Issue of an Improvement Notice, specifying the required improvements to be completed within a certain timescale;
- A Prohibition Notice suspending work at an unsatisfactory site; to
• Prosecution of the most serious cases, where:
  
  o A specific requirement in a regulation made under the HSWA has not been complied with; and / or
  
  o A general duty defined in the HSWA has not been satisfied; and
  
  o It is judged that, given the nature of the offence, prosecution would be in the public interest, and there is sufficient evidence to give a realistic prospect of conviction.

If a Notification of Contravention, or an Improvement or Prohibition notice is issued, this indicates that the HSE takes the view that a material breach of health and safety law has occurred. In such cases, under the Fee for Intervention system, the HSE will recover, from the duty-holder, the costs that were incurred in addressing the material breach. These costs cover the time spent by the HSE in identifying the material breach, assisting the duty-holder with resolving the issue, and any other investigation and enforcement action relating to the breach.

In the event of a criminal prosecution under the HSWA and or subordinate regulations, most offences can be tried and or sentenced in either the lower courts such as a Magistrates’ Court (Sheriff Court in Scotland) or the higher courts such as a Crown Court (High Court in Scotland). The more serious and / or complex cases are tried and / or sentenced by the higher courts, where there are greater, tougher sentencing powers available. The penalties available, in the event of a corporate entity or individual being convicted, depend upon the severity of the offence(s), and can include imprisonment for up to 2 years, disqualification from acting as a director for up to 15 years, and unlimited fines. If the breaches of duty result in a death, then the Corporate Manslaughter and Corporate Homicide Act 2007, and common law offence of gross negligence manslaughter, may apply.

A.1.11.1.1 References

HSE - HSE41 - Enforcement Policy Statement sets out the general principles and approach that the HSE and its inspectors are expected to follow when making decisions regarding enforcement action, which will then take place in accordance with the HSE – Enforcement Management Model.

HSE HSE48 – Fee for intervention

A.1.11.2 POLICE JURISDICTION

The police have criminal jurisdiction, so in the event of an incident involving a fatality or a person sustaining life-threatening injuries, the police should be informed without delay.

A.1.11.3 OTHER BODIES WITH REGULATORY POWERS

A.1.11.3.1 The Civil Aviation Authority (CAA)

The CAA is the aviation regulator for the UK. In relation to wind farms, the CAA defines the requirements for obstruction marking, and is a consultee in the planning process. National Air Traffic Services (NATS) provides air traffic control services in UK airspace, and at major airports, so will often be a consultee in the planning of a wind farm, but is not a regulator. Aviation safety is covered in more detail in Section C.3.
A.1.12 Interfaces with Electricity Distribution and Transmission Systems

The interface arrangements depend on whether a wind farm is connected to the Distribution or Transmission systems:

- National Grid Electricity Transmission (NGET) is the System Operator for all high voltage electricity transmission systems in Great Britain;
  - The transmission system includes substations, even if these are dedicated to a particular wind farm;
- Distribution networks are owned and operated by Distribution Network Operators (DNOs).

The interfaces during the operational phase are summarised in Table 6 below.

Where a new connection between a wind farm and the Distribution or Transmission network is required, certain aspects of its design, construction and commissioning are open to competition, known as “contestable works”. These can be undertaken by Independent Connection Providers (ICPs), contractors who operate within the scope of their registration on the National Electricity Registration Scheme (NERS). Other aspects of design, equipment specification, design approval, monitoring of construction work and witnessing of testing, are reserved to the DNO.

Site layouts should take account of good practice regarding setback distances between WTGs and overhead lines.

Table 6: Electricity Transmission and Distribution Systems.

<table>
<thead>
<tr>
<th></th>
<th>Transmission</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Voltage</strong></td>
<td>275kV – 400kV (UK)</td>
<td>230V – 66kV (UK)</td>
</tr>
<tr>
<td></td>
<td>132kV (Scotland only)</td>
<td>132kV (England &amp; Wales only)</td>
</tr>
<tr>
<td></td>
<td>110kV (NI only)</td>
<td></td>
</tr>
<tr>
<td><strong>Owner / maintainer</strong></td>
<td>NGET (England &amp; Wales); Scottish Power Transmission or Scottish Hydro Electric Transmission Ltd (SHETL) (Scotland)</td>
<td>DNO</td>
</tr>
<tr>
<td></td>
<td>Northern Ireland Electricity (NIE) (NI)</td>
<td></td>
</tr>
<tr>
<td><strong>System Operator</strong></td>
<td>NGET (GB)</td>
<td>DNO</td>
</tr>
<tr>
<td></td>
<td>System Operator Northern Ireland (SONI) (NI)</td>
<td></td>
</tr>
</tbody>
</table>

For wind farms connected to the Transmission system, the responsibilities of the different parties are set out in the:

- Connection and Use of System Code (CUSC), which sets out the contractual framework for grid connection;
- Grid Code, which specifies day-to-day procedures for both planning and operational purposes and covers both normal and exceptional circumstances;
- System Operator – Transmission Owner Code (STC), which defines:
  - Arrangements for agreeing capacity and performance requirements of a transmission asset, and for managing outages;
o Procedures and responsibilities for managing operational switching in a variety of situations, including in emergencies, and switching that is required in order to implement safety precautions;

o Arrangements for communication with others who may be affected by switching operations, including the “Affected Users”, such as the wind farm; and

o Procedures for co-ordination between different parties, where work is to be carried out on equipment, and which requires another party to implement safety precautions in order to allow safe completion of the work.

For wind farms connected to Distribution systems, all GB DNOs operate to the same Distribution Code, which includes arrangements for safety co-ordination.

Wind farm owners / operators should develop site-specific procedures, based on these standard processes, together with suitable bridging documents for their safety management systems in order to ensure safe operation at the interface with Transmission or Distribution systems.

A.1.12.1.1 References

GB transmission codes are available from the [National Grid website](#); the [SONI Grid Code](#) covers use of the NI transmission system.

The Distribution Code and the Guide to the Distribution Code of Licensed Distribution Network Operators of Great Britain can be downloaded from the [Energy Networks Association website](#); safety co-ordination is in Distribution Operating Code 8 (DOC8). The Distribution Code for NI is available on the [NIE website](#).

A.1.13 ACCESS TO LAND

Members of the public may have legal rights to access land on which wind farms are located; landowners may also have duties towards people accessing land, with or without permission. The laws on access are different in Scotland, England and Wales and Northern Ireland; any rights of public access to a wind farm site need to be understood, as they will affect the ways in which public safety can be ensured.

A.1.13.1 ENGLAND AND WALES

The Countryside and Rights of Way Act 2000 defines the legal framework for access to the countryside, both in terms of rights of way and open access land.

Definitive maps of rights of way are maintained by councils, and used as the basis for updating Ordnance Survey maps. It is a criminal offence to obstruct a right of way, but local councils can divert or close rights of way on a temporary or permanent basis.

Open Access Land is land on which the public have the right to walk, run, watch wildlife and climb. This includes access land (as shown on “Conclusive Maps” maintained by Natural England or Natural Resources Wales), registered common land, “dedicated” land (where landowners have dedicated it for public access) and all land situated at more than 600m above sea level, other than “Excepted Land”, in the vicinity of homes, or land which is temporarily closed for land management operations, fire prevention or public safety.

A.1.13.2 NORTHERN IRELAND (NI)

Rights of way are managed in a similar way to in England and Wales, under the Access to the Countryside (NI) Order 1983, although the network of public rights of way is proportionately much smaller. This order also allows for access to open country to be secured by means of Access Agreements or Access Orders, although these powers have not been exercised, so no such areas exist.

A.1.13.3 SCOTLAND

The Land Reform (Scotland) Act 2003 gives everyone statutory access rights to most land, including hills, fields, forests and watercourses, subject to this right being exercised responsibly, with respect for other people’s privacy, safety and livelihoods. This general right is in addition to defined rights of way and core paths, however there is no right of access to construction sites, nor any right to use motorised vehicles.

Rights of way in Scotland run between public places along “more or less defined” routes, but do not necessarily have identifiable paths.

Access rights should be taken into account when considering changes of land use, such as the construction of a wind farm or access roads, and also when planning activities, such as tree-felling, construction or major maintenance, which could put other users of land at risk. Access restrictions and warning signs can be put in place to keep the public safe, but the area and duration of any such restrictions should be the minimum that is needed to allow the work to be conducted safely and efficiently.

If an existing track is used or upgraded to provide access to a wind farm, then if gates are to be locked for security, an appropriate alternative access point for non-motorised users of the track, such as pedestrians, cyclists and horse-riders should be provided. Traffic management should take account of the potential for members of the public to be using wind farm access tracks.

A.1.13.4 OCCUPIER’S LIABILITY

Occupier’s liability legislation imposes a duty of care on occupiers of land (the owner or a tenant who is working the land) towards “visitors”, defined as being people who are invited or permitted to be on their land; such permission can either be express or implied. In the case of a wind farm, the owner of the wind farm could be considered to be an occupier – as could other land managers on the site, such as agricultural or forestry businesses. Occupiers are not expected to protect against hazards arising from natural features such as rivers and cliffs; the focus is on hazards created by the occupier’s activities, such as the presence of deep excavations, or work equipment.

An occupier cannot be prosecuted under this legislation, but could be sued in the civil courts in the event of death or injury of a person on their land. The duties in this legislation are in addition
to the general duty under the HSWA to ensure the health and safety of members of the public; a breach of this duty could lead to prosecution.

**A.1.13.4.1 England, Wales and Northern Ireland**

The Occupier’s Liability Act 1957 requires occupiers to take reasonable care that visitors will be reasonably safe to do whatever activity they have been permitted to do on the land.

In addition, the Occupiers’ Liability Act 1984 sets out occupiers’ duty of care towards people who have not been invited or permitted to be on their land, such as trespassers. If the occupier has reasonable grounds to believe that people could be put at risk, and they could reasonably be expected to protect against the risk, then they owe some duty of care to such people. In such cases, the occupier has to take reasonable care that people do not suffer injury on their land. The nature of protection that is needed to discharge this duty should be appropriate to those who could be put at risk, noting that children may be less careful than adults, so extra precautions may be necessary in locations that could be accessed by unsupervised children. The occupier may also be liable for the actions of contractors that they have employed, if the occupier has failed to take reasonable steps to check the competence of the contractor, and that they have done their work properly.

In Northern Ireland, the Occupiers’ Liability Act (NI) 1957 and the Occupiers’ Liability (NI) Order 1987 have similar provisions.

**A.1.13.4.2 Scotland**

The Occupiers’ Liability (Scotland) Act 1960 imposes a duty of care on the occupier of land towards people on that land. The duty of care is the same, irrespective of whether the people on the land were invited, permitted or had entered without permission; this reflects the differences in access legislation between Scotland and the rest of the UK.

**A.1.13.5 REFERENCES**


The [Scottish Outdoor Access Code](https://www.nationaltrust.org.uk) provides detailed guidance on the rights and responsibilities of land managers and recreational users in relation to outdoor access in Scotland.

[Scottish Natural Heritage - A Brief Guide to Occupiers’ Legal Liabilities in Scotland in relation to Public Outdoor Access](https://www.naturalheritage.org.uk) provides a brief explanation of relevant laws, and numerous examples from case law in relation to claims made in relation to injuries and accidents involving members of the public.

[Northern Ireland Assembly Briefing Paper 19/13 Access to the countryside in Northern Ireland – occupiers’ liability](https://www.niassembly.gov.uk) describes the legislative position and extent of rights of way in NI.
A.2 LEADERSHIP & SAFETY CULTURE

A.2.1 LEADERSHIP

High standards of health and safety performance depend on the commitment and leadership of senior management. Health and safety must be regarded as a key risk-management issue, to be driven from the highest levels of an organisation; failure to do so can put employees and members of the public at risk and expose the organisation, its directors, senior managers and employees to serious legal, contractual and financial consequences. In wind farm development, a failure to manage health and safety effectively can also lead to serious commercial impacts, as it may jeopardise the ability to construct a project to time and budget.

Board members have both collective and individual responsibility for health and safety. Directors and boards need to examine their own behaviour, particularly in relation to the priorities that they set, and the standards that they accept. If they see that their actions fall short of the standards required, then they should take action to change what they do, in order to become more effective leaders in health and safety.

Why directors and board members need to act:

- Protecting the health, safety and welfare of employees, and members of the public who may be affected by their activities, is an essential part of risk management and must be led by the board;
- Failure to recognise health and safety as a key business risk in board decisions can have serious results. Investigations into serious accidents and incidents have often identified failure of leadership as being amongst the root causes; and
- Health and safety law places duties on organisations and employers, and directors can be personally liable when these duties are breached.

The leadership of an organisation is responsible in law for that organisation’s health and safety performance; beyond this strict legal responsibility, leaders have a moral responsibility, as well as the opportunity to ensure that effective management of health and safety contributes to the reduction of risk to the business as a whole.

The Corporate Manslaughter and Corporate Homicide Act 2007 enables corporate bodies to be prosecuted in cases where serious failures in the management of health and safety result in a fatality. The provisions of this act do not change the liability of directors, board members or other individuals under health and safety or general criminal law, so such persons can still be prosecuted for separate health and safety offences.

The HSE, together with the Institute of Directors, has identified essential principles of health and safety leadership as:

- ‘Strong and active leadership from the top:
  - visible, active commitment from the board;
  - establishing effective ‘downward’ communication systems and management structures;
  - integration of good health and safety management with business decisions.
- Worker involvement:
  - engaging the workforce in the promotion and achievement of safe and healthy conditions;
  - effective ‘upward’ communication;
  - providing high quality training.
- Assessment and review:
  - identifying and managing health and safety risks;
o accessing (and following) competent advice;
o monitoring, reporting and reviewing performance.”

The leadership define the structures and behaviours that will determine the safety culture of an organisation, and ultimately determine the safety of all those affected by the organisation’s activities.

A.2.1.1 Reference

HSE INDG417 – Leading Health and Safety at Work – joint publication with Institute of Directors, which puts forward the principles listed above, and provides guidance for leaders on how to fulfil their responsibilities for health and safety, both in terms of a standard to meet, and practical steps to take.

A.2.2 Safety Culture

Safety culture is defined in HSE guidance as:

“the product of individual and group values, attitudes, perceptions, competencies, and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organisation’s health and safety management.

Organisations with a positive safety culture are characterised by communications founded on mutual trust, by shared perceptions of the importance of safety and by confidence in the efficacy of preventive measures.”

In a weak safety culture, typical behaviours include:

- Routinely ignoring safety procedures, which may also be out of date or incorrect;
- Management decisions prioritising schedule over safety; and
- Failing to report or investigate incidents adequately, for a variety of reasons including a blame culture, covering up issues, or a lack of belief that any meaningful improvements will follow from reporting.

A strong safety culture is characterised by:

- Real and visible management commitment to safety, prioritising safe working above other goals, and ensuring that effective safety management systems are in operation;
- Genuine consultation, encouraging workforce participation in setting targets and developing solutions to problems, and ensuring that the organisation is open to continuous learning and improvement;
- High level of trust between workforce and management, where all employees and contractors (not just supervisors and health and safety specialists) are genuinely empowered to raise concerns about safety issues;
- Effective two-way communications, providing clear and relevant information at the appropriate time, and listening and receiving feedback so that responsibilities and critical tasks are clearly understood; and
- People being competent for the roles that they are fulfilling in all parts of the organisation, with effective processes to develop competence.

It must be noted that safety culture involves every level of the organisation: it is not just about increased workforce compliance, or hoping that a good workforce safety culture will compensate for weak systems or unrealistic targets:

- To be safe an organisation has to learn, particularly from errors and near misses, which need to be reported and investigated, with effective preventive actions being followed through; and

7 HSE INDG417 – Leading Health and Safety at Work.
8 HSE Human Factors Common Topic 4: Safety Culture.
To report, staff need to know that they will not be blamed and punished for genuine human errors or "honest mistakes" and that their reports will be used for organisational learning and safety improvement.

However, everyone should remain accountable for their actions, and the line between acceptable behaviour, where honest mistakes are tolerated, and unacceptable behaviour (such as serious deliberate violations) needs to be defined clearly, and understood by all, in order to establish a "just" safety culture.

Establishing a culture can be more difficult in a situation with a transient workforce, as will often be the case in the construction phase. Development of a positive safety culture can be supported by appropriate contractor selection, clear and consistent definition of expectations, and implementation of suitable management arrangements. In the O&M phase, the core workforce is likely to be more stable, but will often work in small teams without direct supervision; the safety culture that is established will affect the long term safety and wellbeing of the workforce who are involved in the longest phase of the life of the wind farm.

A.2.2.1 REFERENCES

HSE Human Factors Common Topic 4: Safety Culture provides practical guidance on how to assess safety culture; it is aimed at HSE inspectors, but is also useful for any situation where the safety culture of an organisation needs to be assessed and improved.

HSE OTO000049 - Safety Culture Maturity Model provides the basis for a deeper assessment of safety culture, outlining a five stage model from "emerging" to "continually improving".

HSE HSG48 – Reducing Error and Influencing Behaviour provides detailed coverage of human factors issues in general, including a wide range of case studies.

HSE RR942 - Safety Culture on the Olympic Park describes the practical steps that were taken to create a safety culture that delivered an outstanding safety performance on a complex multi-contractor project.

HSE Leadership and worker involvement toolkit provides practical diagnostic and improvement tools to help contractors and managers to make health and safety improvements in their businesses.
A.3 WORKFORCE ENGAGEMENT

Employers have a legal duty to consult with employees in matters relating to their health and safety; in addition to this, successful health and safety management needs the shared commitment of all personnel involved.

A.3.1 LEGAL DUTIES

Two different sets of regulations impose specific duties in relation to employee consultation, depending on whether or not employees are represented by safety representatives appointed by recognised trade unions:

- The Safety Representatives and Safety Committees Regulations (1977), made under the HSWA, apply in relation to workers who are represented by a trade union safety representative; and
- The Health and Safety (Consultation with Employees) Regulations 1996, which implement requirements of the EU Framework directive on safety and health at work, apply to other workers.

Both sets of regulations impose duties on employers to consult with the workforce in relation to changes that may affect their health and safety, including matters such as provision of information, competent people for safety-related roles, and allowing employees who are serving as safety representatives to have sufficient time during their contracted working time, and use of facilities, in order to undertake their duties or necessary training. If the workforce in a workplace is a mixture of union and non-union staff, then both sets of regulations will apply; formation of a joint committee for health and safety can ensure that both groups of employees are consulted in a consistent manner.

Trade union safety representatives have a wider range of rights under the regulations than other workforce representatives; these include:

- The investigation of potential hazards, dangerous occurrences, and concerns raised by other employees;
- Carrying out workplace inspections; and
- Representing the relevant group of employees in consultations with the HSE or other enforcing authorities.

These functions can both support and check the performance of the employer’s safety management system.

The regulations also provide for the establishment of a Health and Safety Committee, which is required if requested by a trade union safety representative, and recommended in HSE guidance in other cases.

A.3.2 GOOD PRACTICES

While the regulations impose legal duties on consultation with employees, which must be complied with, businesses may benefit from doing more than the legal minima, and creating a genuine partnership with the workforce to manage health and safety risks. This involves creating a culture in which safety concerns and suggestions are shared freely and addressed effectively, and where the whole workforce participates in improving the health and safety standards in their workplace.

While this guidance refers to employers and employees, a similar approach could be adopted amongst clients and contractors; in the construction phase this will help to fulfil the duty under CDM to co-operate and co-ordinate in matters relating to health and safety.

Effective employee involvement in health and safety can lead to a range of benefits, including:

- Lower accident rates, supported by better control of common workplace risks;
- Creation of a positive health and safety climate, in which employees are encouraged to raise concerns; and
• Ensuring that decisions related to health and safety are informed by the workforce's practical experience and understanding of issues, allowing the development of joint solutions to problems, and encouraging workforce acceptance.

Effective employee involvement is most likely to be achieved in an environment where:

• Senior managers show personal and long-term commitment to health and safety;
• The views of employees are valued, as shown by the response when health and safety concerns or suggestions which are raised;
• People throughout the organisation are clear on their safety-related roles and responsibilities; and
• There is a good level of trust between management and employees, which is reinforced by actions being consistent with policy statements.

These characteristics are part of the safety culture of an organisation.

Workforce consultation should be based on a clear understanding of:

• The methods of consultation that will be most appropriate in a given setting, taking account of the nature of the business, workplace and workforce;
• The topics for consultation; some of these are determined by regulations, but it will be beneficial to consult on others such as incident and accident reports, and occupational health issues; and
• When to consult, both in terms of establishing regular consultation processes, and recognising specific issues that may require additional attention.

A.3.3 CODES OF PRACTICE AND GUIDANCE

HSE L146: Consulting workers on health and safety - Safety Representatives and Safety Committees Regulations 1977 (as amended) and Health and Safety (Consultation with Employees) Regulations 1996 (as amended) Approved Codes of Practice and guidance.

HSENI publishes A guide to the Health and Safety (Consultation with Employees) Regulations (Northern Ireland) 1996, as the regulations in NI differ from those in GB.

HSE HSG263: Involving your workforce in health and safety - Good practice for all workplaces provides extensive practical guidance on good practices for workforce involvement, together with case studies describing initiatives taken in a range of workplaces.

HSE Leadership and worker involvement toolkit provides practical diagnostic and improvement tools to help contractors and managers to make health and safety improvements in their businesses.
A.4 ERGONOMICS, HUMAN FACTORS AND BEHAVIOURAL SAFETY

Direct ergonomic risks to people in the course of their work are discussed in Section C.9; this section focuses on the contribution of ergonomic and human factors to initiating and escalating incidents, and how design and behavioural safety approaches can be used to reduce the risks that human errors introduce.

A.4.1 HUMAN FACTORS

The HSE definition is: ‘Human factors refer to environmental, organisational and job factors, and human and individual characteristics which influence behaviour at work in a way which can affect health and safety’.

Within the different categories in this definition, there is a wide range of contributory factors such as:

- Environmental:
  - Noisy, unpleasant or poorly-maintained workplace;
  - Extremes of temperature;
  - Quality of lighting;

- Organisational:
  - Health and safety culture;
  - Quality of training and supervision;
  - Effectiveness of communications, including at shift changeovers;

- Job:
  - Design of equipment and control / warning systems;
  - Workload / time pressure;
  - Interruptions during complex multi-stage tasks;
    - These could be momentary interruptions, affecting concentration, or longer interruptions such as operations being suspended due to weather;
  - Physical and mental match between the job and the individual;

- Human and individual characteristics:
  - Competence;
  - State of health and fatigue;
  - Boredom;
  - Habits, which can either have positive or negative effects; and
  - Personality and attitudes.

A.4.1.1 TYPES OF ERROR

There are many different forms of human error, with different underlying reasons:

- Deliberate deviation from procedures, which may be:
  - Routine, for a variety of reasons such as:
    - Procedures being incorrect or impractical; or
    - Taking short cuts makes it easier to accomplish the task, and the resulting risk may or may not be recognised by the person involved; and

9 HSE Website: Introduction to Human Factors.
- People not expecting to get caught taking the short cut;
  - Situational, often arising from:
    - Attempting to meet conflicting or unrealistic demands; or
    - Trying to get the job done without having all of the necessary tools available;
  - Exceptional, where a person’s response to abnormal circumstances is to take actions that deviate from the established procedures with which they would normally comply;

- Errors of action, which may either be:
  - Lapses or omissions, such as forgetting to attach oneself to a fall arrest system before descending a ladder;
    - A simple, momentary lapse such as this can have fatal consequences;
  - Slips, where a simple and routine action is performed incorrectly, such as pressing the wrong button on a hoist control pendant;

- Errors of thinking, such as:
  - Correctly following the wrong procedure for the prevailing circumstances; or
  - Having inadequate knowledge of what to do in an unfamiliar situation, so working out a course of action, based on limited knowledge, that turns out to be wrong.

The consequences of errors can affect both operations and safety, and can range widely in severity.

### A.4.1.1 Latent Errors

While some errors and their consequences are immediately obvious, known as “active failures”, people can also be put at risk by “latent failures”, where the error has occurred, but the consequences are not experienced until later; examples include:

- Design and calculation errors, leading to dangerous failures of equipment;
- Ineffective training and communication; or
- Errors in procedures, either relating to the steps to be followed, or a lack of clarity on safety-related responsibilities.

When the risk of such errors is recognised, mitigation can be applied, such as incorporating suitable checks into the design process, improving communications protocols, and undertaking practical reviews of procedures, including emergency drills. In high risk situations, formal Human Reliability Assessment should be undertaken, with competent specialist support.

### A.4.1.2 Relevance to Lifecycle Stages

Human factors should be considered throughout the lifecycle, such as:

- During risk assessments relating to equipment design, procurement, control of change and operating procedures:
  - If safety depends on human actions, then the risk from errors should be assessed:
    - Everyone makes mistakes; good design of equipment and procedures can minimise the probability and severity of mistakes;

- During investigation of health and safety incidents:
  - If the incident appears to have been caused by human error, then seek to understand why the error occurred:
    - Unless the causes of the error are understood and addressed, it is likely that similar errors will occur again in future; or
• If the error cannot be eliminated, then it may be possible to increase the error-tolerance of the system, to minimise the consequences;
• During routine operational management, including ensuring that effective physical and procedural precautions are maintained in the workplace.

A.4.2 STRATEGIES FOR REDUCING RISK FROM HUMAN ERRORS

Risk reduction can be approached in two complementary ways:
• Taking account of human factors in the design process, to identify ways to reduce the probability of errors occurring, and their safety implications; and
• Using behavioural safety approaches to improve human reliability.

A.4.2.1 REDUCING HUMAN ERRORS BY DESIGN

There are various ways in which design can take account of human factors, such as:
• Where correct assembly of components is critical to their function, the design should minimise the potential for latent errors to occur;
• The potential for operational errors can be reduced by making the layout of controls and operation of equipment as intuitive as possible;
  o Local control panels and indicators should give clear and consistent indications of status;
  o Design of SCADA and alarm systems should provide clear information, and avoid overloading operators with large quantities of trivial or repeated information that can mask critical alarms;
  o In control centres on large sites, or supporting multiple sites, the design should enable efficient use of multiple systems, including SCADA, communications and records of personnel locations, in order to ensure that these systems can support peaks in site workload, and provide effective co-ordination in emergency situations;
  ▪ The effectiveness of control room systems and the demands on operators should be assessed during emergency exercises, and any necessary improvements implemented;
  o Monitoring systems should not depend on people sustaining their concentration; and
• Procedures should ensure that the sequence of assembly and installation operations minimises the risk to the safety of the people involved.

A.4.2.2 REDUCING HUMAN ERRORS THROUGH BEHAVIOURAL SAFETY

Safe behaviour has an important place within the overall management of health and safety: any risk control measures that rely on procedures being followed, or PPE being used, will only be fully effective if they are understood and complied with by all of the people involved. It should be noted that procedural measures and PPE are at the lower levels of the hierarchy of risk reduction, so while safe behaviour increases the effectiveness of these measures, it is not a substitute for the adoption of measures that are higher on the hierarchy, particularly where a human error could have serious consequences.

Figures are often quoted indicating that human behaviour is a contributory factor in 70-80% of accidents, however, this does not mean that behaviour is the only reason for the accident, or that only the behaviour of front-line personnel should be considered. Any programmes to improve safety by means of behaviour modification should form part of a range of measures to address human factors and the safety culture of an organisation.

Behavioural safety programmes typically involve workplace observation of behaviour and conditions, supported by follow-up work to resolve identified issues, and a reporting system, in order to address the different types of human failure. Programmes should also involve observation of, and positive feedback on, safe practices in order to identify and be able to disseminate and reinforce safe behaviour. The success of such a programme will be strongly
influenced by an organisation’s culture: if a programme involves observing and giving feedback, the willingness to do so will depend on safety improvement being a shared objective that transcends hierarchical and workgroup boundaries.

Both deliberate deviations and errors can be reduced by identifying and addressing underlying causes, variously referred to as “Performance Influencing Factors” or “antecedents” of behaviour, together with increasing the awareness of the consequences of deviations and errors. Performance Influencing Factors are wide ranging, and can include organisational and management arrangements, contractual incentives, and the working environment:

- Errors are particularly likely if the design of operations leads to high levels of distraction, for example, if the person supervising a task is also operating complex equipment that is critical to the safe execution of the task;
- Deviations are most likely in cases where the design of the equipment and task make it inconvenient to operate in the correct way, for example, if a point of isolation is not readily accessible, then this can introduce the temptation to use other, less reliable, means of stopping equipment.

Behavioural safety programmes can be effective in reducing the frequency of low-severity personal injuries, but have less impact on reducing incidents that result from technical failures or inadequacies in procedures, which can lead to accidents with high potential severity. The precursors of high severity accidents may differ from those of more minor incidents, hence different management approaches are required.

Prior to embarking on a behavioural safety improvement programme, an organisation should ensure that:

- Risk assessments have been undertaken, in order to:
  - Identify hazards;
  - Apply the hierarchy of controls to reduce risk; and
  - Identify where the control of residual risks relies on correct behaviours being adopted;
- Suitable and effective operating procedures are in place, including those for response to abnormal / emergency situations;
  - This will be supported by establishing a culture where, if an employee judges a procedure to be incorrect, they are required to stop the task, and seek clarification / revision, rather than ignoring / deviating from the procedure; and
  - Implementation of the procedures will need a combination of training and supervision in order to develop competence;
- There is adequate resourcing to:
  - Respond to safety concerns identified by the workforce;
  - Implement lessons learned from site / corporate / industry experience; and
  - Keep safety management systems and risk control measures relevant and up to date.

These preparatory measures help to ensure that the behavioural safety programme can focus on true behavioural issues, and is not attempting to compensate for systemic weaknesses in the organisation’s safety culture and risk management.

A.4.3 REFERENCES

A wide range of literature is available, from introductory overviews to detailed guidance on specific aspects.

HSE Website - Human factors and ergonomics.

BS EN ISO 6385:2004 - Ergonomic principles in the design of work systems.
HSE HSG48 – Reducing Error and Influencing Behaviour provides detailed coverage of human factors issues in general, including a wide range of case studies.

HSE - Performance Influencing Factors (PIFs) provides a useful one page checklist.

HSE Inspectors Toolkit - Human factors in the management of major accident hazards - Introduction to human factors provides guidance on understanding and addressing the different categories of human failures.

HSE Human Factors Briefing Note No. 3 - Humans and Risk provides concise and practical guidance on how to address human factors in risk assessment and incident investigation.

HSE Human Factors Briefing Note No 6 - Maintenance Error addresses the hazards that errors during maintenance work can introduce into a system, and gives practical guidance on ways to reduce or eliminate such errors, benefiting both safety and reliability.

HSE - Improving maintenance - a guide to reducing human error provides very detailed guidance on how to manage maintenance so as to reduce the risk from human errors.

International Association of Oil and Gas Producers, Report No. 454 – Human Factors Engineering in Projects – aimed at engineering contractors working on the design and execution of major capital projects, from screening to operational feedback; especially Appendix 3 (Human factors screening tool) and Appendices 8,9 (Human factors consideration during HazOp).

HSE – Behavioural safety and Major Accident Hazards – magic bullet or shot in the dark discusses the usefulness of behaviour modification techniques, and gives practical guidance based on experience of regulating major hazard sites.

HSE – Human Failure Types – chart and descriptions, categorising and explain the main types of human failure in the workplace.

HSE Contract Research Report 430/2002 - Strategies to promote safe behaviour as part of a health and safety management system discusses how behavioural safety measures can be integrated with an organisation’s safety management system, and used to promote wider risk-control behaviours, rather than being addressed in isolation.

A.4.3.1 ELSEWHERE IN THIS GUIDANCE

Safety Culture
Incident Investigation, Nonconformity, Corrective and Preventive Actions
Ergonomics
A.5 OCCUPATIONAL HEALTH AND MEDICAL FITNESS TO WORK

The health of the workforce can be:

- Affected by the hazards that they are exposed to, and the activities that they undertake while at work; and
- A risk to their safety when undertaking work activities.

For these reasons, employers need to identify and assess workplace hazards to health, and monitor and review the health of the workforce.

While accidents and injuries are readily identified, and can have immediate and severe impacts on those involved, health risks can also have life-changing adverse impacts on people, and identical legal duties apply, including adopting the same hierarchy of risk reduction. However, work-related ill health may not become fully apparent until some time after exposure to hazards, and it can be more difficult to assess the risk that a given level of exposure to a hazard represents to the people involved.

The consequence of these challenges is that additional effort and specialist assistance may be needed, in order to understand and manage the potential health impacts of proposed activities. Occupational health therefore needs to be integrated into health and safety management strategies, so that employers have a clear understanding of the state of health of their workforce, in terms of short and long term physical health and wellbeing.

A.5.1 DEFINITIONS

Health surveillance is a system of health checks, undertaken either as an outcome of a risk assessment, or when required by law. Its purposes include:

- Early detection of health problems, so that improved controls can be introduced to prevent worsening;
- Provision of data to enable health risks to be evaluated, and the effectiveness of control measures to be assessed; and
- Enabling employees to highlight concerns about health effects of their work, and reinforcing training and education on health-related hazards and protective measures.

Certain regulations require health surveillance to be undertaken by an HSE-appointed doctor; this is known as statutory medical surveillance.

Fitness for work assessments are specific checks to assess whether an individual is fit to undertake the work they will be doing without unacceptable risk to themselves or to others."

The HSE define Occupational Health as being “about protecting the physical and mental health of workers and ensuring their welfare in the workplace. This includes a wide range of activities, but the key priority is to prevent ill health arising out of conditions at work by identifying, assessing and controlling health risks”. 10

The occupational health function may also provide support in areas such as:

- Ensuring initial and continued fitness to perform a job safely;
- Advising on the provision of first aid and emergency medical services;
- Health education and promotion; and
- Rehabilitation after illness or injury.

This broad definition of occupational health includes the occupational hygiene function, which is focused on prevention of work-related ill health, by anticipating, recognising, evaluating and controlling the risks to which people may be exposed as a consequence of work activities, and the working environment.

10 HSE Website: Occupational health risks offshore; definition remains valid onshore.
A.5.2 Risk Control

Wind farm construction and maintenance activities involve a combination of hazards that are common to other forms of construction and maintenance work, however, the control of these risks should take account of industry-specific factors such as work at height and in remote locations.

As the full effects of hazards to health are often delayed, the risks can be difficult to assess, particularly in cases where the relationship between a level of exposure to a hazard, and the subsequent health impact, is not widely understood. In order for a risk assessment to be suitable and sufficient, suitable competent advice should be obtained. This is where occupational hygienists can provide support, by helping to anticipate, recognise, evaluate and control risks to health. This support can include:

- Assisting designers (both machinery manufacturers, and Designers under CDM) to identify and eliminate risks to health;
- Assisting CDM Co-ordinators, Principal Contractors and Contractors to ensure that suitable and sufficient assessments of risks to health are undertaken, and appropriate methods of work are devised; and
- Carrying out workplace assessments and robust measurement of exposure to hazards, to ensure that control measures are effective and appropriate.

Adopting this approach ensures that the full hierarchy of risk control can be applied; as well as minimising the risk to workers, this can reduce or simplify PPE requirements, thereby minimising inconvenience to workers and enhancing productivity.

A.5.3 Medical Fitness to Work

Safe working requires that a person’s capability is well matched to the tasks that they will be undertaking as part of their job. While the risks to people can be minimised through the ergonomic design of equipment and operating methods, together with training and supervision in the use of safe methods of work, functional assessment of people may be necessary in order to determine their fitness to undertake the work that a role requires.

While good ergonomic design principles should be applied in all situations, the need for, and scope of, medical assessment of people, should be based on the outcomes of risk assessments.

Medical fitness is relevant to all stages of the lifecycle that involve on-site work. The challenges will vary between phases; for example the construction and commissioning phase is likely to involve large numbers of people working on a project for short periods of time, whereas the O&M phase is likely to have a core staff who may work on one or more sites for many years. This will affect the nature of the assessment that is needed, in terms of initial fitness, and ongoing monitoring to identify any effects that the work is having on the workforce.

Medical fitness for driving is regulated according to the class of vehicle.

A.5.3.1 Potential Hazards and Risks

If a person is not medically fit to undertake the tasks that a job involves, then this can lead to a range of adverse outcomes such as:

- The person may be unable to perform their job effectively, for example, if a cardiovascular condition impedes climbing;
- Pre-existing medical conditions may be worsened by the demands of the job, for example, symptoms of cardiac conditions can be worsened by strenuous activity;
- It may be unsafe for a person to undertake certain tasks, for example if they suffer from blackouts, then this could lead to falls or harness suspension if working at height; and
- If a person becomes ill as a consequence of a pre-existing medical condition, even if this is not aggravated by their work, this could lead to:
  - A need for emergency evacuation from a WTG, in which the remoteness from medical facilities and the difficulties of evacuation increase the risk to the casualty; or
Other workers being put at risk, if a worker in a safety-critical role, such as a crane or plant operator, loses concentration or consciousness.

Employers should therefore ensure that fitness for work assessments are specific to the tasks that the person will be undertaking, in order to ensure that the person is fit for the demands of the job, and in order to monitor the effects of the work that they are doing. Imposing a single standard across a project is unlikely to reflect the diversity of tasks that will be involved, and could be contrary to the requirements of applicable equality legislation.

A.5.3.2 APPROACHES TO RISK ASSESSMENT

Fitness for the demands of a particular role may be assessed as part of pre-employment medical checks. Any such check should reflect the requirements of the role, thereby ensuring that people are not unnecessarily excluded from roles that they would be capable of fulfilling, and that potential risks are not overlooked. Work on wind farms represents an area of employment without a long history, but which places clearly recognisable demands on the workforce, such as:

- Ergonomic risks, such as restricted working positions and regular climbing;
- Construction work, during which risks include:
  - Plant operator exposure to Whole Body Vibration (WBV), or Hand Arm Vibration (HAV) from the use of percussive tools;
  - Exposure to dusts and vapours, with an associated risk of respiratory conditions;
  - Exposure to substances such as wet concrete, grouts and sealants, with the associated risk of skin conditions.
- Extremes of heat and cold in the working environment.

Areas to consider include aspects of physical fitness such as:

- Eyesight and hearing;
- Cardiovascular and respiratory function;
- Musculoskeletal fitness;
- Chronic conditions such as diabetes and epilepsy;
- Effect of drugs (including prescription and over-the-counter medication) and alcohol;
- Skin conditions;
- Peripheral circulation.

While these conditions, and the effectiveness of any ongoing measures being taken to control symptoms, may determine the fundamental capability to complete tasks, a more holistic view of fitness to work in a role will include consideration of other factors such as:

- Mental / psychological health:
  - Conditions related to stress and depression;
  - Tolerance of lone working etc.; and
- Social factors:
  - Effects of remote and lone working, including separation from family; and
  - Needs for access to medical provision.

Taking such a view of the demands that a job places on people allows for better identification of risks, and definition of suitable fitness assessments.

Both an individual’s health, and the demands of their role, may change over time, so on-going fitness assessment may be appropriate; employers should establish policies for this, which may include:

- Repeating the fitness to work assessment at fixed intervals, or after events such as illness or incidents, where these may affect fitness;
- Random or with-cause testing for drugs or alcohol; and
- Pre-work fitness check by supervisors, to gain awareness of any relevant changes in the individual’s health.

A.5.3.3 ASSESSMENT STANDARDS

RenewableUK has developed medical fitness to work guidelines, which outline the nature and scope of assessments provided to wind turbine technicians and other personnel who may need to work on, access and climb a medium or large wind turbine. The guidelines have two main components:

- Health assessment, focusing on underlying medical conditions that may give rise to a risk of falling, or sudden incapacity leading to a rescue being required; and
- Medical fitness assessment to assure capability for regular climbing of vertical ladders and for working in hot and/or restricted spaces.

In order to make a valid assessment, it is important that the occupational health professionals involved have sufficient understanding of the nature of the work and risks that a role involves.

Within the construction industry, Constructing Better Health has published standards for workplace health, including guidance on the assessments that should be done with respect to different roles and hazard exposures, the frequency of assessment and the standards to be achieved.

A.5.4 HEALTH SURVEILLANCE

The primary aim of health surveillance is to ensure that the control measures in place to protect an individual from an identified health risk are suitable and adequate.

Under the MHSWR, employers are required to provide health surveillance to employees in certain circumstances, in order to detect damage to health at an early stage, and enable further harm to be prevented. Provision of health surveillance should be determined on the basis of a risk assessment, which should consider whether:

- The work activity and conditions carry a recognisable health risk;
- Valid techniques exist to detect indications of the disease or health condition; and
- Health surveillance is likely to enhance the protection of the health of the employees.

The existence of a valid technique is important, as health surveillance is only worthwhile where it can reliably show that damage to health is starting to happen or becoming likely. A technique is only useful if it provides accurate results, and is safe and practical. Undertaking health surveillance can reveal the accuracy of the initial risk assessment, and the effectiveness of control measures, and also help to identify and protect those individuals whose work puts them at increased risk.

A.5.4.1 SPECIFIC REGULATORY REQUIREMENTS FOR HEALTH SURVEILLANCE

Certain regulations specify health surveillance requirements, for example:

- The Control of Noise at Work Regulations 2005, and the Control of Vibration at Work Regulations 2005, impose duties on employers to ensure that workers exposed to health risks, due to noise or vibration, are placed under health surveillance;
- The COSHH Regulations specify conditions under which users of certain hazardous substances are to be placed under health surveillance; and
- The Road Traffic Act 1988 defines the medical requirements for driving different classes of vehicle.

The regulations specify whether health surveillance by a competent person is sufficient, or if statutory medical surveillance is required.

While not a regulation, BS 7121:1 specifies that crane operators should have evidence of medical fitness, obtained at intervals of not more than 5 years; the form of evidence and frequency of assessment will depend on the type of crane and the risks involved.
A.5.4.2 Fitness for Driving

A wide range of health conditions can affect an individual’s fitness to drive, especially conditions that could lead to a loss of consciousness, or impairment to vision; fitness may also be affected as a side-effect of medical treatments for other conditions, which, of themselves, would not affect driving.

Under the Road Traffic Act 1988, drivers have a duty to disclose, to the DVLA, any health condition that may cause their driving to be a source of danger to the public, regardless of the class of vehicle that they are driving. Although this duty of disclosure does not apply to new disabilities that are expected to last less than three months, individuals should seek medical advice on any condition that could impair their fitness to drive.

Drivers of “Group 2” vehicles such as Large Goods Vehicles (LGVs) are subject to statutory medical surveillance, as part of their licence renewal at five-yearly intervals.

Health surveillance should be based on risk assessment, rather than being confined to satisfying legal minima; if people are working in a particularly demanding environment, at night, or operating especially large, heavy vehicles, then more frequent surveillance may be appropriate, particularly as an individual’s state of health may change significantly in the interval between statutory medicals. Employers should ensure that employees are aware of their responsibilities, line managers are alert to the signs of impairment of driving ability, and procedures are in place to manage any concerns about fitness to drive.

A.5.5 Further Guidance

HSE Health surveillance webpages provide an overview, detailed information and decision-making tools on health surveillance.

RenewableUK Medical Fitness to Work - Guidelines for near offshore and land based renewable energy projects provides industry-specific guidance.

HSE WEB02 Working together to prevent sickness absence becoming job loss - Practical advice for safety and other trade union representatives is aimed at workforce representatives, and suggests ways in which they can work in partnership with employers and the workers whom they represent to help prevent illness, injury and disability leading to prolonged sickness absence and job loss.

Health & Safety Laboratory table indicating likely work-related health risks by trade focuses on typical construction activities, and indicates appropriate forms of health surveillance.

Constructing Better Health Occupational Health Standards for the UK Construction Industry is available for free download; registration is required. It includes a health assessment matrix, with respect to different roles and hazards involved in construction work.

Strategic Forum for Construction Good Practice Guide – Medical Fitness to Operate Construction Plant provides a process and standard (see Annex G) for medical fitness assessment.

DVLA – for medical practitioners – At a glance guide to the current medical standards of fitness to drive states the specific requirements for different classes of vehicle. It is updated on a 6-monthly interval; revised versions can be obtained from the DVLA website.
A.6 MANAGEMENT SYSTEMS

The MHSWR impose a duty on employers to assess the health and safety risks presented by the activities of their organisation, and to have appropriate arrangements "for the effective planning, organisation, control, monitoring and review of the preventive and protective measures" identified in the risk assessment. This duty can be fulfilled in a systematic way by means of a suitable health and safety management system, which provides a framework and tools to enable the organisation to achieve the aims of its health and safety policy.

Management systems commonly use the “Plan – Do – Check – Act” approach, which is outlined in current HSE guidance and in BS OHSAS 18001; this approach supports integration of health and safety management with quality, environmental and other management systems. The standard can both be used to support internal development and assessment, and as the basis of certification of the management system by an external auditor. While the standard provides a common approach, it does not specify performance levels, so assessment of an organisation’s performance is still necessary.

The key activities in the Plan – Do – Check – Act process are:

- “Plan”: set objectives, and identify the processes that will be needed;
- “Do”: implement the processes that are needed;
- “Check”: assess and report on the performance of processes against health and safety policies, objectives, legal and other requirements; and
- “Act”: periodic management review of the health and safety management system to assess its continued effectiveness, suitability and adequacy for the organisation’s activities.

These activities should be viewed as parts of a continual improvement cycle, rather than as one-off actions.

Wind farm development generally involves multiple organisations, from a range of backgrounds, such as the WTG manufacturer, civil and electrical Balance of Plant contractors, working together; given that each organisation will have its own health and safety policy and management systems, effective bridging processes will be needed at interfaces.

A.6.1 HEALTH AND SAFETY POLICY

An organisation’s health and safety policy records management commitment to:

- The prevention of injury and ill health;
- Achieving continual improvement in health and safety management arrangements and performance; and
- Fulfilling relevant legal duties, and other requirements (for example, from contracts or industry guidelines) that may apply to the health and safety hazards in the organisation’s activities;

The policy provides a framework for setting and reviewing health and safety objectives, and should be formally documented, implemented (by means of the health and safety management system), and reviewed and maintained as necessary to ensure that it remains appropriate, with particular respect to changes in legal duties, performance standards and the activities of the organisation. The policy should be communicated to all personnel (including both employees and contractors) working under the control of the organisation, in order to ensure that they are aware of their responsibilities; it should also be made available to others as required.

The policy should influence all of the organisation’s activities, including the selection and development of people, the planning and execution of tasks, and the procurement, design and provision of goods, services, equipment and materials.

The policy needs to recognise that organisational failings often contribute to causing accidents, or increasing their severity; integrating health and safety into the business strategy should ensure that staff who are responsible for implementing company policies can do so on the basis of clear and consistent guidance, and are not left to reconcile conflicts between corporate objectives and health and safety requirements.
A.6.2 “PLAN”

The Planning stage starts with identification of hazards that are presented by the organisation’s activities, and then defines the arrangements for the control of the associated risks, throughout the organisation and in accordance with regulatory duties.

A.6.2.1 HAZARD IDENTIFICATION AND RISK ASSESSMENT

The MHSWR impose a duty on employers and the self-employed to make a suitable and sufficient assessment of the risks to the health, safety and welfare of their employees whilst they are at work, and to the health and safety of others who may be affected by the work that they undertake. Further, in the context of the general duty to reduce risk ALARP, robust risk reduction can only take place when risks have been adequately identified and assessed.

A specific assessment of risk is also required under other several sets of regulations, including Control of Substances Hazardous to Health (COSHH) and Manual Handling.

Risk assessments should address all health and safety risks, during every phase of the lifecycle of a wind farm, and include risk to members of the public, as well as personnel working on site. Risk assessment techniques should be selected according to the hazards being considered, and the phase of the wind farm lifecycle. The health and safety management system should provide a structure for the risk assessment process, including the risk assessment techniques to be used, and competence requirements for those performing or reviewing risk assessments.

The findings of all risk assessments should be recorded (this is a legal duty in any company with five or more employees) and reviewed at regular intervals to ensure that they remain up to date, and they should also be reviewed as part of the management of change process, or when there is new learning from incidents or safety observations. More detail on risk management is given in Section A.7.

The identified risks should be prioritised, considering the severity and probability of the risks and the effectiveness of the controls in place at the time of the assessment.

A.6.2.2 DETERMINING RISK CONTROLS

Risk controls should be determined in accordance a hierarchy such as the General Principles of Prevention given in the MHSWR, or as given in BS OHSAS 18001:

1. Elimination;
2. Substitution;
3. Engineering controls;
4. Signage / warnings and / or administrative controls;
5. PPE

The design phase offers the greatest opportunity to eliminate risks, or reduce them ALARP. Designers have similar duties under CDM and the Supply of Machinery (Safety) regulations to identify and eliminate hazards, and reduce risks at every stage of the design process, and to provide information with the design or product regarding any significant residual risks. Clients can help to ensure that Designers fulfil these duties.

Some findings of a risk assessment may be in the form of controls to be applied to the workplace to reduce exposure to the identified risks. Both the identified risks, and the control measures selected to prevent the realisation of those risks, must be communicated to those carrying out the work, prior to work commencing. Records of all information, instruction and training should be retained as evidence that they were provided.

A.6.2.3 REGULATORY REQUIREMENTS

As the health and safety management system supports the organisation in fulfilling its legal duties, the organisation needs to have a procedure for ensuring that relevant legal requirements are identified, and that the management system will fulfil them. This compliance needs to be maintained, taking account of regulatory changes, and changes in the organisation’s activities. Relevant information on legal requirements should be communicated to personnel working under the control of the organisation, and to others who may have an interest.
A.6.2.4 **OBJECTIVES AND PROGRAMME**

Health and safety objectives for relevant functions and levels of the organisation should be cascaded through the organisation from the policy, in order to ensure that they are consistent with it, and contribute to its delivery.

In order to manage progress towards the objectives, a programme should be established, identifying the responsibilities, authority, method and timescale for actions to be carried out.

A.6.3 “Do”

This stage is focused on the actions that are necessary for the implementation and operation of the health and safety management system.

An effective health and safety management system will be capable of controlling risks, adapting to changing demands, and promoting a positive health and safety culture; such a system must be implemented effectively. Doing so will help to prevent accidents, ill health and losses by systematically identifying, eliminating and controlling hazards and risks, across the whole scope of an organisation’s activities.

Key components of the system to be implemented include:

- Workplace precautions, which address the hazards and risks of all work activities undertaken within the organisation, through a combination of physical protection, information, training, competence, supervision and the operation of safe systems of work;
- Risk Control Systems (RCSs), which ensure that adequate workplace precautions are established and maintained, with respect to the inputs, internal processes and outputs of the organisation;
- Management arrangements, which provide for the establishment and operation of the RCSs, including auditing their effectiveness.

A.6.3.1 **RESOURCES, ROLES, RESPONSIBILITY, ACCOUNTABILITY AND AUTHORITY**

The ultimate responsibility for health and safety lies with the board of directors, or other top management of the organisation, who should ensure that:

- The necessary resources are made available to establish, implement, maintain and improve the health and safety management system; and
- The roles, responsibilities, accountability and authority for health and safety management are defined, documented and communicated throughout the organisation.

As the board is normally in overall control of the organisation, it has a duty under the MHSWR to obtain the advice and assistance of ‘Competent Persons’ on health and safety matters. These Competent Persons can be in-house advisers or a team of safety professionals, or the advice may be obtained from external consultants.

Although health and safety is the responsibility of everyone in an organisation, specific responsibilities may be delegated by the board to individuals involved in the management of health and safety. These responsibilities need to be appropriate for each level of the organisation, and the relationships between those individuals may be set out along normal reporting lines. The aims of the organisation should be to:

- Establish and maintain management control of health and safety throughout the organisation;
- Promote co-operation throughout the organisation, in order to ensure that the management of health and safety is a collaborative and consistent effort;
- Ensure communication of relevant information throughout the organisation, and where it interfaces with external stakeholders; and
- Secure and enhance the competence of employees, including arrangements relating to recruitment, training, supervision and competence assessment.

While Competent Persons may be providing advice to the company, safety management should be the first priority of all line managers, and should be integrated into design and project
development processes, rather than leaving a separate part of the organisation to “police” work activities. Elimination of hazards at the earliest stages can avoid incurring the costs associated with having to make late changes to improve safety, or having to maintain precautions to mitigate residual risks.

A.6.3.2 COMPETENCE

The organisation should ensure that all personnel under its control, both direct employees and contractors, have the necessary competence to undertake their tasks without adverse effects on the health and safety of themselves or others. Such competence may be gained through a combination of training and experience, with formal competence assessment where necessary.

In order to develop competence, training requirements should be identified, based on the risks identified in the risk assessment, and the requirements of the health and safety management system. The need for competence applies to all levels and functions of an organisation, and is not limited to those who may be directly exposed to hazards, such as technicians and construction personnel. Other relevant groups, whose competence could affect health and safety, include people in management and supervisory positions, those undertaking risk assessments, audits, monitoring activities on a site and investigating incidents.

In addition to competence for specific tasks, people should have sufficient awareness of health and safety aspects of their work, including site-specific information such as emergency procedures, as well as an understanding of the potential health and safety consequences of their actions, behaviour and any deviations from policies and procedures.

Further details on training and competence are given in Section A.8.

A.6.3.3 COMMUNICATION, PARTICIPATION AND CONSULTATION

Effective communication and consultation can increase the understanding of health and safety issues, encourage participation in the development and use of the health and safety management system, and the adoption of good practices. Communication processes should enable the flow of information between different levels and sections of an organisation, and should work in both directions.

Participation in activities such as hazard identification, risk assessment, incident investigation and development of risk controls helps to ensure that these are based on relevant experience, and increases ownership of the outcomes. In addition to fulfilling the legal duty under the HSWA to consult with employees in matters affecting their health and safety, effective consultation arrangements can help to ensure that risks are adequately controlled, and that systems work well in practice.

A.6.3.4 DOCUMENTATION AND DOCUMENT CONTROL

The MHSWR imposes a duty that, where there are five or more employees, risk assessments and health and safety arrangements shall be recorded. As well as documenting the health and safety management system itself, its operation will involve the creation of documents and records; these should be properly controlled, in terms of approval, issue, review, updating, distribution and ensuring that obsolete documents are not unintentionally used.

Documentation will be most effective if it is kept to the minimum that is required for effective operation of the health and safety management system; it should be proportionate to the complexity of the activity, and the hazards and risks involved. Effective document control ensures that information is available where and when it is needed, both in normal operation and emergency situations. This may affect the format in which documents are kept; for example, emergency information may be more effectively provided through signs and laminated cards, rather than solely in an electronic format.

A.6.3.5 OPERATIONAL CONTROL

Operational controls are the means by which the risks associated with the identified hazards are controlled. They include:

- General measures, such as those addressing risks arising from workplace conditions, work activities and behaviour;
- Specific control measures, such as procedures for hazardous activities, procurement of goods and services, and contractor management.
The level of detail in the operational controls should be proportionate to the hazards that they address; in many cases, detailed operating criteria, which specify approved equipment and methods, will be defined. Operational controls should be maintained to ensure that they remain effective, both as part of a management of change process and through periodic reviews, so that they are updated when operating activities or equipment are changed.

A.6.3.6 Emergency Preparedness and Response

Organisations have a duty under the MHSWR to have suitable procedures in place to deal with situations involving “serious or imminent danger”, and for contacts with external emergency services. This duty can be fulfilled by implementing an Emergency Response Plan (ERP), which identifies potential emergency situations, and then defines the methods and equipment that should be used in the response. The procedure should also identify requirements for training, periodic practice drills and review processes. See section A.16 for further details.

A.6.4 “Check”

A.6.4.1 Performance Measurement and Monitoring

In order to check that the health and safety standards are actually being achieved in practice, performance needs to be measured against a range of active and reactive indicators, and any necessary improvements implemented.

A.6.4.1.1 Active / Pro-active Monitoring Systems

Active monitoring systems measure the extent to which plans are being implemented, and policies complied with. They typically use leading indicators from sources such as:

- Monitoring of performance against health and safety objectives;
- Systematic inspection of premises, plant and equipment by supervisors, maintenance staff, management and safety representatives, or other employees to ensure the continued effectiveness of workplace precautions;
- Environmental monitoring and health surveillance to check on the effectiveness of health protection measures, and to detect early signs of harm to health; and
- Direct observation of work and behaviour by first line supervisors and co-workers to assess compliance with procedures, rules and risk control.

A.6.4.1.2 Reactive Monitoring Systems

These measures consider where health and safety standards are not being met, and report and analyse failures – for example, accidents, cases of ill health or damage to property.

When reporting and response systems are put in place, the information from monitoring activities should be evaluated by people who are competent to recognise situations in which there is an immediate risk to health or safety, as well as longer-term trends. They must have sufficient authority to ensure that appropriate remedial action is taken.

Performance data is often summarised as statistics; for these to be useful and meaningful, particularly if data is to be used for benchmarking, or for monitoring trends over time, it is important that the measurement systems are carefully defined, including:

- Using standard categories of incident / injury; and
- Expressing data as frequency rates (for example, per million hours worked) rather than as simple totals of occurrences, ensures that the data allows for changes in the level of activity.

A.6.4.1.3 Combining Active and Reactive Monitoring

Reactive monitoring provides lagging indicators, such as accident data, which record the performance that has been achieved. Active monitoring provides leading indicators that can be used to measure the inputs to the health and safety performance, such as the number of inspections undertaken, safety observations identified, or relevant safety training undertaken. Appropriate leading indicators take account of the safety culture maturity of an organisation, and should be directly relevant to the risks to which the workforce is exposed. The combination of
leading and lagging indicators, and trends over time, can show if workplace precautions and RCSs are:

- Receiving minimal effort, but despite this the organisation has been lucky, and has had few incidents;
- Receiving minimal effort, with a correspondingly high level of incidents;
- Receiving a high level of effort, but the efforts that are being measured have yet to reduce a high level of incidents, or are not focused on the risks that are giving rise to the incidents; or
- Receiving a high level of effort, with a low level of incidents occurring, which suggests that the risk control effort has been well targeted up to the point in time at which performance was measured.

This approach gives a deeper understanding of an organisation's performance, and the reasons behind it, than would be the case if only reactive monitoring were undertaken, and can therefore allow improvement efforts to be targeted more effectively.

**A.6.4.1.4 Further Guidance on Performance Measurement**


*Step Change in Safety - Leading Performance Indicators - Guidance for Effective Use* considers how to identify suitable leading performance indicators for an organisation, and then combine these with lagging indicators to prioritise improvement actions.

**A.6.4.2 EVALUATION OF COMPLIANCE**

Part of the purpose of the health and safety management system is to ensure compliance with legal requirements, and other requirements from industry codes or contracts; therefore this compliance should be evaluated periodically. This evaluation should consider both external factors, such as a review of current legal requirements, and internal factors such as audit reports, reviews of documents, activities and projects, workplace inspections and interviews.

**A.6.4.3 INCIDENT INVESTIGATION, NONCONFORMITY, CORRECTIVE AND PREVENTIVE ACTIONS**

**A.6.4.3.1 Incident Investigation**

When an incident occurs, it is vital that it is properly investigated, and that steps are taken to prevent a recurrence. A procedure should be established for the investigation of incidents, with the aim of identifying underlying causes, opportunities for corrective and preventive actions and improvements, and communicating the outcomes.

The first step in this lies in the immediate response to the incident: all necessary actions to protect people and prevent escalation of the incident should be carried out, but nothing else should be done that could hamper investigation of the incident, such as removing equipment or debris, or resetting controls. Thereafter, the effort expended on investigation and follow-up activities should be proportionate to the risk that the incident represents, in terms of its potential consequences and probability of recurrence, and not just the severity of the outcome on the particular occasion being investigated. This is illustrated in Figure 1 below.

In the event of any significant incident, and in particular where this has resulted in a fatality or major injury, appropriate legal and professional advice should be considered. There are also certain statutory reporting requirements, and in some cases, more than one report will be necessary:

- In the event of a fatality or life-threatening injury, the police should be informed immediately;
- Certain categories of incident and dangerous occurrence are reportable to the HSE (see section A.1.5); and
- Leases and contracts may specify further reporting requirements.
Figure 1: Event triangle, illustrating a typical ratio of events of different actual severity, but with the high potential events highlighted. These events demand the greatest attention in incident investigation and follow-up.

When selecting actions to prevent recurrence of an incident, the hierarchy of protective measures should be applied, with hazards being eliminated where reasonably practicable; note however that it will be more difficult to eliminate hazards in equipment that has already been built, than it would have been at the design stage.

The outcomes of the investigation need to reach management with sufficient authority to initiate remedial action, including organisational and policy changes. The actions identified in the investigation should be recorded, and their completion monitored across all relevant parts of the organisation, to ensure that an incident is not repeated as a consequence of identified actions not being completed.

A.6.4.3.2 Levels of Causation

When investigating an incident, several different levels of causation need to be considered, which can be categorised as:

- Immediate cause: the most obvious reason why an event occurs;
- Underlying cause: less obvious factors that contributed to the event occurring, often related to failings in systems or organisations; and
- Root cause: the initiating event or failure, without which the incident would not have occurred.

Getting to the root cause offers the best prospect of preventing a recurrence of the event. The example given in Table 7 below illustrates the different levels of causation of an incident, showing how these will lead to different follow-up actions, and protect different groups of people.
Table 7: Getting to the root cause of an incident

<table>
<thead>
<tr>
<th>Level</th>
<th>Question</th>
<th>Potential answer</th>
<th>Type of cause</th>
<th>Possible follow-up action</th>
<th>Whose safety is improved?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Why</strong> did the worker fall through the hatch?</td>
<td>Hatch had been left open</td>
<td>Procedural violation</td>
<td>Warning / disciplinary action</td>
<td>Individual worker</td>
</tr>
<tr>
<td></td>
<td>Worker forgot / did not notice that it was open</td>
<td></td>
<td>Lapse / Error</td>
<td>Toolbox talk</td>
<td>Work group</td>
</tr>
<tr>
<td>2</td>
<td><strong>Why</strong> was the hatch open?</td>
<td>Letting light in to area below</td>
<td>Design</td>
<td>Improve lighting</td>
<td>All workers</td>
</tr>
<tr>
<td></td>
<td>Frequent access required during task</td>
<td></td>
<td>Procedure</td>
<td>Improve planning of task</td>
<td>All workers</td>
</tr>
<tr>
<td>3</td>
<td><strong>Why</strong> didn’t the worker see that it was open?</td>
<td>Lighting conditions</td>
<td>Design</td>
<td>Improve lighting</td>
<td>All workers</td>
</tr>
<tr>
<td></td>
<td>Stepping backwards while undertaking adjacent task</td>
<td></td>
<td>Procedure</td>
<td>Improve planning of work</td>
<td>All workers</td>
</tr>
<tr>
<td>4</td>
<td><strong>Why</strong> was it possible to fall through the hatch?</td>
<td>Lack of edge protection when hatch open</td>
<td>Design</td>
<td>Retrofit edge protection at similar locations</td>
<td>All workers</td>
</tr>
<tr>
<td>5</td>
<td><strong>Why</strong> was a hatch without edge protection accepted at the design stage?</td>
<td>Inadequate design review / prototype acceptance</td>
<td>Procedure</td>
<td>Update specifications and checklists</td>
<td>Future workers and projects</td>
</tr>
</tbody>
</table>

The above table only provides a simplified summary of how the root cause of an incident could be identified, and seeks to demonstrate the importance of going deeper than the immediate cause of an incident. In practice it is invariably more complex, and more sophisticated techniques and models (including proprietary systems) can provide deeper insight and evaluation.

A.6.4.3.3 Further Guidance on Incident Investigation

HSE HSG245 - Investigating accidents and incidents provides detailed guidance, and tools for undertaking investigations.

Energy Institute – Guidance on investigating and analysing human and organisational factors aspects of incidents and accidents.

IOSH - Learning the Lessons: How to Respond to Deaths at Work and Other Serious Incidents

A.6.4.3.4 Nonconformity, Corrective and Preventive Actions

In order to ensure the continuing effectiveness of the management system, the organisation needs to have a procedure for identifying and responding to actual or potential nonconformities. A nonconformity is defined as the non-fulfilment of a requirement, which may either be a requirement of the health and safety management system, such as failing to carry out specified
actions, or a failure to achieve specified health and safety performance. Nonconformities should be addressed by corrective actions, and potential nonconformities by preventive actions. For example:

- If an item of lifting equipment was damaged due to being overloaded during lifting, then this would be an incident;
- If a load was about to be lifted, but the requirement in the lifting procedure to provide information on the weight of the load had not been fulfilled, then this would be a nonconformity, and a corrective action could be to weigh the load;
- Having identified the existence of the nonconformity, there may be potential nonconformities, such as similar deviations from procedure occurring on other lifts, so preventive actions could be to increase awareness of the requirements with other workgroups, and increase monitoring of similar activities.

A.6.4.4 CONTROL OF RECORDS

Records should be kept to demonstrate conformance to the requirements of the health and safety management system and applicable regulations, and as evidence of how risks are being managed. A wide range of different records may be created, such as risk assessments, incident reports, inspection reports, training records and records of legal compliance checks. The procedure for control of records should specify the retention requirements for different types of record, and also maintain confidentiality of personal data held in the records, such as health surveillance reports.

A.6.4.5 INTERNAL AUDIT

The health and safety management system should be subject to periodic internal audits, to determine if the system is operating as intended, and to assess its effectiveness in meeting the requirements of the organisation’s health and safety policy and objectives. Auditing helps to ensure that all components of the health and safety management system remain fit for their purpose, and that they are not allowed to deteriorate, or become obsolete as a consequence of changes in the organisation or its activities. Audits will be most meaningful if the audit schedule takes account of risk factors, such as:

- Areas where changes have occurred, such as new activities, hazards or personnel; and
- Areas of concern identified in previous audits, or incident and nonconformity reports.

Auditors need to have sufficient understanding of the hazards that are present in the activities covered by the processes being audited, in order to be able to make a valid assessment of the effectiveness of the risk controls. Audits generally begin with an initial review of relevant documentation and previous audit reports, followed by discussions with the person or group being audited, collection and evaluation of information and records, and preparation of a report.

The audit findings may identify the need for corrective or preventive actions to be taken, and it is important that completion of these actions is monitored.

A.6.5 “ACT”

Organisations need to review their health and safety performance and management systems, and take action on the basis of any lessons learned.

A.6.5.1 MANAGEMENT REVIEW

The health and safety management system should be subject to periodic management review, in order to assess its performance, in terms of its:

- Suitability for the organisation, considering factors such as its current size, activities and related risks;
- Adequacy, in terms of giving complete coverage of the organisation’s health and safety policy and objectives; and
- Effectiveness, which will be demonstrated by the health and safety performance being achieved.
The management review should draw on data and reports on the performance of the system (which will come from the steps in the “Check” stage above), with additional reports if greater understanding of specific areas is needed. The review may also look ahead, to anticipate potential changes arising from foreseeable changes in activities, strategy, legislation and technology. The review may identify the need for actions to be taken to improve aspects of the health and safety management system.

A.6.6 CODES OF PRACTICE AND GUIDANCE

HSE HSG65 – Managing for health and safety (2013 Edition) describes the Plan – Do – Check – Act approach, identifies key actions for different groups of personnel within an organisation, and provides useful descriptions of “what to look for” when assessing the effectiveness of different aspects of a management system.

A.6.6.1 REGULATIONS AND STANDARDS

BS OHSAS 18001:2007 Occupational health and safety management systems. Requirements

BS OHSAS 18002:2007 Occupational health and safety management systems. Guidelines for the implementation of OHSAS 18001:2007 provides more detailed guidance on the components and operation of such a system.
A.7 RISK MANAGEMENT

Effective management of risk is vital to the safe development and operation of complex projects; wind farm development involves undertaking major projects in potentially challenging locations, and therefore requires thorough risk management.

Such projects may involve a large number of different parties, at different stages and in different roles within the supply chain; the collective risk burden will be minimised where it is recognised that responsibility for the health and safety performance of the project extends right through the supply chain. Each party should therefore manage both the direct risks that are present in their own activities, and the risks to and from the activities of other parties.

A.7.1 PRINCIPLES AND PRACTICE

The hierarchy of risk management prioritises the actions to take:

1. Eliminate hazards where possible, for example by design changes, elimination of a hazardous operation, or selection of a different method;
2. Reduce the potential of those hazards that cannot be eliminated;
3. Reduce the exposure of people to hazards, by means of collective protection measures such as fixed guards;
4. Where fixed guards or similar are not possible, protective systems such as interlocks may be used; these should be designed such that if they fail, the machine will default to a safe state; and then
5. Mitigate residual risks by systems of work and use of PPE.

The effort invested in risk assessment and reduction should be proportionate to the hazards and risks, to ensure that the overall level of risk is minimised in the most efficient manner.

A.7.1.1 DEFINITIONS: HAZARD AND RISK

A hazard is anything with the potential to cause harm, such as articles, substances, plant or machines, work equipment, work activities, the working environment and the way in which work is organised.

Risk considers both the probability of harm occurring, and the potential severity of that harm.

A.7.1.2 SUITABLE AND SUFFICIENT RISK ASSESSMENT

The MHSWR impose a legal duty to undertake a suitable and sufficient risk assessment; “suitable and sufficient” is not defined in the regulations, although guidance is given in HSG65.

An effective risk assessment process will typically need to:

- Take account of risks arising from or in connection with an activity, with the thoroughness of the assessment being proportionate to the risk;
- Make use of specialist knowledge where necessary for particularly complex operations or techniques;
- Consider all who may be affected by the activity;
- Involve workers or their representatives in the process;
- Make use of available information when identifying risks; this may include sources outside the organisation, such as regulations, vendor information, industry reports and publications, or competent advisers; and
- Ensure that precautions are reasonable, and the residual risk is low.

When new designs or techniques are being considered, there may be less historical data on which to base judgements, so other approaches will be needed in order to provide evidence of the level of risk presented.

The overriding aim is to ensure that all reasonably foreseeable risks are adequately assessed.

A complex project will require many risk assessments to be carried out; it is important that the scopes of individual risk assessments, how they relate to each other, and Designer / Contractor /
Client responsibilities, are managed as part of a coherent process, to avoid risks at interfaces or from interactions being overlooked.

### A.7.2 Lifecycle Approach

Risk management is best viewed as an ongoing process throughout the project lifecycle, both to assess and inform decisions. As a project is developed from concept through to commissioning and operation, the ability to make fundamental changes reduces, while the detailed understanding of specific risks increases. This change in data availability will also affect the appropriateness of different risk assessment techniques.

The concept phase offers the greatest opportunity to eliminate risks, by substituting hazardous equipment, substances or activities by less hazardous alternatives.

As design activities progress, risks may be combated by engineered protective measures, such as:

- Designing equipment so that it separates people from hazards, by measures such as guarding and interlocks;
- Minimising inventories of hazardous substances;
- Provision of remote diagnostic systems to minimise on-site investigation of performance problems, and optimise planning of maintenance activities; and
- Provision of isolation systems to ease implementation of safe systems of work for maintenance activities.

Once the design has largely been frozen, the residual risks can be minimised by:

- Designing suitable systems of working;
- Using personal protective clothing and equipment, although this should not be used as the primary means of protection.

If the risk assessments at this late stage identify risks that cannot be mitigated to an acceptable level by the above means, then modifications may be required, almost certainly resulting in a far greater impact on cost and schedule than if the risks had been identified earlier.

### A.7.3 Overview of Risk Assessment Techniques

A wide range of risk assessment techniques is available; appropriate selection is important in order to fulfil the duty to undertake suitable and sufficient risk assessment. Some of the factors to consider in selecting an approach are described in Table 8 below, while the effect of lifecycle stage on the choice of technique is given in Figure 2 below.
Table 8: Factors affecting choice of risk assessment technique

<table>
<thead>
<tr>
<th>Factor</th>
<th>Effect on choice of technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lifecycle stage</td>
<td>Availability of design details and project-specific data is limited in early stages, encouraging use of qualitative approaches or external data sources to learn from relevant experience elsewhere; the output of early stage risk assessment should guide later detail design work. This is illustrated in Figure 2.</td>
</tr>
<tr>
<td>Hazard potential</td>
<td>More significant hazards may need quantitative methods to demonstrate acceptable risk levels, whereas qualitative approaches or engineering judgement may be appropriate for lower hazards.</td>
</tr>
<tr>
<td>Context</td>
<td>Assessment of established practices and standard designs may be supported by historical data and published design codes, whereas novel proposals may require more detailed individual analysis.</td>
</tr>
<tr>
<td>Enterprise risk</td>
<td>Where the outcome of a risk assessment may affect the viability of a development, additional rigour in assessment, and senior management support, may be required.</td>
</tr>
</tbody>
</table>

Figure 2: Example of how different risk assessment approaches may be used over a project lifecycle.

The techniques listed in Figure 2 are briefly summarised in the sections below.

For all of these techniques, it is vital to ensure that the right people are involved, with a study leader who is trained and experienced in the risk assessment process, supported by a team with sufficient experience of the subject of the study, and the process being used, to be able to give suitable consideration to all relevant risks. It is important to recognise that risks may arise from both technical and human factors, so both of these areas require sufficient consideration.

As the risk assessment process needs to continue throughout the project lifecycle, it is important to ensure that the outcomes of each stage of the process are recorded, and made available to subsequent stages, perhaps including a formal handover from one stage to the next. This ensures that the investment in risk assessment is not wasted through duplication or loss of information, and that assumptions are not made about the level of risk assessment that has already been undertaken.

A.7.3.1 HAZARD IDENTIFICATION

A range of techniques exists, with their suitability depending on the stage in project development, and the resulting level of project-specific detail. In the earliest stages of project development,
experience on other projects should be used to inform the design of the project under consideration, while in later stages, the project itself can be assessed in increasing detail. Available techniques include:

- **Hazard Review:**
  - A qualitative review, based on previous experience of similar developments, industry guidelines and codes of practice;
  - Useul in concept or outline design, to ensure that prior learning is utilised, but the ability to do this is reduced for novel situations;

- **Hazard Checklists, Structured What-If checklist Technique (SWIFT):**
  - Standard checklists, based on previous experience, are used to prompt consideration of hazards which may be present;
  - “What-if” questions are used to prompt consideration of novel failure modes, and human factors;

- **Hazard Study / HazOp (Hazard and Operability Study):**
  - Each step of a process is reviewed, by a study team, against foreseeable deviations from the design intent;
  - Considers physical properties such as speed and temperature as well as operating sequences and procedures;

- **Failure Modes, Effects (and Criticality) Analysis (FMEA / FMECA):**
  - Identifies failure modes at the individual component level of a system, and assesses the effect of such failures on the performance of the system as a whole, taking account of the ease with which they can be detected;
  - Requires a detailed system structure to have been defined;

### A.7.3.2 Qualitative Risk Assessment

Having identified the hazards, an assessment can be made of their:

- Probability, which may range from “likely” to “highly unlikely”; and
- Severity, which may range from “catastrophic” to “slight”.

These categories must be carefully defined, and understood by the team members, as the study relies on their assessment of the probability and severity of each hazard. For this reason, although this approach can give numerical outputs, it is still a qualitative approach. It is also important to be clear on exactly which event and outcome is being assessed:

- Does the probability relate to an event involving, for example:
  - A single WTG in a discrete stage of its lifecycle, or a single occurrence of an operation; or
  - An entire wind farm over its whole lifecycle, or an operation that is to be repeated regularly?

- Does the severity relate to, for example:
  - The most likely severity; or
  - The most severe foreseeable outcome?

Where new designs or methods are being considered, there may be very limited evidence to support these judgements.

The outputs may be in the form of a:

- Risk Priority Number, which is generally the product or sum of numerical values assigned to probability and severity;
This approach does not distinguish between “high probability, low severity” and “high severity, low probability” events; these require different management approaches;

- Risk Matrix, with probability and severity on its axes.
  - This ensures that high severity risks are clearly identified, regardless of their probability; this is particularly important where there is uncertainty in the probability.

### A.7.3.3 Semi-Quantitative and Quantitative Risk Assessment

The most common techniques in these categories are Fault Tree Analysis (FTA), Event Tree Analysis (ETA), and Bow Tie diagrams; the ability to quantify risk will depend on the quality and availability of failure and event data.

Fault Tree Analysis generally starts with the potential “Top Event”, in which the hazardous situation occurs, and works down through logic gates to identify the combinations of basic (initiating) events that could cause the top event, and safeguards or protective systems which could prevent it.

Probabilities may be assigned to events and safeguards, based on failure rate data. FTA can consider combinations of technical and human factors. As it breaks complex systems down into discrete functions, it may be possible to model novel systems, where they are composed of established components or practices, provided that suitable allowance is made for effects of the new operating context.

Event Tree Analysis starts with an initiating event, such as a component failure, and then models the potential outcomes, taking account of actions or systems that could mitigate the consequences, and their probabilities of success. It may also include environmental factors such as weather, where these can affect the outcome, although the method is clearest when these can be captured in a binary state, such as wind towards / away from structure.

A Bow Tie diagram effectively combines FTA and ETA; for a given Top Event, the FTA works back to the initiating events, while the ETA works forward to the consequences. This captures the full range of initiating events and safeguards on a single diagram, and can also consider the effect of elements of a Safety Management System. While Bow Ties are most commonly used in a semi-quantitative manner, software can be used to assist in calculating probabilities.

### A.7.4 Risk Control

Risk control systems (RCSs) are the basis for ensuring that adequate precautions are provided and maintained, to minimise the identified risks. The different areas to be subject to RCSs may be classified as:

- **Input:** minimising hazards and risks entering the organisation:
  - This includes areas such as the selection of contractors, personnel, and equipment, management of the supply chain and outsourced design activities;

- **Process:** minimising risks to those within the organisation:
  - This includes risks arising from carrying out the organisation’s activities, such as its premises, plant, substances, procedures and people; and
  - The controls should address all foreseeable operating states such as normal operation, maintenance and emergency situations;

- **Output:** minimising risks from the organisation’s activities to others outside the organisation:
  - This includes operational effects on other land users, host communities, customers and clients; and
  - Physical outputs such as the organisation’s products, services, installations, disposal of materials and provision of information.

The classification of an activity will depend on the organisation’s place in a supply chain.
Organisations need RCSs that are appropriate to the hazards arising from their activities, and sufficient to cover all hazards. The design, reliability and complexity of each RCS needs to be proportionate to the particular hazards and risks.

A.7.4.1 Method Statements

Project and task-specific risk assessments may be used to devise methods of work (sometimes referred to as ‘method statements’). These method statements should not be prepared entirely as generic ‘process’ documents unless the process is unlikely to change. If there is a possibility that these method statements will be revised (for example, if the scope of work may change, depending on the findings of initial diagnostic work), then the method statements should be under the control of a person with sufficient competence, authority, time and resources to be able to review the appropriateness of the method, or to suspend the task pending revision of the method.

Sufficiently robust work instructions should be given to personnel involved, to ensure that work is suspended if necessary. In addition, there should be suitable contractual arrangements for delay caused as a result of safety precautions; this will also encourage thorough preparation, to minimise the risk of such delay occurring.

If the method of work is not capable of change without reference to a manufacturer or designer then these people should be available to assist with revision of the method statement as needed. Contractual requirements in procurement may assist with securing this responsiveness.

The effectiveness of method statements can be increased if they are used in conjunction with Point of Work Risk Assessments. These should be carried out immediately before commencing a task or activity, to identify hazards and review mitigation measures, and to check whether the outcomes of risk assessments performed while preparing for the task have achieved satisfactory risk reduction, or if unforeseen risks are present, in which case the task should stop until adequate controls are put in place. Point of Work risk assessments benefit from being carried out by the actual personnel involved in the task or activity, at the work location; their effectiveness depends on the competence of those involved, so clear thresholds must be set for the level of hazard that can be addressed in this manner.

A.7.5 Codes of Practice and Guidance

A.7.5.1 Regulations and Standards

BS ISO 31000-2009: Risk management – Principles and guidelines provides a comprehensive framework for risk management, and is applicable to health and safety and other categories of risk.

A.7.5.2 Other Relevant Guidance

HSE HSG65 - Managing for Health and Safety

HSE INDG163 - Five Steps to Risk Assessment provides an overview of basic risk assessment; not sufficient for complex operations or projects.

HSE RR637 – Optimising hazard management by workforce engagement and supervision provides detailed examples of Bow Tie usage in Appendix B, mainly focused on barrier decay issues.

HM Treasury - The Orange Book - Management of Risk - Principles and Concepts provides detailed guidance on risk management across an enterprise, and considers both the organisation’s strategy and management approaches, in relation to external and internal sources of risk.

HSE Website – Risk Management pages provides guidance and tools to help businesses understand what they need to do to assess and control risks in the workplace and comply with health and safety law. Although written with small businesses in mind, the site is relevant to all businesses.

EU-OSHA report E-Facts 80 - Hazard Identification Checklist: Occupational Safety and Health (OSH) Risks in the Wind Energy Sector provides useful hazard identification checklists, considering both physical and organisational hazards, that could be used to prompt consideration of risks over the project lifecycle.
A.8 TRAINING AND COMPETENCE

Under the HSWA, once an employer has fulfilled their duty to eliminate risks so far as is reasonably practicable, they are required to provide such information, instruction, training and supervision as is necessary to address the residual risks.

A person can be considered competent if they have:

- Sufficient understanding of the risks and safe systems of work that are relevant to the location where they are working;
- Sufficient knowledge of the specific tasks to be undertaken, and the risks that they entail; and
- Sufficient training, experience and ability to undertake their assigned duties, and sufficient understanding to recognise their own limitations.

Being competent means that a person has the ability to undertake the work that a role entails, safely and to the required standard; the level of competence that a person needs is determined by:

- The level of risk that a task presents; and
- The level of supervision under which the task will be performed; for example, an apprentice technician, working under the direct personal supervision of another technician who is both competent in the task, and in the supervision of an apprentice, could safely undertake tasks that they would not be competent to undertake on their own.

Different levels of training are necessary in order to develop competence:

- Entry level: health and safety training for any person newly exposed to a relevant health and safety risk;
  - This is typically required for new employees, newly appointed contractors and service providers, and visitors;
  - It primarily addresses company, contractual and project-specific requirements; and
  - It is typically carried out as part of a company and / or site induction programme;
- Basic level: specific health and safety training for any employee undertaking a defined role or task on a project, in any lifecycle phase;
  - Its scope and application primarily addresses the specific risks to which the individual is exposed, in addition to any company or project requirements; and
- Advanced or specialist training, which may relate to technical operations such as installation of a particular equipment item, or a role within a safe system of work, such as Authorised Technician.

A.8.1 REGULATORY REQUIREMENTS

In addition to the general duties under the HSWA, mentioned above, many other regulations impose specific duties. These include:

- The MHSWR require employers to take account of employees’ capabilities in relation to health and safety, and to provide adequate health and safety training; this:
  - Should be provided when employees are initially recruited; and thereafter when they are exposed to new or increased risks, which may arise from changes in their role, or in the work equipment, technologies or systems in use; and
  - Should be repeated periodically where appropriate;
  - This is particularly relevant to skills that may only occasionally be used; for example, in an emergency, it is vital that every employee is competent to fulfil their responsibilities, even though such situations should not be frequent occurrences;
Under CDM, Clients, CDM Co-ordinators and others in control of work are required to assess the competence of organisations and individuals who will be involved in projects, and the ACOP provides detailed guidance on competence assessment; and

PUWER requires that users of work equipment have received adequate training in its use, the risks that this entails, and the precautions to be taken.

These regulations have broad application, and affect almost every work activity; regulations relating to other specific activities and hazards also address training requirements, including those for lifting, work in confined spaces, working with electricity, work at height, manual handling, fire and first aid.

A.8.2 RISK ASSESSMENT AND ANALYSIS OF TRAINING REQUIREMENTS

In order for an employer to fulfil their legal duty, suitable and sufficient risk assessments and analysis of training requirements should be undertaken. This typically requires an employer to:

- Assess the training requirements, taking account the findings of relevant risk assessments, current levels of competence, and lessons learned from accident and incident data;
- Prioritise the delivery of training, taking account of legal duties and in particular identifying situations where a lack of information and / or training might result in serious harm;
- Deliver the training, by selecting and using the most effective approaches, ensuring that information provided is easy to understand and delivered by competent trainers; and
- Review the training, including assessing its effectiveness in terms of ensuring that employees understand the training provided, and apply it in their safety behaviours in the workplace.

Suitable advice should be taken from the nominated competent persons for health and safety, and consultation with employee representatives.

A.8.3 INDICATIVE TRAINING FRAMEWORK

While there are challenges in identifying and agreeing training standards, there is a developing consensus that they should endeavour to:

- Be risk-based and take account of the particular roles and responsibilities of the individual;
- Be supported by a suitable workplace assessment process, to verify the scope and suitability of any training identified;
- Be delivered in a structured manner to enable additional training to be added if new or additional risks arise as part of the role or activity;
- Take account of relevant training standards, where they exist, to minimise duplication of training, while retaining the integrity of the approach to address regulatory or contractual requirements; and
- Be flexible, to take account of the developing state of knowledge and emerging industry good practice.

In taking these into account, the following are considered to be an industry good practice framework against which duty holders can benchmark their training and competence arrangements. They are not an official or agreed industry standard, but do nonetheless consider the most relevant entry and basic level health and safety training that is likely to be suitable in order to address the most significant risks associated with onshore wind projects in the UK.

These are:

- Entry level training; a typical scope may include:
  - Company inductions covering general health and safety policies and arrangements;
o General overview of health and safety risks in the sector, with a focus on key risks; and
o Project / site inductions covering specific health and safety policies and arrangements;

• Basic level training – identified by the risk assessment and taking account of any role, task or contractual requirements. Such training is likely to include some or all of the following areas:
  o Appropriate modules of the Global Wind Organisation (GWO) Basic Safety Training standard (endorsed by RenewableUK), such as:
    ▪ First aid;
    ▪ Work at height and rescue;
    ▪ Manual handling;
    ▪ Fire awareness;
  o Other relevant hazards such as lifting, work in confined spaces, or hazardous substances;
  o Safety rules and safe systems of work in use on the site; and
  o Any additional training to address specified risks;

• Any advanced or specialist training, which relates to an individual’s role in normal operations and emergency situations.

A.8.3.1 Standards and Accreditation Schemes

There are no mandatory training schemes or standards that specifically apply to wind farms. Each duty holder is responsible for identifying their own training requirements, and determining whether any particular training standards or schemes can fulfil these needs. However, standards and schemes that have been developed and supported through industry consensus (such as the GWO / RenewableUK standards) are likely to be regarded as a benchmark of good practice. This is relevant in the event of enforcement or intervention action by regulators, as it may show evidence that recognised good practices have been adopted. It is recommended that where they are suitable for the risk profile and job role performed, preference should be given to the “standards” below in the following order of priority.

• Wind industry standards, such as GWO / RenewableUK training standards:
  o These standards have been developed by the industry to address significant risks that are specific or particular to the sector, and are supported by suitable third party accreditation systems;

• External standards:
  o These standards may address specific risk areas but either do not include adequate wind farm-specific content and / or include elements that are unnecessary, or even potentially conflicting with wind farm-specific approaches. There are numerous potential examples, including a range of safety passport and trade competence card schemes, such as:
    ▪ Construction Skills Certification Scheme (CSCS), which has a range of categories reflecting different roles and levels of experience;
    ▪ Construction Plant Competence Scheme (CPCS) provides skills cards for plant operators, with two levels of card for Trained and Competent Operators;
    ▪ The Energy & Utility Skills Register (EUSR) manages several schemes:
      ▪ Utility Safety Health and Environmental Awareness (Power) (SHEA);
• Basic Electrical Safety Competence for Access, Movement & Egress Scheme, which can have endorsements for substations, underground cables and overhead lines; and

• Plant for Utilities Scheme, which covers specific items of construction plant, and is managed by the Electrotechnical Certification Scheme (ECS);
  - Client / Contractor National Safety Group (CCNSG) Safety Passport; and
  - Assuring Competence in Engineering Construction (ACE) cards, with different levels reflecting the holder’s level of training.

○ National Occupational Standards (NOS) are developed by a range of sector skills councils or standard setting organisations, such as the Construction Industry Council (CIC), Construction Industry Training Board (CITB), Engineering Construction Industry Training Board (ECITB) and the Mineral Products Qualifications Council (MPQC);
  - NOS qualifications range from specific task-orientated subjects such as the use of tools and equipment, to more general qualifications such as contributing to a positive safety culture, and qualifications aimed at team leaders;

○ There are also various health and safety qualifications, such as IOSH Working Safely and Managing Safely, some of which can be tailored to the wind industry.

• Internal standards:
  - These will consider the specific requirements of the duty holder, arising out of risk assessments and training needs analysis;
    - Scope and content may vary considerably and will not typically be subject to third party accreditation. However, these can still play a key role in providing additional and / or complementary training to supplement any benchmark or external training provided.

A.8.4 CONTRACTUAL ARRANGEMENTS

The variety of training standards and accreditation schemes introduces risks when entering into contracts:

• If clients demand specific qualifications or courses, and will not consider equivalents, then this can result in contractor personnel who work on multiple projects having to undertake multiple similar training courses; or

• If there is inadequate scrutiny of training records and standards, then gaps in competence may later be revealed.

Either of these outcomes can affect safety, quality and cost for all parties concerned. The situation can be eased by the fact that some of the competence schemes listed above provide mutual recognition, based on having a common core of health and safety knowledge, for example, the ECS card fulfils the requirements of the CSCS scheme.

It is therefore highly recommended that the agreed training and competence standards are clearly set out in company policies and contractual documentation, and properly communicated to all concerned in a timely manner. While recognising the benefits of referencing benchmark standards where they exist, some degree of flexibility and recognition of equivalent content of external training standards may be appropriate, in order to avoid unnecessary duplication of training. This would still need to be subject to an appropriate risk assessment process.
A.8.5 Codes of Practice and Guidance

A.8.5.1 Regulations and Standards

HSE L144 - Managing health and safety in construction - Construction (Design and Management) Regulations 2007 Approved Code of Practice – especially appendices 4-6, competence development and assessment.

A.8.5.2 Other Relevant Guidance

HSE INDG345 Health and Safety Training – A brief guide explains what employers may need to do to ensure that employees receive appropriate health and safety training.

RenewableUK - Health & Safety Training: Entry- and Basic-Level Health & Safety Training and Competence Standards: Scope and Application to Large Wind Projects provides an overview of the different areas and levels of training for work on wind energy projects.

The GWO / RenewableUK standards are available from the RenewableUK website.

Further information on the passport and competence schemes can be obtained from:

- Construction Skills Certification Scheme
- Construction Plant Competence Scheme
- Electrotechnical Certification Scheme
- Energy & Utility Skills Register
- Client / Contractor National Safety Group (CCNSG) Safety Passport
- Assuring Competence in Engineering Construction (ACE)
- Institute of Occupational Safety and Health
A.9 WTG CERTIFICATION, SAFETY AND PRODUCT STANDARDS

Certification schemes and standards can support compliance with legal duties under health and safety legislation; they do not create additional legal duties, and may not cover all of the legal duties on owners and employers over the lifecycle of a development. Employers and others in control of the provision and use of work equipment have duties under PUWER, which applies to many parts of WTGs, including ensuring that work equipment is suitable for its purpose, installed, maintained and inspected as necessary to ensure that health and safety conditions are maintained.

A.9.1 SAFETY STANDARDS FOR WTGS

The Machinery Directive imposes duties on manufacturers and suppliers of machinery to assess health and safety risks, and implement appropriate protective measures. Harmonised standards provide a route to compliance with the Essential Health and Safety Requirements (EHSRs) of the Directive, within the limits of their scopes, as outlined in Section A.1.7.

For WTGs, EN50308:2004 Wind turbines – Protective measures – Requirements for design, operation and maintenance defines safety requirements and protective measures; WTG design has advanced since publication of this standard, so its applicability is limited. Further, as EN 50308 is not harmonised, compliance with its requirements alone does not allow presumption of conformity with the EHSRs of the Machinery Directive.

A.9.2 TYPE AND PROJECT CERTIFICATION

The IEC 61400 series of standards is focused on technical aspects of WTG performance, with limited direct focus on health and safety, although reliable operation and sustained integrity minimise risks to people. These standards address many aspects of the WTG lifecycle, including:

- Part 1 applies to all sizes of WTG, and specifies minimum design requirements, including:
  - Structural integrity;
  - Control and protective functions;
  - Measures to ensure the safety of people;
  - Criteria for reliable operation and survival of the WTG, with respect to the operating conditions for a particular class of site;
  - Basic design requirements for safe operation, inspection and maintenance;

- Part 2 applies to small WTGs, defined as having a swept area of less than 200m², equivalent to a rotor diameter of less than 16m, or a maximum rating of about 50kW. It covers safety philosophy, quality assurance and engineering integrity, through design, testing, installation and operation of small WTGs. (The standard was under revision in October 2014; the revisions are expected to include annexes on specific conditions, and increased caution regarding the use of simplified equations in small WTG design);

- Part 22 describes the type and project certification processes, which provide assurance of conformity and quality for a wide range of aspects of a WTG. Type certification of a WTG addresses:
  - The design basis;
  - An assessment of the design against standards, including those relating to protection and control systems;
  - Testing requirements for components; and
  - Quality systems in manufacturing.

Note that type certification does not take account of project-specific conditions or designs, and largely relies on the manufacturer’s quality assurance processes to ensure that the design intent is achieved in practice.
A.9.3 SMALL WTG CERTIFICATION

Small WTGs supported under the Feed-in Tariff (FIT) in Great Britain are subject to the Microgeneration Certification Scheme (MCS). This includes several relevant product and installation standards, which help developers to fulfil some of their duties under health and safety legislation, however, on its own, certification does not address all of a developer’s legal duties. Relevant MCS standards include:

- **MCS 006: Product Certification**, which provides a route to certification against requirements of the RenewableUK Small Wind Turbine standard or IEC 61400-1;
  - Note that the RenewableUK Small Wind Turbine Standard largely refers to the requirements of IEC 61400-2, but specifies which requirements are not mandatory, and how certification, modification and reporting are to take place.

- **MCS 010: Factory Production Control**:
  - This aims to ensure that the products meet the appropriate standards, and includes:
    - Initial assessment of production; and
    - Maintenance and surveillance of certification, involving periodic factory assessment visits, supported in some cases by product testing or assessment.

- **MCS 011: Acceptance Criteria for Testing Required for Product Certification** sets the standard for evidence from tests, in support of product certification.

In addition to product certification, contractors who supply, design, install, commission and hand over WTGs of up to 50kW rating, are subject to Microgeneration Installation Standard MIS 3003. This standard includes requirements on:

- Equipment, which must be listed under the MCS, and suitable for the intended application;
- System performance, including estimates of annual energy production and noise emissions, and notification of aviation stakeholders;
- Suitability of the site, the WTG and its foundation or other mounting arrangement;
- Shadow-flicker assessment;
- Responsible siting, based on a documented risk assessment, and as a minimum considering hazards such as:
  - Objects falling, being thrown or being ejected from the WTG, whether these objects are part of the WTG, or from external sources such as ice;
  - Toppling of the WTG;
  - Potential effects of vandalism;
  - Dangerous accessible mechanical or electrical components;
  - Vehicle impacts;
- Electrical connections in accordance with relevant standards;
- Commissioning, in accordance with a documented procedure, and with a record of commissioning checks being retained;
- Competence of design and installation staff; and
- Information to be provided at handover.

The requirements of the scheme apply even in cases where the MCS-certified contractor is not involved in the full scope of the project:

- If an installation is designed by others, then the MCS-certified contractor is responsible for verifying the design against the standard;
• If some of the installation works are undertaken by others, such as the client or their contractors, then:
  o For a private client, such works have to be carried out under subcontract to the MCS-certified contractor; or
  o For a commercial client, there must be a contract between the MCS-certified installer and the client, ensuring that any works carried out by the client or their other contractors meets the MCS requirements; this includes measures such as ensuring the competence, training and supervision of the contractors, and sampling inspection, by the MCS-certified installer, of the installations.

As these duties lie with installers, certified against a national scheme, there should be a consistent approach, irrespective of the level of health and safety competence of the owner, or the size of their organisation. Once commissioned, the MCS does not impose any requirements, so all activities in the O&M phase are outside their areas of application.

A.9.3.1 SMALL WIND ACTIVITIES OUTSIDE THE MCS

There are several circumstances in which MCS certification does not apply to activities involving small WTGs:

• If a small WTG was / is to be installed without participating in the GB FIT, then there is no requirement for it to be certified under the MCS.
  o This can either occur through the owner’s choice, or if the WTG is installed in Northern Ireland, which is outside the GB FIT;
  o MCS certified WTGs can still be used in these situations, and the requirements of MIS 3003 could be used to support contractor selection and contract specifications, although lacking the third party assessment provided by the MCS;

• O&M activities are not subject to the MCS.

In these situations, the owner or employer still has to fulfil their duties under health and safety legislation. Key considerations include ensuring that:

• The selected WTGs and BoP are suitable for use, regarding any aspect that could have a reasonably foreseeable effect on the health or safety of any person; and

• The installed equipment is maintained in efficient working order;

Fulfilling these duties depends on ensuring that appropriate maintenance and inspection work is carried out by competent personnel, and that any replacement parts or modifications ensure the continued integrity of the WTG.

A.9.4 MEDIUM WTG CERTIFICATION

Medium WTGs are defined as having a swept area from 200 to 1000m², or a rotor diameter of approximately 16 to 36m, giving a typical rated capacity range of 50 to 400kW. Medium WTGs may either have been developed recently, targeting this market segment, or may be based on older WTG designs that were in production before the current large WTGs. As IEC 61400-1 applies to all WTGs, it is the applicable standard for design requirements; however some adjustments to the certification process may be necessary – for example, verification or a written declaration of conformity to other parts of IEC 61400 may be all that is achievable, rather than full certification. From a health and safety perspective, the combination of WTG integrity over its life, and the protective measures in its design, are key to minimising risk to people.

If a medium WTG is to be installed on a site with a very complex wind regime, this may go beyond the standard approaches and limits given in IEC 61400, in which case additional analysis may be needed in order to ensure that the WTG is suitable for the site; appropriate analysis is important to ensuring WTG integrity, which becomes even more important when a WTG is located adjacent to occupied premises;

Certification should also ensure that suitable information on installation, commissioning, operation and maintenance is provided; this becomes particularly important if the WTG manufacturer is supplying a WTG that will be installed and maintained by others, without the direct involvement of the manufacturer’s personnel.
A.9.5 REFERENCES

BS EN 50308-2004: *Wind turbines – protective measures* (Note that attempts have been made to update this standard to reflect the current state of the art, but no agreement has been reached on the content of a revised standard).

BS EN 61400-1:2005: *Wind turbines – Design requirements*

BS EN 61400-2:2014: *Wind turbines – Small wind turbines* specifies design requirements applicable to WTGs up to 200m² swept area.

BS EN 61400-22:2011 *Wind turbines: Conformity testing and certification* specifies the process and requirements for WTG type and project certification.

Small and Micro Wind [Product Standards (MCS006, 010, 011)] and [Installer Standard (MIS3003)] can be downloaded from the Microgeneration Certification Scheme website.

[RenewableUK Small Wind Turbine Standard](#).
A.10 SAFE SYSTEMS OF WORK

All employers have a general duty under the HSWA to establish and maintain systems of work that are, so far as is reasonably practicable, safe and without risks to health; this includes systems for:

- The control of work activities, including both normal operation and maintenance activities, and managing the interaction between different activities; and
- Means of keeping people safe from the inherent hazards that plant presents, where they could be exposed to these in the course of work.

In some cases, the owner of a wind farm may not have the necessary competence to establish and operate the necessary Safe Systems of Work (SSoW), for example, if the owner buys a wind farm as an investment, but is not closely involved in its operation; in such cases, the owner should obtain suitable advice, select competent contractors to manage the necessary SSoW, and audit their operation. Conversely, employers are always subject to the general duties under the HSWA, so even if a potential client is not specifying safety management requirements, the employer must still fulfil their legal duties regarding the health and safety of their employees and others.

In terms of the hierarchy of risk management (see Section A.7.1), safe systems of work are a means of mitigating residual risks arising from hazards that it is not reasonably practicable to eliminate, or mitigate by engineered protective measures such as guards. Safe systems of work are therefore particularly relevant to construction, assembly and maintenance activities, during which the inherent level of safety that the completed design provides may be compromised, for example:

- It may be necessary to remove guards to work on equipment, in which case other protective measures will be needed in order to mitigate the risk from moving machinery; or
- The construction of site roads, which will later provide safe access to the completed site, may involve working in difficult ground conditions.

A.10.1 SCOPE

The full scope of SSoW covers the whole process of managing and undertaking work, including:

- Identifying the requirement, and defining the task;
  - The requirement may come from a project plan, scheduled maintenance, or responding to defects;
- Assessing the task, including hazard identification, risk assessment and preparation of method statements;
- Resourcing the task with the necessary competent people and work equipment;
- Planning the task, including any interactions with other activities or supporting work;
- Scheduling the task, to reflect priorities and constraints, both operational and health and safety;
- Preparing the work area, taking account of general workplace hazards as well as those that are directly related to the task;
- Setting to work, including:
  - Communicating essential information on the scope, method, hazards and controls relating to the task;
  - Checking that competence requirements have been fulfilled;
  - Issue of safety documents, such as a Permit to Work;
  - Defining how the work is to be supervised and / or monitored;
  - Final point of work risk assessment to check for any remaining hazards that are present and not adequately controlled;
• Carrying out the defined work, in accordance with the method statement, within the defined supervision and monitoring arrangements, and continuing the point of work risk assessment process to identify any changes in hazards;
  o Should a change in scope or method appear to be necessary, or inadequately controlled hazards be identified, then the task should be stopped until changes are authorised; the authorisation process should be proportionate to the extent of the changes, and involve people with the necessary competence;
• Completion and handover, either returning the equipment to service, or handing it over to the next team who will work on it; this may include:
  o Identification and communication of hazards and risk controls relating to return to service;
  o Commissioning or re-commissioning and functional checks;
  o Handing back or closing off safety documentation in preparation for handover to normal operation, or communication of any operational restrictions;
  o Providing information to enable records and drawings to be updated; and
• Reviewing the task, to identify any opportunities to improve safety or efficiency on future occasions.

A.10.1.1 COMMON SYSTEMS IN USE

Safe management of work generally involves a combination of supervision and control of operations, supported by management systems:

• Normal (or Routine) Operating Procedures define tasks that are:
  o Part of normal operation, and
  o Where operation of the equipment does not expose the people undertaking the task to health and safety risks;

• A Permit to Work (PTW) system covers all other activities. Over the lifecycle of a wind farm, various different PTW systems are likely to be operated:
  o During the construction phase, the Principal Contractor (PC) will generally operate a PTW system, as part of its safety management plan;
    ▪ Part of the function of a PTW system is to manage potential interactions between tasks, therefore only one PTW system should be in operation at a location at any time;
    ▪ The PTW system should make provision for circumstances where work being carried out under a PTW could have effects on systems or personnel beyond the boundaries of the system; such effects could potentially occur, for example, if lifting operations result in site access roads being obstructed;
  o Once a WTG is in operation, plant investigation and maintenance activities are likely to be undertaken under:
    o The Wind Turbine Safety Rules (WTSR) on mechanical and low voltage (LV) electrical systems; or
    o HV safety rules, on HV systems (defined as 1000V AC or 1500V DC and higher). These rules may also include LV rules and also extend to plant other than just the WTG.

A.10.1.2 INTERFACES

On many sites, both the owner and major contractors, such as a WTG manufacturer undertaking maintenance activities, will have their own established safe systems of work (SSoW); the interfaces must be absolutely clear, considering aspects such as:

• Whose rules apply to which activities;
• Physical interface points and arrangements between different sets of rules;
• Limits of authorisation for different persons to carry out work;
• Precedence of rules in the event of conflict, such as the owner and a maintenance contractor having different procedures for work at height; and
• The roles of persons from different employers in managing, working within, and auditing the operation of, a common SSoW.

Managing SSoW interfaces is particularly important during commissioning, as there is likely to be a phased handover process, with the construction PTW system, HV Safety Rules and the WTSR being in simultaneous operation on different parts of the project. In order for this to be done safely, the plan, boundaries, completion requirements and responsibilities for this transition must be absolutely clear, and must also correspond to the handover arrangements in the construction, commissioning and operations contracts for the project. The precise arrangements are likely to differ between sites, so site-specific briefings or training will be necessary for personnel working within the different systems, with more formal competence checks for those who will be operating the systems and their interfaces. Construction work normally takes place under the PC’s PTW system, and the PC will generally have responsibility for site safety management until completion of the construction project, which will often overlap with commissioning; key considerations in determining how to manage this overlap are:

• Does the PC have the competence and willingness to manage the safe execution of work taking place under HV Safety Rules or WTSR?
• Alternatively, does the WTG supplier have the competence to fulfil the role of PC?
• How will responsibilities be handed over?

These questions should be addressed early in the project, as they affect the scope of safety management work that the PC is to undertake. The potential spans of competence and control that a PC may have to manage are addressed in more detail in Section B.3.3.1.

A.10.2 PERMIT TO WORK SYSTEMS

A PTW system operates on the basis of defined roles, standard procedures and forms. It must be noted that there is a wide variety of roles, definitions and titles used in association with permit to work systems. The most common are set out by the HSE Guidance on Permit to Work System (HSG 250). In every case it is essential that all parties involved fully understand what terms and definitions will be used for the specific situation concerned.

A typical PTW process would normally consist of the following steps:

• The need for a task to be undertaken is identified, and a permit is requested;
• Prior to the commencement of a task, the person responsible for issuing the permit will:
  o Review the scope of a task;
  o Identify hazards and precautions associated with a task (often making use of risk assessments and method statements that have been prepared for the task);
    ▪ Depending on the hazards and precautions identified, additional supporting assessments and documents may be required, for example to cover work involving sources of ignition, or in confined spaces;
  o Check for conflicts with other work activities;
  o Notify personnel as required;
  o Ensure that all necessary isolations have been securely implemented, for example by ensuring that the keys to points of isolation remain in safe custody;
  o Confirm the conditions at the work location before the task commences;
  o Issue the permit to the person accepting the permit on behalf of the permit user(s) and record it in a register;
- The person accepting the permit along with any others operating under the permit then undertake the task in accordance with the requirements of the PTW;
  - The PTW system may require the person accepting the permit to apply their own lock to isolations, as a safeguard against unintentional de-isolation. (In some systems the person accepting the permit and the person responsible for issuing the permit may have joint custody);
  - The person accepting the permit should retain the safety documentation in safe custody after briefing his working party;
  - If unforeseen circumstances require any change in the work (such as a change of intent, scope, method or sequence) from that which was recorded in the PTW, then the person accepting the permit will raise this with the person responsible for issuing the permit. Permits should never normally be altered and any additional work would only be accepted by the person responsible for issuing the permit if the changes form part of the agreed scope of work and the points of isolation are adequate;
  - The PTW system should include arrangements to enable permits to be transferred, extended or cancelled as necessary;
- On completion or abandonment of the task, the permit should be returned to the person responsible for issuing the permit, and the status of the work site and equipment communicated.

Awareness of the need for PTWs would typically be covered in a site safety induction, while further training and competence assessment would be required for people carrying out work under the system.

Given that a PTW can be used to manage both the safety of discrete tasks, as well as their potential interactions, employers may determine that all work on a site shall be carried out under the PTW system, even where there are no task-specific risks to control; the level of detail in the PTW should be proportionate to the risks that the task presents.

The above summarises the general scope and approach for PTW systems; some variation may apply in practice. However in the context of safe systems of work and PTW systems operated on a wind farm, attention needs to be given to the particular risks and operational circumstances to ensure such systems are properly implemented and communicated to all parties concerned. This should take into account:

- Ensuring that the task and its nature in the context of a particular situation is identified by an authorised and competent person familiar both with the applicable systems and rules relevant to site and turbine specific arrangements;
- The need for documentation to be correctly approved to ensure that controls have been properly applied to achieve safety from the system; and
- The importance of having in place a robust process to ensure that the issue and handover of all documentation to nominated and competent persons is properly communicated and understood by all individuals concerned, including specifying any limitations to the work activity.
  - This may be supported by processes to assess the competence of individuals to fulfil their role within a system, prior to appointment, or to audit contractors’ processes for competence assessment.

These core aims are embedded into the Wind Turbine Safety Rules (WTSR), which are summarised below.

### A.10.3 The Wind Turbine Safety Rules

The WTSR have been developed by wind farm owners and operators for the purpose of formalising a safe system of work for operational wind turbines (onshore and offshore), and are widely used at wind farms throughout the UK and Ireland. The WTSR perform the functions of a PTW system, but with modifications that take account of the differences between wind farms and conventional industrial situations, in particular the fact that there is unlikely to be a person...
responsible for issuing the permit at the location of the task, thereby requiring the person accepting the permit (e.g. Authorised Technician) to have greater involvement in the management of isolations.

Adoption of the WTSR is not a legal requirement, and the WTSR do not impose any duties that exceed legal requirements, however the WTSR, when implemented correctly and appropriately should:

- Represent industry good practice for safeguarding employees from the inherent dangers that exist from installed electrical and mechanical equipment in wind turbines;
- Assist in the development and application of safe systems of work in a consistent manner; and
- Provide a robust approach to demonstrating legal compliance with relevant health and safety regulations.

In order to assist in the adoption of the WTSR, detailed guidance and model procedures are available from RenewableUK; duty holders should fully familiarise themselves with these. A brief summary of the WTSR is provided in the following sections.

A.10.3.1 SCOPE AND EXCLUSIONS

The type of work that can be carried out under the WTSR must be clearly defined, to ensure that the appropriate safe system of work is used for any given task. In addition, it is important to establish clear boundaries between the WTSR and other Safety Rules systems, and ensure that these are effectively communicated across the site, for example by displaying a single line diagram in appropriate areas, defining the boundary points that have been agreed to by the owners of the different safety rule sets.

The WTSR can be applied to all mechanical and LV electrical systems on a WTG:

- The WTSR do not apply to HV electrical systems; these are subject to HV safety rules;
- In cases where making LV equipment safe to work on requires actions to be implemented on HV systems, or vice versa, then both sets of rules will have to be used, and steps taken to co-ordinate the actions of the different persons involved.

Certain tasks may be carried out by a Competent Technician under Routine Operating Procedures where an Approved Written Procedure (AWP) is not required; these may include tasks such as cleaning of work areas (e.g. floors) or visual inspections (without removal of any guards). For these tasks, the safety of the technician is assured through a combination of the wind turbine being safe in normal operation, and the scope of the procedure ensuring that it does not interfere with normal operation.

The interfaces between HV safety rules, the WTSR, and Routine Operating Procedures (the last part of which are part of the WTSR) must be clearly defined; based on this, for every procedure in the manufacturer’s service manual, a decision can be made as to which set of rules applies. Note that for WTGs having HV components such as the transformer in the nacelle, the boundary between HV and LV will extend right up the tower and into the nacelle. Any tasks being carried out in these areas under the WTSR need to be carefully assessed to ensure that they do not interfere with HV systems.

A.10.3.2 ASSURANCE OF SAFETY

The WTSR consider both:

- General Safety, which includes ensuring that:
  - A safe means of access and egress is available at all times;
  - The place of work is safe for the work or testing to progress;
  - Appropriate tools and equipment are available;
  - Any necessary PPE is available;
  - A safe method of work is available; and
• Achieving Safety from the System, defined as a “Condition which safeguards persons working on or testing Plant and/or LV Apparatus from the Dangers that are inherent in the System”, i.e. safety from the mechanical and LV electrical hazards that would put people at risk if they were to work on equipment that had not been isolated / blocked / de-energised.

**A.10.3.3 Key Elements of the WTSR**

Effective operation of the WTSR is achieved by a combination of:

- Appropriately trained and authorised persons, fulfilling the defined roles of:
  - Authorising Engineer;
  - Authorised Technician;
  - Competent Technician;
  - Operational Controller; and
  - Selected Person.

- A clear set of procedures for defined activities:
  - Routine Operating Procedures;
  - Transfer of Control; and
  - Approved Written Procedure (AWP).

These persons and procedures are explained in more detail in the following sections. Arrangements for appointment of persons, and preparation of procedures, need to be defined in the company’s own Management Instructions. (Note that all aspects of the implementation of the WTSR need to be reviewed and adapted where appropriate by duty holders.)

**A.10.3.3.1 Persons**

The main duties of named Persons under the WTSR are summarised in this section; these descriptions are not exhaustive, and full definitions are given in Part D of the WTSR, together with guidance on processes and criteria for determining the competence of these appointees. A clear understanding of each person’s role, responsibilities and limitations of authority is vital to the safe operation of the WTSR. The named persons and their duties are:

- **Authorising Engineer:**
  - Determines when work can be carried out under a Routine Operating Procedure (ROP);
  - Is responsible for the approval of AWPs for packages of work, ensuring that they:
    - Include all necessary safety precautions, points of isolation, and signature check points;
    - Provide clear instruction as to how Safety from the System will be maintained at all stages of the procedure, including stages where isolations are to be removed; and
    - Identify where additional assessments are required from Selected Persons;

- **Authorised Technician:**
  - Undertakes Transfer of Control from / to the Operational Controller;
  - Establishes General Safety prior to commencement of work, and suspends work if General Safety cannot be maintained;
  - Ensures that the necessary precautions to provide Safety from the System (such as isolations) are in place during the work, in accordance with the AWP;
  - Sets working parties to work, providing supervision as required in the AWP; and
o Administers the use of the AWP, including transfer, clearance and cancellation as appropriate, and records these steps on the AWP;

• Competent Technician:
  o Obtains consent from the Operational Controller before undertaking work under a ROP and informs them on completion / suspension of the work;
  o Establishes General Safety prior to commencement of work, and suspends work if General Safety cannot be maintained;
  o Performs work in accordance with ROPs; and
  o Sets working parties to work, and provides personal supervision to the working party;

• Operational Controller:
  o Undertakes Transfer of Control to / from Authorised Technicians with respect to work to be carried out under an AWP, and contributes to provision of Safety from the System;
  o Gives consent for work to be carried out under ROPs; and
  o Co-ordinates activities on the wind farm to ensure that different work packages do not give rise to unsafe interference;

• Selected Person:
  o Provides additional competence where special precautions are required in order to safeguard persons. For example, if the work to be carried out under an AWP involves specific hazards such as entry into a confined space, then the Authorising Engineer should ensure that the Selected Person is satisfied with the precautions to enable this work to proceed; these might include carrying out on-site testing and examination, and preparation of task-specific rescue plans prior to commencement of work.

A.10.3.3.2 Routine Operating Procedures

These procedures define work that can safely be carried out during normal operation of the WTG whilst under the supervision of a Competent Technician. No isolations are required for this work, as it does not expose the technician to any hazards relating to the operation of the equipment; clearly, this limits the scope of work to tasks such as inspection, cleaning and diagnostic activities, where the design of the equipment allows safe access during normal operation.

A.10.3.3.3 Transfer of Control

This is a formal process in which control of equipment is released from the Operational Controller to the Authorised Technician, and later returned, either on completion / termination of the task, or the end of the working period. The Authorised Technician records the Operational Controller’s name on the AWP, together with the time and date of the transfer.

The WTG will not be switched to Local control until this process is complete.

A.10.3.3.4 Approved Written Procedures

All work carried out under the Rules must be performed in accordance with an AWP or a ROP where applicable:

• The procedure is created by someone with sufficient knowledge of the Rules, the equipment and the work to be carried out; it is then checked and approved by the Authorising Engineer, thereby becoming an AWP;

• AWP s will include clear and unambiguous cross-references to the maintenance procedure or work instruction, (contained within the manufacturer’s service manual), to which it applies; there will normally be no need to duplicate the details contained in the maintenance procedure or work instruction, but the AWP must contain details of all the safety precautions necessary to achieve and maintain Safety From The System;
• The AWP provides part of a system of work and can refer to other relevant documents ("Associated Documents") such as method statements, risk assessments, maintenance manuals etc. Each AWP is uniquely identified (usually by a serial number), and relates to a single package of work;

• Each AWP requires signature by the Authorised Technician at various points over the course of the work package, so is most likely to be created as a paper document. This does not preclude the use of an electronic system, provided that an equal level of control, traceability and retention is achieved;

• The AWP can refer to “Associated Documents”, which may include method statements, specialised risk assessments etc.;

• It is essential that the AWP identifies all the hazards that may arise from the task, and the precautions to be taken, which may include measures such as isolations, instructions, PPE and / or ventilation;

• If necessary, the AWP will specify how Safety from the System is to be maintained during any periods when isolations are to be removed (for example, for testing or repositioning of components), as this may give rise to additional hazards;
  o As it is safer to work with all sources of motive power fully isolated, wherever possible tasks and equipment should be designed to avoid the need to restore motive power at any intermediate step.

Under the WTSR, when an AWP is in force for work or testing on any items of Plant / LV apparatus then no other AWP shall be implemented on those same items of Plant / LV apparatus at the same time. However if there is a need for more than one AWP to be in operation at any one time on a single WTG, then the Authorising Engineer has to assess the potential for the two work packages to interact, before permitting this situation to occur. If more than one AWP is to be worked on at the same time on the same WTG, then the Authorising Engineer must authorise this and there should only be one Authorised Technician who holds both (or more) AWPs on that WTG. The Authorised Technician must control both work activities, so they do not have any conflict with each other. The points of isolation will be separate for each of the AWPs, and isolation keys are to be segregated. If the same points of isolation are required then a suitable device / system should be used to enable more than one padlock to be applied at the same point.

A.10.4 HV SAFETY RULES

A.10.4.1 INTRODUCTION

All work on HV systems must be undertaken in accordance with HV Safety Rules (HVSR). These detail both general and specific requirements for work on HV apparatus. They are specific and prescriptive, providing sufficient detail to be clear and unambiguous.

A.10.4.2 GENERAL REQUIREMENTS

The general requirements of the HVSR are that no person shall undertake any repairs, maintenance, cleaning, alteration, testing or similar work on any part of an HV system unless those parts of the system are:

• Released from Operational Control;

• Isolated, including LV supplies, voltage and auxiliary transformers and other sources from which the equipment could become live, and a Caution notice attached;

• Tested dead;

• Protected by a connection to earth, applied by a switch or another approved means;

• Identified at the point of work; and

• Released for work by the execution of an appropriate Safety Document.

A.10.4.3 DUTIES OF PERSONS

Note: Different HVSR may have different persons named and defined within their systems, for example, some HVSR do not have Authorised Person (APs).
The basic duty as a Competent Person is to receive a safety document, and then:

- Be conversant with, and understand the nature and extent of the work to be carried out, and not exceed this;
- Ensure that all persons under their control also understand the extent of the work; and
- Provide supervision to the working party.

The duties of an AP are, in addition to those of the Competent Person, to carry out operations on the system such as switching, isolations and earthing.

The duties of a Senior Authorised Person (SAP) are typically to issue and cancel safety documents.

**A.10.4.4 AUTHORISATIONS**

Typical authorisations are Competent, Authorised (to various levels) and Senior Authorised.

Competent Persons must have sufficient technical knowledge or experience to avoid danger.

APs are Competent Persons, adequately trained, possessing technical knowledge, and appointed in writing to carry out specific operations. They would be likely to possess an electrical qualification, and have suitable and sufficient experience, including:

- Adequate knowledge of electricity;
- Adequate experience of electrical work;
- Adequate understanding of the system to be worked on and practical experience of that class of system;
- Understanding of the hazards that may arise during the work and the precautions that need to be taken; and
- Ability to recognise at all times whether it is safe for work to continue.

Any person that has been nominated or authorised under a set of safety rules has to be deemed competent by that company. This will normally take into account evidence such as recognised electrical qualifications and relevant experience in relation to the role and tasks to be performed. It is the responsibility of duty holders to clearly define and justify what and how competence will be determined, taking into account the safety rules applied and the system to which they apply. It is also vital that evidence to support these competence assessment decisions is properly documented and where necessary shared with relevant contracting parties. In view of the potential complexity of the issues involved, professional advice may need to be taken.

**A.10.4.5 OPERATIONS AND SWITCHING**

Where practicable the use of remote live switching should be seen as the preferred option. Even if this can be achieved, the operation of the HV system must be managed by the person who has responsibility for the system, to ensure personnel and system safety. Specific procedures often allow delegation of this control at a specific location to a SAP, who may be a representative of the local Distribution Network Operator (DNO), a specialised subcontractor or the wind farm Balance of Plant (BoP) maintenance contractor. In all cases a form of HV Safety Rules will apply to the control of the HV network.

HV system management is also likely to be performed within the WTGs (for example HV switching of the WTG switchgear to undertake WTG transformer inspections). The wind farm operator must ensure that appropriate HV Safety Rules are in place to cover these activities.

**A.10.4.6 SAFETY DOCUMENTS**

The Rules typically define three types of safety document:

- Limitation of Access, for work in proximity to the HV system;
- Permit to Work, for work on the HV system; and
- Sanction for Test, for testing on HV system, where the removal of earths is permitted.
A.10.4.7 INTERFACES WITH WTSR

The most common interface point between the WTSR and the HV Safety Rules is the LV circuit breaker, connected to the transformer LV side. This circuit breaker can be used as:

- A point of isolation for work on the generator LV system under the WTSR; and
- A point of isolation for work on the transformer under the HV safety Rules. (LV circuit breakers can be used as a point of isolation as long as they have been designed for that function by the manufacturer, and in accordance with applicable technical standards e.g. BS EN 60947.)

Work on any equipment / apparatus (including for example the LV circuit breaker itself) must be carried out under the safety rules that apply to that system within its set boundary.

If the LV isolator is being used to permit safe work on HV systems, then this isolation would have to be made by an Authorised Technician under the WTSR, with a second lock or other means of preventing de-isolation applied by the HV Authorised Person; persons must not work outside the boundaries of their authorisations.

In such situations, a specific cross-boundary AWP will need to be in place to ensure that cross-boundary precautions are implemented, involving both the Authorising Engineer and the HV contractors’ representative. Further information is set out in the guidance issued to support the WTSR.

A.10.5 DESIGN OF MACHINERY TO SUPPORT SAFE SYSTEMS OF WORK

The Essential Health and Safety Requirements in Annex 1 of the Machinery Directive include:

"Machinery must be fitted with means to isolate it from all energy sources. Such isolators must be clearly identified. They must be capable of being locked if reconnection could endanger persons. Isolators must also be capable of being locked where an operator is unable, from any of the points to which he has access, to check that the energy is still cut off…

… After the energy is cut off, it must be possible to dissipate normally any energy remaining or stored in the circuits of the machinery without risk to persons.

As an exception to the requirement laid down in the previous paragraphs, certain circuits may remain connected to their energy sources in order, for example, to hold parts, to protect information, to light interiors, etc. In this case, special steps must be taken to ensure operator safety."

Machinery that complies with these requirements will readily enable operation under a safe system of work; conversely if the need for isolation has not been given due consideration at the design stage, with respect to foreseeable tasks, then it will be much more difficult to provide essential isolations.

A.10.6 REFERENCES

HSE HSG250 - Guidance on permit-to-work systems provides detailed guidance on the essential requirements of a PTW system.

HSE HSG85 – Electricity at Work: Safe working practices provides guidance on the key elements that need to be considered when devising safe working practices for people who carry out work on or near electrical equipment.

HSE HSG253 - The safe isolation of plant and equipment provides guidance for the on / offshore oil or gas industry, chemical manufacturing and associated industries to enable duty holders to develop, review and enhance isolation standards and procedures.

TASK Assessment Card provides a generic point of work risk assessment checklist

RenewableUK website: Health and Safety – the Wind Turbine Safety Rules

A.11 SITE MANAGEMENT

A.11.1 OVERVIEW
Site management has a key role in the safe and efficient running of all activities on a site; the exact scope of the role will depend on the lifecycle phase, the scale of the site, and the activities taking place. The site management functions will typically be carried out by a combination of on-site and off-site personnel, depending on the organisational and contractual arrangements for the site.

A.11.2 REGULATORY REQUIREMENTS
The MHSWR impose several duties that site management arrangements will have to fulfil, including:

- Implementing requirements from the health and safety policy;
- Ensuring that risks are assessed, and that the necessary protective measures are put into practice;
- Operation of emergency response plans;
- Ensuring that suitable supervision is in place;
- Ensuring that employees are consulted regarding workplace risks and precautions.

The Workplace regulations impose duties on employers and others in charge of workplaces to ensure the safety and good upkeep of places of work, and to provide suitable welfare facilities.

During construction work being carried out under the CDM regulations, the Construction Phase Plan may determine site-specific requirements.

Fulfilling these duties will generally involve working in cooperation with other parties on a site, both through formal arrangements such as bridging between management systems, and regular communication between site personnel.

A.11.3 KEY ACTIVITIES
Site management typically involves a range of asset, task and personnel management responsibilities, such as:

- Monitoring WTG and BoP performance, and responding to alarms;
  - The effectiveness of such monitoring depends on having suitable software systems, operated by competent people, with realistic demands on their time;
- Identifying the need for work to be carried out, whether on a reactive or scheduled basis;
  - In some situations, site management would then assign the necessary resources to the tasks, and schedule the work; on other sites, they would submit work order requests to company management;
- Ensuring that all personnel on site are inducted to the appropriate level for their work;
- Ensuring that all work is done in accordance with site Safe Systems of Work (SSoW);
  - This will generally include reviewing and / or preparing RAMS, and carrying out audits and inspections;
  - The site should reach agreement on whether the SSoW for a lifecycle phase will be those of the owner or a contractor;
- Ensuring that scheduled inspections and servicing are carried out on all relevant parts of the site, whether for safety, operational or compliance purposes;
- Agreeing standards for the performance of work, and monitoring performance against these standards;
- Ensuring that Operational Restrictions are implemented effectively, for example, if certain items of equipment are out of service;
• Ensuring that housekeeping and waste management standards are maintained;
• Ensuring that welfare facilities are available and properly maintained;
• Performance and incident reporting (health, safety, environmental and operational) in accordance with company policies;
• Providing up to date information to personnel on site;
  o This could include maintaining documentation, registers, signs and notices, carrying out toolbox talks, and providing real-time information if required in an emergency;
• Scheduling and authorisation of work, and in particular taking account of interactions between work activities;
• Maintaining the site Emergency Response Plan (ERP), including
  o Identifying where any changes in circumstances or activities may affect the operation of the ERP;
  o Taking part in drills;
• Leading emergency response on the site (depending on roles defined in the ERP);
• Knowing who is on site, and where they are – especially if there are any lone workers, or small teams in remote areas of large sites;
• Liaison with landowners (of the site or adjacent land), their contractors, and other site users;

Given the range of activities and their importance to health and safety, it may be necessary to have a site management team on large sites or during peaks in activity; conversely, a small site with steady-state activity would typically rely on remote monitoring and a part-time presence on site. If site management are required to be on call outside normal working hours, then their employer must fulfil their duty to manage the associated significant risks arising from fatigue.

If the site manager is also the line manager of any people working on the site, this will bring further responsibilities for the health and safety of these employees, such as consultation on health and safety matters, and providing a link to occupational health.

Given the potential breadth of responsibilities, it is important that the site management have clearly defined responsibilities and authority.

### A.11.4 Training and Competence

The CITB Site Managers Safety Training Scheme (SMSTS) provides a recognised (but not mandatory) qualification for site managers on construction sites, as it provides core knowledge in the safe management of key construction activities. Additional or alternative training would be necessary in order to cover the different duties of site managers in the operational phase.

### A.11.5 Interfaces

#### A.11.5.1 Site Safe Systems of Work

During the construction phase, the Principal Contractor is responsible for implementing the Construction Phase Plan, which sets out how health and safety risk will be managed, and will generally define the SSoW to be used for the work on site.

During the Operations and Maintenance phase, the site owner needs to ensure that suitable safety rules are in place for all work; this might be achieved by implementing their own WTSR, HV rules and permit to work systems, or by adopting the systems operated by the main contractors in these areas of work, and managing the interfaces.

#### A.11.5.2 Interfaces between Work Packages

Site management should review planned work, to identify any potential hazardous interactions; for example, repairs to site roads may require the introduction of a temporary traffic management plan, to enable other work on the site to proceed without interference.
A.11.5.3 Interfaces with Other Site Users

As WTGs and associated infrastructure only occupy a small proportion of the land area of a site, other land users and managers are likely to be active on the site; these could include agricultural and forestry work, stalking and shooting, and recreational users such as walkers and cyclists.

Effective formal and informal two-way communication and understanding of activities and hazards is essential, for example:

- Forestry operations can be hazardous to any personnel in the vicinity; the necessary exclusion areas for different operations must be understood and implemented;
- Agricultural contractors need to be aware of hazards such as buried cables, while wind farm personnel need to be aware of hazards from farming operations, such as the use of pesticides and the presence of livestock;
- Muirburn, the controlled burning of moorland vegetation for agricultural or sporting estate management purposes, can be hazardous to people and equipment if it takes place on wind farms or their access routes;
  - The Muirburn Code (applicable in Scotland) specifies that all occupiers of land within 1km of the intended burn site should receive at least 7 days’ prior notification;
- Shooting can be a significant hazard to people, if hunting or stalking takes place on a wind farm; conversely, wind farm operations can disrupt these activities.

Advance knowledge of such activities can allow all parties to plan ahead, and minimise risk and disruption to their legitimate business.

Recreational users may be unaware of hazards from wind farm activities such as site vehicle movements:

- In the construction phase, access to areas where plant is working can be closed off; however
- On completion of construction, on sites in Scotland, the Land Reform (Scotland) Act creates a right of responsible access to open country, including non-motorised use of tracks, so drivers on sites should expect to encounter walkers and cyclists at any time of day;
  - Such users do not have to seek permission to enter sites, do not have to follow designated routes, or to notify anyone of their presence, and will often be fairly inconspicuous;
  - It is good practice to provide hazard information and emergency contact numbers at likely access points, but such information should not set out to discourage or restrict access to a site.

A.11.6 References

HSE HSG65 – Managing for health and safety describes core elements of health and safety management, much of which is directly relevant to site management.

HSE Human Factors Briefing Note No 6 - Maintenance Error addresses the hazards that errors during maintenance work can introduce into a system, and gives practical guidance on ways to reduce or eliminate such errors, benefiting both safety and reliability.

The Muirburn Code provides guidance for the controlled burning of heather, grass and other moorland in Scotland, and must be followed if land managers are claiming state payments for this work.

See also Section A.1.10 Workplace (Health, Safety and Welfare) Regulations 1992
### A.12 STAKEHOLDER ENGAGEMENT

The consenting process for wind farms is handled by several different bodies, including local councils, the Planning Inspectorate (England and Wales), and Scottish and Welsh Ministers, depending on the size and location of a proposed development. The process takes account of the views of statutory consultees and other stakeholders, including:

- Environmental regulators such as the Environment Agency, Scottish Environmental Protection Agency (SEPA), Natural Resources Wales and the Northern Ireland Environment Agency;
- Conservation bodies, such as Natural England, Scottish Natural Heritage, Natural Resources Wales and the Council for Nature Conservation and the Countryside in Northern Ireland;
- The Civil Aviation Authority and Ministry of Defence, with respect to civil and military aviation;
- Host communities, near to the wind farm and along transport routes; and
- Membership and campaigning organisations with interests in land use and landscape.

Some of these stakeholders will be directly concerned with aspects of health and safety; in other cases, the stakeholders’ areas of concern may introduce additional challenges to the safe development and operation of the project. For example, if planning conditions prohibit the erection of signage on a site, this could hinder the emergency services in responding to an incident; this could potentially be resolved by reaching agreement on limited, essential internal signage, but if that were not possible, the site emergency response plan would have to contain other arrangements for ensuring that emergency service personnel can reach the required locations.

Engagement with stakeholders can take several forms; an appropriate approach should be chosen in order to address effectively their needs and expectations relating to the issue; these forms of engagement include:

- One-way provision of information;
  - In simple, non-controversial cases, this may be all that is required to address potential or actual concerns, particularly if it is provided in a clear, timely and willing manner;
- Two-way consultation, and deeper involvement and participation in a collaborative process:
  - These approaches can help to identify issues, provide information and develop solutions;
  - They provide an opportunity to learn from internal and external experience.

The appropriateness of each of these approaches depends on the issue being considered, in terms of:

- The level of concern about the issue; and
- The level of discontent with how the issue is being addressed.

An effective stakeholder engagement process will:

- Be supported by the provision of suitable information, in a format that is useful to the participants, and with an appropriate level of detail;
- Be transparent, with a clear process that demonstrates how the outcomes relate to the inputs;
- Be targeted at the issues that are most relevant to the stakeholders involved;
- Take place at appropriate stages of project development, so that the outcomes can influence the next stage of the process, rather than giving the appearance of “consulting” on decisions that have already been made; and
- Have demonstrable support from senior levels of the organisation, so that it is clear that it is a real part of the decision-making process.

Similar processes can also be applied to engagement with internal stakeholders, such as employees, in the development of safety management arrangements:

- Where employees are involved in the development of procedures, possibly including testing or trialling novel approaches, not only is it likely to result in more effective procedures, but it can also increase ownership and support for their adoption;
- In some cases, the engagement process is fully empowered to make decisions, rather than just advising a separate decision-maker.

The effectiveness of internal stakeholder engagement approaches is strongly connected to an organisation’s safety culture, and also reinforces it.

A.12.1 PUBLIC HEALTH

Concerns about alleged adverse health effects on people living in proximity to WTGs may be raised in connection with specific projects. While employers have a duty of care in relation to the health of the public, the current state of knowledge does not confirm any consistent evidence of any physiological or behavioural effects from infrasound or low frequency noise. A detailed evaluation is outside the scope of these guidelines. However, proactive engagement in the area is still recommended.

A.12.1.1 RECOMMENDATIONS

RenewableUK recommends that a proactive approach be taken by the industry in addressing this complex subject. Whilst there is no scientific evidence that WTGs have any patho-physiological health effects, it is important to understand that certain individuals and interested parties may nevertheless perceive that health effects remain. Although it is difficult to counter these views, the industry can still take a number of actions that can assist in alleviating some or all of these concerns. Examples RenewableUK would encourage the industry to consider include:

- Consultation
  - Early dialogue and communication with the public and key stakeholders on any proposed development;
  - Recognising and understanding that lay perceptions of health risks are valid and should be taken into account;

- Planning:
  - Ensuring environmental impact assessments include a robust evaluation of the noise and vibration risks of the project;
  - Taking specific account of any sensitive receptors (e.g. local residents) that may have concerns particular to the project;

- Design:
  - Ensuring that the design of the WTG, and where appropriate the wind farm, takes account of the relevant project and environmental issues concerned;
  - Ensuring that suitable mitigation measures are considered following completion of risk assessment to address any residual risks where they exist;

- Monitoring:
  - Ensuring that a regular programme of environmental noise measurements is performed; and
  - Ensuring, post consent, that there is regular community engagement, and there are mechanisms in place to address any general or specific concerns relating to noise and related issues.

In the vast majority of cases, these recommendations merely reflect existing good practice, as operated by developers and operators throughout the UK.
A.12.2 PUBLIC SAFETY

Wind farm development and operation can give rise to a range of risks to public safety; these include:

- Traffic, especially lorries during construction, and abnormal loads for the transport of WTG components;
  - Note that this risk can affect people beyond the site boundary;
- Construction site hazards, particularly to any people entering the site without the knowledge or consent of the site management; and
- Effects of catastrophic WTG failures, which may on rare occasions result in blade throw, tower topple or fire;
- Ice throw, if the WTG is operated with ice build-up on the blades.

Developers should ensure that risks to public safety are considered and managed effectively over the project lifecycle, and should be prepared to share their plans for managing these risks with stakeholders and regulators; effective engagement can both build trust, and help to reduce the level of public safety risk by taking account of local knowledge.

A.12.3 REFERENCES

Rail Safety & Standards Board - Engaging Stakeholders in Safety Decision Making: while some of the comment is specific to the rail industry, Section 3 reviews the approaches used in a range of industries, and Section 4 outlines a framework for determining appropriate approaches to engagement, together with assessment of the strengths and weaknesses of different approaches.

RenewableUK - Wind Turbine Syndrome Review


Cranfield University – Doughty Centre for Corporate Responsibility – Stakeholder Engagement: A Road Map to Meaningful Engagement provides both theoretical background and practical tips on effective stakeholder engagement, ranging from local to global situations.
A.13 SUPPLY CHAIN MANAGEMENT

The development and maintenance of a wind farm rely on procurement of services and goods from a wide range of contractors and suppliers, so the overall health and safety performance of a development will largely depend on how well these entities fulfil their duties.

A.13.1 CONTRACTED SERVICES

The majority of wind farm survey, design, construction, installation, commissioning and maintenance is generally undertaken by contractors; successful management of project safety therefore depends on processes such as:

- Appointment of suitable Competent Persons for key safety-related roles;
- Ensuring that contractor selection includes adequate consideration of safety culture, performance and experience, and recognises the value of investments made by contractors in developing competent people and implementing robust systems that can support the safe and efficient execution of their works, rather than just considering the initial price;
  - The required level of competence in safety management will depend on the contractor’s scope of work, the hazards present in such work, and the contractor’s level of responsibility for safety management; these could range from undertaking a major package of high-risk work, to supplying labour to work under direct supervision on low-risk tasks;
- Ensuring that contractors have the necessary capabilities and resources, including financial security, to fulfil their legal and contractual responsibilities;
- Agreement of suitable contractual arrangements, that promote safe working and define relevant KPIs;
- Effective communication of safety information to relevant personnel at the appropriate times, both pre-contract and after award, and including information flow between contractors and phases of a project; and
- Effective monitoring of contractor performance according to KPIs, operation of safety management systems and compliance with method statements.

During the O&M phase, work may be carried out by a combination of the owner’s employees and contractors, some of whom may work at the site on a long-term basis, with others undertaking specific tasks as required; the balance of in-house and contracted work will be influenced by factors such as the size of the site, and the owner’s business model. Increased stability in the workforce can support the development of a positive site safety culture; short-term contractors can then be expected to integrate with the site’s safety culture and management systems, supported by the effective communication and fair and consistent application of site rules and expectations.

A.13.1.1 COMPETENCE AND CONTRACTOR SELECTION

The CDM regulations, which apply to all construction projects in the UK, impose duties on all parties involved in construction work to ensure their own competence, and the competence of those whom they appoint, to undertake the tasks for which they are appointed; the appendices to the CDM ACOP describe processes for assessing the competence of CDM Coordinators and contractors. The level of effort in assessing competence should be proportionate to the risk that the work in question represents.

Prior to appointment of contractors, clients typically use pre-qualification processes to carry out initial screening of potential contractors. Repeated pre-qualification for multiple potential customers can impose a significant administrative burden on contractors, which can be mitigated in various ways, such as using:

- Intermediary organisations that pre-qualify suppliers on behalf of a large number of potential customers; or
- Standard formats such as BSI PAS 91 Construction related procurement – Prequalification questionnaires.
Such approaches can be used where appropriate to the nature of the work, and supplemented as necessary by project-specific assessment.

While the CDM regulations only apply to construction work and enabling activities, the approach that they adopt to verifying Contractor competence could be applied to selection of contractors in other situations. However, CDM defines clear roles and responsibilities, such as Client and Principal Contractor; when work is undertaken that does not come under CDM, then there is an increased need for the client to work with the contractor to agree how health and safety will be managed, such as:

- Whether the work is to be undertaken by the contractor operating under:
  - The client’s health and safety management system (SMS); or
  - Their own SMS, with bridging documents to manage the interface with the client SMS, and an agreed level of audit by, and reporting to, the client;
- Allocation of responsibilities for instruction and supervision of the works;
- Arrangements for verifying the competence of key contractor personnel, including any requirements for the client to review CVs, or even interview potential appointees;
- Arrangements for subcontracting, to ensure that competence is maintained at every level of the supply chain;
  - This may include limits on subcontracting, or approval processes; and
- Arrangements for managing safety-related interfaces.

The suitability of any given approach to these issues will depend on the nature of the work, and the capabilities of the parties involved.

There may be occasions on which work is subcontracted to the landowner or tenant on whose land a development is taking place; their competence to undertake the work safely should be checked, and their work should be managed within site safe systems of work to ensure that they are not put at risk by site hazards that would not previously have been present in the location.

**A.13.1.2 CONTRACTUAL ARRANGEMENTS**

Conditions set out in contracts should be aligned with health and safety objectives – indeed, this should be clear from the start of the tendering process. The contract schedule should ensure that realistic durations are allowed for preparatory work, as well as on-site activities, and that any incentives or penalties in the contract avoid giving rise to unintended adverse health and safety consequences.

Where contracts are let on a one-time basis, there may be less opportunity for the mutual influencing of contractor performance and client demands than in cases where a longer-term alliance is formed.

Contracts will also need to define the arrangements for performance monitoring, incident investigation and reporting, to ensure that there is visibility of suitable leading and lagging indicators, and appropriate follow-up of incidents. On a multi-contractor project, common arrangements will be needed for all contractors, to ensure consistency. Recognising that contractors work on multiple sites, increasing commonality in reporting requirements across the industry can reduce the administrative burden and improve the quality of reporting.

**A.13.1.3 END OF CONTRACT REVIEW**

On completion of the contract, both the client and contractor can benefit from undertaking a joint review to consider areas of learning, such as:

- Outputs of active and reactive monitoring of health and safety, to understand how effectively safety management systems operated, and provide feedback on incidents;
- Adequacy of pre-contract information;
- Any late changes to the planned works; and
- Suitability and performance of equipment and techniques that were used.
The outcomes of the review should be shared as appropriate within the organisations involved, and through industry reporting schemes, in order to avoid the same issues being repeated elsewhere.

A.13.2 SUPPLY OF PLANT, EQUIPMENT AND STRUCTURES

Development of a wind farm involves the procurement of a very wide range of physical goods, ranging from sophisticated mechanical and electrical systems, to aggregate for running surfaces of site roads. Procurement decisions affect the project risk profile in several ways, such as:

- The degree to which health and safety is considered in the design and quality of products will affect the risk to people, both immediately, and in the course of O&M activities during the operating life and ultimate decommissioning / disposal of the product;
- The scope and robustness of quality assurance arrangements and traceability through the supply chain should reflect the risk that a component failure would present; and
- The management of health and safety in the facilities where the products are manufactured will affect the risk to the people involved;
  - This may be seen as a corporate social responsibility issue, recognising that WTGs include numerous heavy fabricated structures, which may pose high risks to those involved in their production unless suitable safety management processes are in place throughout the global supply chain.

The ability to engage effectively with suppliers in each of these areas will depend on the importance of the customer to a supplier; in some cases, engagement may be limited to assessing the supplier’s performance, while in other cases, the customer may be able to influence the supplier’s practices.

For simple purchases of standard items, which do not affect the project risk profile, streamlined approaches such as electronic auctions may be appropriate, particularly in cases where the required characteristics of the product can readily be quantified.

A.13.2.1 REFERENCES

HSE L144 - Managing health and safety in construction - Construction (Design and Management) Regulations 2007 Approved Code of Practice – especially Appendices 4,5, which relate to competence assessment.

BSI PAS 91-2010: Construction-Related Procurement details a standard prequalification process and questionnaire, and can be downloaded free of charge from the BSI website (registration required).
A.14 MANAGEMENT OF CHANGE

An effective design process will minimise the need to make changes later in the project lifecycle, however several different types of change are inevitable over the lifecycle of a wind farm; these may be:

- Technical, relating to the design or specification of equipment and materials;
  - These can be highly visible, such as exchange of hardware, or invisible but still very important, such as changes to software;
- Organisational, relating to staff, contractors or systems;
- Permanent or temporary, such as an operational restriction on an item of equipment until checks or repairs have been undertaken.

Unexpected or unforeseen events or situations may arise at any stage throughout the wind farm lifecycle. These may require changes to be implemented quickly, which if not managed effectively, may significantly increase health and safety risks. Other changes may arise as a consequence of the project progressing, with different management arrangements being required in construction and O&M phases; while these are foreseeable, care is still required in their management.

A.14.1.1 OVERVIEW OF CHANGE MANAGEMENT

Whether changes are planned or unplanned, their potential impact on health and safety must be properly assessed, so that hazards or risks associated with technical or procedural changes and their implementation are identified and managed effectively. The health and safety management system should define an effective Management of Change process, which should be implemented across all phases of the wind farm lifecycle, so that changes can be introduced effectively into the workplace. This process should consider aspects such as:

- The need for the change;
- How the change will affect the health and safety risk presented by the wind farm;
  - In general, modifications should reduce risks; if the assessment indicates increased risk, then the proposed change should be reconsidered;
- The risks that will occur during the installation and commissioning of the modification, including any additional equipment or materials that will be used;
- Requirements for follow-up activities, such as:
  - Provision of training and information those who will be affected, updating of drawings, and changes to spares inventory;
  - Review, and where necessary, revision of existing risk assessments, safe systems of work, method statements and work instructions;
  - Any additional control measures – organisational, procedural, engineering controls and/or PPE;
  - Issuing modified information and instructions to relevant people, and the withdrawal of information and instructions that are superseded; and
- The allocation of sufficient time and resources to implement the change.

Given the wide range of implications that a technical change can have, effective communication is key to minimising risk.

In many cases, given the number of individual WTGs within a large wind farm, changes will be phased in over an extended period of time, leading to the parallel operation of modified and unmodified equipment. This will require the operation of very effective task management systems in order to minimise the risk of this temporary inconsistency causing confusion, such as provision of incorrect spare parts, or use of inappropriate procedures.

The change management process should involve people with direct experience of the equipment and activities involved, in order to have the clearest understanding of potential effects and any previous attempts to address the issue to which the modification relates.
A.14.1.2 IMPLEMENTATION OF MAJOR MODIFICATIONS

Where modification programmes involve major changes such as structural alterations, or where the implementation of the modifications will involve “substantial dismantling or alteration of fixed plant which is large enough to be a structure in its own right”, then such work falls within the definition of construction, under the CDM regulations, and should be managed in accordance with the duties defined in the regulations.

Depending on the scope of construction work, the project may also be notifiable to the HSE, and require the appointment of a CDM Co-ordinator and a Principal Contractor (PC). This introduces an interface between other parts of the wind farm that are in normal operation, under the control of the Operational Controller, and those that become a construction site, under the control of the PC; this is similar to the situation that occurs in a phased handover from construction to operation, and requires both the owner and the PC to take account of this in their safety management systems.

A.14.1.3 CONTROL OF SOFTWARE CHANGE

While some modifications will be obvious to any technician approaching an item of equipment, software modifications can introduce fundamental changes to the operation of equipment, without of themselves being visible. Software changes should be managed with the same rigour as physical changes, with additional attention being paid to aspects such as ensuring that:

- Unintended effects and interactions are avoided, by undertaking suitable validation of code, and functional testing of the system after the modification has been implemented;
- Backups are made before the changes are implemented, in order to provide a path for reversal of the change;
- Any parameters that may have been set during initial commissioning of equipment are retained in the correct state when the upgrade is applied, and not reset to default values; and
- The software archive is updated on completion, to ensure that any future developments are based on the most recent version of the programme, so that modifications are not unintentionally lost in future.

The level of effort to be applied to managing a software modification should reflect the level of risk that the software can give rise to, with particular care being taken where software can affect the safety of people, or the protection of equipment. In cases where software updates can be implemented from remote locations, close co-operation is needed between the software engineering function and the operator in order to maintain satisfactory control of such changes.

A.14.2 PERSONNEL CHANGES

In addition to technical changes, personnel changes require careful management. These can be very obvious, such as a change of contractor, or more subtle, such as:

- Introduction of new people to established work groups; or
- Loss of experienced people to other duties or employers.

Thorough induction processes should be in place, supported by formal systems to assess training needs and provide increased supervision and support for new employees, ideally differentiating between those who are new to a site, and those who are new to the industry. These processes address the fact that a person who is working in an unfamiliar environment is at increased risk of making mistakes that affect the safety of themselves and others around them.

A.14.3 REFERENCES

IMCA SEL-001 – The Management of Change in the Offshore Environment: While this is written for the offshore environment, it provides clear and practical guidance that could be applied anywhere.

HSE Human Factors Briefing Note No. 11: Organisational Change
A.14.3.1 ELSEWHERE IN THIS GUIDANCE

Modifications & Upgrades considers where changes will occur in the wind farm lifecycle, and the management of major organisational change.
A.15 STRATEGIC PLANNING

The management systems described in Section A.6 provide the framework for the control of risk in day to day operations, as well as short-term forward planning and reviewing past performance. However, the management systems must be suitable for the nature of an organisation’s activities at a given point in time, taking account of the state of development of the industry, and should therefore be driven by a strategic planning process. This is similar to the approach by which successful organisations determine their wider business strategy; the strategic planning of health and safety can follow on from this, in order to identify how the objectives determined by the business strategy can be achieved safely. Taking such an approach is particularly important in organisations, or industries, that are changing rapidly.

Strategic planning is a formal, periodic process by which an organisation looks ahead, typically over the next 3-5 years. Various tools are used, with SWOT analysis being one of the most common approaches; in the context of health and safety, this could consider:

- **Strengths and Weaknesses**: these are internal factors, describing the current state of the organisation, such as:
  - Comparing the experience gained on past projects with the scale and nature of planned future projects;
  - Resources available;

- **Opportunities and Threats**: these are external factors, likely to shape the future operating environment for the organisation; these may include aspects such as changes in:
  - Market conditions, such as tariff changes, which may create peaks and troughs in demand for equipment and services, and encourage project timelines to be compressed to meet tariff qualification deadlines;
  - Technology, ranging from entirely new WTG designs to new access or diagnostic methods; or
  - Regulation and licensing, such as changes in health and safety legislation.

The outcomes of this analysis are then considered in the context of the organisation’s fundamental purpose (its mission), informed by the organisation’s vision of how it will operate in future, and its values, which set the priorities. These combine to define the strategy for how the organisation is to move from its present state to the desired future state.

In organisations that are growing rapidly, or moving from one phase of the project lifecycle to another (for example, from design to construction of a wind farm), this type of process should be used to guide the development of health and safety management competence. Even for an organisation that is apparently operating in a steady state, periodically undertaking such a review could reveal needs such as succession planning, or changes in the market or regulatory regime that will require adjustments to the organisation’s strategy.

A.15.1 PREDICTING AND ADAPTING TO NEW AND EVOLVING SITUATIONS

Part of the function of the strategic planning exercise is to gain some foresight of developments that may cause shifts in the future risk profile, so that the organisation is prepared for them in advance. Present examples of emerging risks include:

- Increasingly frequent siting of WTGs adjacent to industrial sites, to provide embedded generation;
- Introduction of new models of WTG to suit Feed-In Tariff sites; and
- Decommissioning and / or repowering taking place on some early wind farm sites.

Strategic planning should also consider emerging opportunities, such as the potential to share support services between developments.

The organisation can use this foresight to ensure that suitable contingency plans are in place prior to situations arising, thereby enabling appropriate and effective responses and continuity of operations.
A.15.2 REFERENCES

HM Treasury - *The Orange Book - Management of Risk - Principles and Concepts* provides detailed guidance on risk management across an enterprise, and considers both the organisation’s strategy and management approaches, in relation to external and internal sources of risk. The PESTLE approach (which considers Political, Economic, Socio-cultural, Technological, Legal / regulatory and Environmental risks) is particularly relevant to strategic planning.
A.16 EMERGENCY RESPONSE & PREPAREDNESS

A.16.1 OVERVIEW

In the event of an emergency occurring at any stage of the wind farm lifecycle, suitable arrangements need to be in place for the initial response, including care and evacuation of any casualties, and liaison with external emergency services. While every employer has a responsibility for ensuring that such arrangements are in place for their employees, it is important that arrangements are co-ordinated at a site level, with the responsibilities of the owner, other employers and the Principal Contractor being clearly defined.

Emergency response will normally follow the predetermined procedures detailed within the site’s Emergency Response Plan (ERP). In general, the aim is that wind farms will have the necessary capability available (from the owner / operator, contractors or other employers) for responding to foreseeable situations.

Should the scale or severity of the incident exceed the employer’s capability to respond, and in any case where a casualty’s life is endangered, assistance should be obtained from external emergency services, in accordance with agreed arrangements; liaison with the emergency services should start from an early stage in project development, in order to understand their capabilities, concerns and information requirements, and continue over the project lifecycle, particularly when major changes in activities or personnel take place.

A generic sequence of steps in the response to an incident is shown in Figure 3 below; the details of the response will depend on employers’ arrangements, and will be site-specific.

Emergency response planning should not be restricted to wind farms, but should also consider contingency plans for safety-critical assets such as control centres, where a loss of power, IT or communications systems could impair emergency response or personnel location tracking across a number of sites.

A.16.2 REGULATORY REQUIREMENTS

The MHSWR require employers to:

- Establish and implement “appropriate procedures to be followed in the event of serious and imminent danger to persons at work in his undertaking”;
- Provide employees with relevant and comprehensible information on these procedures; and
- Arrange the necessary contacts with external emergency services in aspects such as emergency medical care and rescue.

In the construction phase, the CDM regulations impose several duties regarding emergency preparedness:

- Where a Client has existing emergency arrangements in place, as may be the case when construction work is to take place within an existing wind farm, or on an active industrial site, the Client should provide information on these arrangements as part of the Pre-Construction Information;
  - This should also highlight any cross-boundary risks, such as incidents on an adjacent industrial site affecting the wind farm;
- The Construction Phase Plan should define the site fire and emergency response procedures, which will be part of the site rules, and briefed as appropriate in inductions;
- Contractors have a duty to provide workers under their control with any necessary information that they need in order to work safely, including what they should do in an emergency; and
- Emergency arrangements should be tested at suitable intervals.

Both sets of regulations require employers who share a workplace to co-operate and co-ordinate their activities in the interest of health and safety.
The site emergency procedures should be based on the outcomes of risk assessment, and take account of factors such as:

- The types of work taking place on the site, and the work equipment being used;
- Characteristics of the site, such as its size and the number and location of places of work on the site;
  - Some sites have more than one type of WTG, which may lead to significant differences in procedures and work equipment requirements for emergency response;
- How many people are likely to be present on site at any time;
Either very high or very low numbers could increase the complexity of emergency response; and

- External support available, considering both support provided by the employer, and by emergency services.

A.16.3 APPLICATION AND EXAMPLES

Emergency plans need to cover a wide range of situations, noting that, at a practical level, the emergency response may be different depending on the exact work that is taking place. For example, if a casualty were located in the hub of a WTG, their rescue could need a larger team and additional equipment compared to a rescue from more accessible locations in the nacelle or tower. Managing these different levels of emergency preparedness can be simplified by the identification of rescue requirements for different areas of WTGs, which can then be used as the basis for task planning; the aim should be to ensure that no person is ever in a location from which they could not be rescued without undue delay, in the event of injury or illness occurring.

A.16.3.1 LIMITATIONS AND INTERFACES

The ERP will address interfaces for a given site in detail; in general, key interface points with emergency services are:

- Ambulances may transport casualties from a wind farm to hospital:
  - Agreement should be reached with the local ambulance service as to whether their vehicles can be used on site roads, and under what conditions (such as the state of the road, and weather at the time of the incident). This may mean that the site has to be able to transport casualties to an agreed handover point, and/or transport paramedics to the casualty;
  - Note that ambulances are only intended to be used if someone is seriously ill or injured, and their life is at risk; if the situation is not a life-threatening emergency, but medical attention is still needed, employers should transport casualties to the local Accident & Emergency hospital;
  - In very serious and urgent cases, the ambulance service may determine that an air ambulance should be despatched, in order to give faster transport to hospital. Air ambulances may be able to land on site roadways, close to the scene of the incident, provided that these are free from obstructions such as trees and overhead lines;
    - Loose debris should be cleared to avoid being blown about by rotor wash;
    - Dusty areas should ideally be damped down;
    - Ground personnel should only approach a helicopter when clearly signalled to do so by the crew;
    - Early liaison between the wind farm and the local air ambulance service can allow requirements and expectations to be defined, and incorporated in the ERP;
  - On other occasions, the UK Search And Rescue (SAR) service may become involved; this comprises a mixture of dedicated assets, including government bodies such as the Ministry of Defence (MOD) and the Maritime and Coastguard Agency (MCA) (whose combined resources provide helicopter SAR coverage throughout the UK), and volunteer organizations such as mountain rescue teams. SAR helicopters may either:
    - Winch a casualty from the WTG nacelle; or
    - Land on the ground in a location that is clear of wind farm obstructions, in order to collect a casualty.

Should winching from the nacelle be necessary, the WTG will have to be prepared for helicopter transfer in accordance with MGN371, with respect to locking the rotor in a suitable position and

12 Note that while MGN371 refers to Offshore Renewable Energy Installations, any winching from the nacelle of an onshore WTG would be carried out by the same SAR services as offshore, and the WTG would need to be prepared for winching in the same manner as offshore.
isolation of yaw drives. Note that helicopter crew members may enter the nacelle, but are not trained to undertake technical rescues from inside other areas of a WTG; wind farm staff would therefore have to transfer a casualty to the nacelle.

In the event of any incident involving a fatality or life-threatening injury, the police should be informed without delay.

The ambulance services include specialist teams, with additional training, known as Hazardous Area Response Teams (HART) (England, Wales, Northern Ireland) or Special Operations Response Teams (SORT) (Scotland); their purpose is to triage and treat casualties in difficult locations that would be inaccessible to other paramedics. The existence of these teams is a valuable support to emergency response in challenging locations, but does not change the employer’s responsibility for the care of their employees in an emergency.

In some rural areas, the ambulance services work with local First Responders, who are members of the public who volunteer to help their community by responding to medical emergencies while the ambulance is on its way; while their training goes beyond standard first aid techniques, they do not have the same level of training as paramedics or ambulance technicians, and are not sent to road traffic collisions or traumatic injuries, so would not be expected to support an accident on a wind farm.

A.16.4 Risk Assessment and Risk Management

A.16.4.1 Risk Assessment

Employers are responsible for completing hazard identification for all aspects of the wind farm and ensuring that proportionate barriers and mitigation measures are put in place. Such mitigation should form the basis for the wind farm ERP, which needs to provide procedures to follow in the event of foreseeable emergency situations such as:

- Failed lifting operations;
- Accidents involving light or heavy vehicles, including overturning;
  - This includes both accidents occurring on site, and on public roads used as transport routes to / from site;
- Fire;
- Illness or injury;
- Bomb threat, sabotage or theft; and
- Extreme weather, including flooding or snow / ice;

The employer is responsible for the initial stabilisation of any casualties, and providing care up to the point where they are handed over to external medical teams; depending on the situation, this could be at an ambulance at the wind farm, or at the local Accident and Emergency hospital. In remote areas, external assistance could on occasions take a considerable time to arrive, therefore the level of medical / rescue provision by the employer should be proportionate to the hazard exposure and time for external response; the required level of provision at any point in time therefore depends on:

- The operations being undertaken;
- The location; and
- Any other factors (such as winter road conditions) that could affect external response times.

First aid provision should be determined according to a needs assessment, as described in Section A.17.3.

A.16.4.2 Risk Management

The ERP should identify:

- Roles and responsibilities, including:
  - Immediate response;
 Additional on-site support;
Co-ordination of response, including liaison with off-site support and third parties;
  ▪ Depending on the incident and organisation involved, this might be done by the team on site, or by a corporate emergency management centre, supporting site personnel and handling external liaison;
  ▪ Whichever approach is adopted, the personnel who are providing immediate on-scene assistance to the casualty should have support available for co-ordination, including essential logistical matters such as unlocking gates and guiding emergency services to the incident location;

• Communications requirements:
  o Who to contact:
    ▪ On site;
    ▪ Within other parts of the organisation;
    ▪ Third parties such as suppliers and utilities;
    ▪ Emergency services;
  o Hardware requirements, particularly for sites without good mobile phone coverage;
  o Protocols: how and when to contact support, and the information that should be provided;

• Access points and site layout;
• Significant hazards such as HV systems, and the necessary steps to take to make these safe;
• Work equipment that could be needed in foreseeable emergencies;
• Support procedures such as:
  o First aid and emergency medical care;
  o Evacuation of WTG;
  o Firefighting;
  o Emergency shutdown / isolation and earthing of systems;
  o Emergency co-ordination;
  o Personnel location tracking;
  o Notification of next of kin;
  o Statutory reporting, and arrangements for supporting employees during interviews with regulators;
  o Communication with relatives;
  o Media liaison;
• Training requirements, to ensure that people are competent in the procedures that support the plan, including defining initial requirements, and periodic drills / exercises.

Interfaces with external emergency services need to be clear, including understanding of factors such as:
• The support that they can provide, and their expectations of site personnel, in different types of emergency;
• Arrangements for co-ordination, given that the technicians on site may be fully occupied in providing immediate assistance to a casualty;
- Limitations on access to sites, for example, standard ambulances may not be suitable for use on site roads; and
- Realistic response times to sites in remote areas.

Early dialogue between developers and local emergency services will help to develop a clear mutual understanding of capabilities and operational activities.

A.16.4.3 TRAINING, COMPETENCE AND INFORMATION

In the event of an emergency, it is essential that all personnel involved are fully familiar with their roles and responsibilities, which may vary depending on the nature of the emergency and their location at the time. For this reason, thorough training in the ERP is required before each phase of the development lifecycle, or when the plans are updated, together with regular exercises to ensure preparedness. Risk assessments should identify the specific areas in which the persons involved may require to be competent; depending on their role, these may include:

- Rescue and evacuation;
- First aid;
- Incident control and co-ordination;
- Fire awareness;
- Media and community liaison;
- Communication with next of kin; and
- Liaison with regulators and police.

Emergency information should be displayed at suitable locations, so that it is available to personnel when required; this typically includes:

- WTG nacelles and bases;
- Site offices / SCADA rooms / construction site security huts;
- Off-site control / incident management centres.

The information should be made available from the earliest stages of on-site work, should be appropriate to the location, and updated as necessary as the project progresses, so that personnel have immediate access to relevant and up to date emergency information, even if they are only on site for a brief period.

A.16.4.4 RESPONSE PRIORITIES

It is essential that the ERP and supporting systems and arrangements set out clear priorities for the incident response team, to enable them to manage an incident effectively. PEAR(LS) is a commonly accepted response hierarchy used offshore. It sets out the priorities of the incident response team as follows:

- People – saving and safeguarding life;
- Environment – protection and mitigation;
- Asset – protection of plant and property;
- Reputation – protection of company image;
- Liabilities – commercial and contractual commitments; and
- Sustainability – on-going business continuity.

A.16.5 MONITORING / REVIEW AND CHANGE MANAGEMENT

The ERP should be tested and reviewed regularly, and revised as necessary. A formal review should be conducted to capture lessons learned after the activation of the ERP.

During the construction phase, the Principal Contractor (PC) may take the lead responsibility, rather than the developer / operator; any such transfers of responsibility must be managed with
absolute clarity, both within the project team and externally, particularly if handover from the PC to the operator is phased to match the development of different geographical areas of a project.

Individual elements of the plan, such as rescues from within WTGs, communications equipment and arrangements for liaison with emergency services, should be tested at suitable intervals, this testing could include both desktop exercises and full scale exercises in the field, involving wind farm personnel, control centres and local emergency services where it is safe and practicable to do so.

A.16.6 RELEVANT GOOD PRACTICE

While emergency services may be stood down once the casualty has been evacuated to a place of safety, the employer still needs to ensure that the casualty receives all necessary support; this includes practical arrangements, recognising that the casualty may be in a location that is remote from their home – possibly even in a different country, with no keys, money or change of clothing, and even if they are fit to drive, they are unlikely to have access to a vehicle.

A.16.6.1 ADDITIONAL CONSIDERATIONS

While the ERP will define formal processes for issuing press releases, employers need to be aware of the likelihood of information becoming available by other routes, including social media. Depending on the nature of the emergency, and its location, it may be highly visible to local communities, therefore it is important to communicate honestly, and as openly as possible, subject to the need not to prejudice any subsequent investigations.

In the event of an incident occurring on any wind farm in an area, a high volume of media enquiries may also be received by adjacent owners / operators, even if there is no incident on their own site; owners / operators may need to be prepared for this situation arising, both in terms of readiness to handle enquiries, and co-operation with neighbouring sites.

A.16.7 LEGISLATION & STANDARDS

HSE HSG65 - Managing for health and safety (2013) provides guidance on the arrangements that are needed for emergency preparedness.

The HSE provides a checklist of considerations for assessing preparedness for emergencies; it is not aimed at renewables, but has a focus on human factors.

Search and Rescue (SAR) Framework Document for the United Kingdom of Great Britain and Northern Ireland details the UK’s comprehensive SAR service for those reported in trouble or missing. (Note: document published in 2008, some organisational aspects have since changed).

MCA MGN371 – Offshore Renewable Energy Installations (OREIs) - Guidance on UK Navigational Practice, Safety and Emergency Response Issues is primarily written for offshore, however Annex 5 specifies the necessary preparatory steps before a helicopter can safely winch a casualty from a WTG nacelle.

The Cabinet Office website Risk Assessment pages give information on national and local emergency management and resilience arrangements, while the Civil Contingencies pages set out the regulations and statutory guidance for Emergency Preparedness including establishing a clear set of roles and responsibilities for those involved in emergency preparation and response at the local level. Note that Category 2 responders potentially include utility companies.

BSI PAS 200:2011 - Crisis management – Guidance and good practice is designed to help organisations to take practical steps to improve their ability to deal with crises; it recognises that crises are distinct from operational incidents, and therefore require different management approaches.

BS ISO 22301:2012 Societal security - Business continuity management systems – Requirements defines the requirements for establishing business continuity management systems, of which emergency response preparedness is a part.

A.16.7.1 ELSEWHERE IN THIS GUIDANCE

Medical Fitness to Work
First Aid
A.17 FIRST AID

A.17.1 OVERVIEW

While the main objective of health and safety management is to reduce the risk of people suffering injury or illness at work, the risk cannot be entirely eliminated. Suitable arrangements should therefore be put in place, in order to minimise the severity of the effects on a person who is ill or injured; these arrangements aim to:

- Preserve life, by the application of first aid techniques;
- Prevent further harm, by taking steps to reduce the risk of the condition worsening; and
- Promote recovery, by enabling the start of the recovery process from the illness or injury.

The definition of first aid in the Health and Safety (First-Aid) Regulations 1981 includes “in cases where a person will need help from a medical practitioner or nurse, treatment for the purpose of preserving life and minimising the consequences of injury and illness until such help is obtained”, as well as the treatment of minor injuries where no medical support is necessary. This definition is clearly focused on preserving life and minimising consequences; the exact scope of assistance that may have to be provided to the casualty depends on where and when medical support can be obtained.

First aid provision should be integrated with the Emergency Response Plan for the wind farm, and is likely to comprise successive levels of support, for example:

- The immediate response is likely to be provided by the casualty’s colleagues in the working party; they will raise the alarm, and where it is safe to do so, rescue the casualty from immediate danger and provide initial first aid within the remit of their training; and
- Other personnel within the wind farm may provide further assistance in the care of the casualty, particularly where they have more advanced first aid training; they may also assist with casualty evacuation;

Each level of support must be capable of taking care of the casualty until the next level of support is available, until the casualty is handed over to full medical care.

A.17.1.1 POTENTIAL HAZARDS AND RISKS

Work on wind farms presents a variety of hazards that the first aid provision may have to address:

- There is the potential for complex and difficult injuries to occur, such as suspension intolerance / syncope, electric shock, major trauma, crushing / entrapment, hypothermia, and heat stress;
- Injuries may occur in locations that are difficult to access, or in restricted working positions such as work at height or in confined spaces;
- Underlying medical conditions may give rise to acute illness;
- Wind farms are often located in remote locations, potentially delaying the arrival of emergency services;
  - Ambulances may not be able to use site roads, so it may be necessary to transport a casualty to an agreed location;
  - If paramedics attend a site, they may not have the necessary training to attend a casualty in a WTG.

It should be noted that, in general, the emergency services will only become involved if there is a danger to life; in less critical cases, the resources of the wind farm should be capable of providing all necessary care and evacuation; the detailed interfaces will be defined in the ERP, including limitations on areas that emergency services can be expected to access.
A.17.1.2 Relevance to Key Lifecycle Phases

The risks to people, and the number of people exposed, will both vary over the lifecycle, as will the level of support available within the wind farm; a typical pattern could be:

- During construction:
  - Large numbers of people will be undertaking high-hazard activities; and
  - The workforce will be provided by multiple contractors, often from a number of different countries; and
  - Construction site welfare facilities will be more comprehensive than on the completed site;

- During commissioning:
  - Most heavy lifting and assembly work will have ceased; electrical systems will be energised, and moving machinery will be present; and
  - The workforce will be smaller, provided by a reduced number of employers;

- During operations and maintenance:
  - The work will be very varied, ranging from low-hazard inspection activities to repair or replacement of major components;
  - Only the largest wind farms will have a core on-site workforce; on most sites, teams will be mobilised to sites when required;
  - The combined effect of these is that the level of risk to people on a site, the number of personnel on site, and their level of training, will vary on a daily basis.

A.17.2 Regulatory Requirements

The Health and Safety (First-Aid) Regulations 1981 require employers to provide “adequate and appropriate” equipment, facilities and personnel to ensure that their employees receive immediate assistance if they are injured or taken ill at work; the regulations do not prevent personnel with appropriate training from taking action beyond initial casualty management. In summary, the regulations require duty holders to:

- Assess the first aid needs of a workplace, to determine what will constitute adequate and appropriate provision, based on the circumstances of a particular workplace;

- Based on the assessment of needs, provide:
  - A suitable number of persons, with an appropriate level of training, for rendering first-aid to employees; and
  - The necessary first aid materials, facilities and equipment;

- Ensure that persons who provide first aid are competent and trained to an appropriate level; fulfilling this duty may involve:
  - Assessing the suitability of available first aid qualifications, and the competence of training providers, and
  - Providing additional training, if standard qualifications do not give sufficient preparation for the situations that may occur in the workplace; and

- Inform employees of the arrangements that have been made for first aid provision.

During the construction phase, the Principal Contractor has a duty to define the arrangements for provision of first aid, as part of the construction phase plan, and to inform personnel of the arrangements as part of their site induction. On a multi-occupied site, the different employers should co-operate to ensure that their combined or shared first aid provision is adequate, with respect to the hazards and risks on the site, and that employees are kept informed of arrangements.

The HSE provides guidance on the syllabus of standard Emergency First Aid at Work and First Aid at Work courses, however the duty to provide additional training where necessary is
particularly relevant to wind farms. The HSE no longer approves any first aid training courses or qualifications; it is the employer’s duty to select a competent training provider. This duty can be fulfilled through various different approaches, including:

- Voluntary approval schemes, with third party accreditation against an industry standard;
  - This allows for the development of first aid training that is targeted at the specific needs of an industry, such as the RenewableUK (GWO) first aid standard;
- Approval by a qualification regulator, such as Ofqual, Scottish Qualifications Authority or the Welsh Government;
- Operation within the assurance systems of a Voluntary Aid Society; or
- Direct provision of evidence to the employer;
  - This may be particularly relevant for specialist training that goes beyond the scope of industry standards.

Irrespective of the approach taken to approval, the training should be in accordance with current Resuscitation Council (UK) guidelines, and the first aid manual of the Voluntary Aid Societies, or with other published guidelines that are consistent with these or supported by a responsible body of medical opinion.

The NI regulations still include a requirement for HSENI to approve first aid qualifications, however, in addition to those courses directly approved by HSENI, they also recognise Ofqual-approved awarding organisations for the delivery of training, and will recognise holders of a First Aid at Work or Emergency First Aid at Work qualification that is approved by a GB qualification regulator or Voluntary Aid Society.

There is also a duty to report certain accidents and incidents at work under RIDDOR (Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013).

**A.17.3 MANAGING THE RISKS**

**A.17.3.1 APPROACHES TO RISK ASSESSMENT**

The factors that determine the suitability of first aid provision can be grouped together as the combination of:

- The risk to people, arising from factors such as the:
  - Nature of the work to be carried out, and workplace hazards and risks;
  - Severity of potential injuries or illnesses that may occur;
  - Number of people exposed, their distribution and working patterns;
  - Location (including remoteness) of the workplace;
  - Previous history of accidents and acute illness, within the organisation and the industry;
  - Scale and complexity of the activities being undertaken; and
- The response time, which comprises the time taken to:
  - Raise the alarm;
  - Rescue the casualty from immediate danger;
  - Get first aiders and further support to the casualty; and
  - Transfer the casualty to the care of paramedics, in the agreed location, which could range from the site entrance to the scene of an accident in a WTG.

The level of provision should be directly related to the foreseeable risks, response times and emergency service capabilities for a particular wind farm and task.
A.17.3.2 RISK MITIGATION MEASURES

First aid provision should consider the:

- Level of training of technicians who will provide the immediate response;
- Availability of others with additional skills on the site;
- Equipment and supplies to be provided; and
- Locations where equipment and supplies should be stored, such as in the nacelle, tower, or site offices.
  - In practice, a tiered approach is often adopted, with basic first aid kits being available in the base and nacelle of every WTG, and other items such as stretchers and spine boards being kept at the site office.

The on-site emergency responders may benefit from being able to consult off-site specialists if advice is required on managing serious or complex injuries. In some cases, the needs assessment may show that further medical support, that goes well beyond the remit of a first aider, is necessary, particularly if some locations will not be accessible to paramedics.

HSE guidance provides suggested contents for first aid kits, but these lists are not mandatory; the actual contents should be determined by the first aid needs assessment.

A.17.3.3 MONITORING, REVIEW AND CHANGE MANAGEMENT

Given that the factors affecting risk and response will vary, both between project phases and arising from changes in daily operations, first aid provision should be considered in the planning of site work. Employers should also undertake periodic formal reviews, as well as after any significant operating changes. The review would consider:

- Facilities and equipment: should any changes be made, in order to manage the identified risks of injury and illness?
- Training: should any changes be made to the first aid and associated training that is provided?
- Procedures: do any procedures need to be revised or developed, and communicated, to ensure that the first aid response is suitable and effective?

Given the close relationship between first aid provision and the site ERP, neither should be changed without considering the other.

Where first aid equipment and supplies are provided at various locations within wind farms, suitable procedures need to be in place to ensure that these provisions are replenished after use, and before expiry of perishable items.

Where accidents or illnesses have occurred and first aid has been required, the first aid response should be reviewed as part of the incident investigation, to identify any learning that could improve the response in future. Employers should also ensure that employees who have been involved in emergency response, particularly where it was concerned with the serious injury or illness of a colleague, are suitably debriefed and supported afterwards.

A.17.4 CODES OF PRACTICE AND GUIDANCE

A.17.4.1 REGULATIONS AND STANDARDS

HSE L74 - First aid at work - The Health and Safety (First-Aid) Regulations 1981 - Guidance on Regulations.

The HSENI website explains the arrangements for approval and recognition of qualifications.

A.17.4.2 OTHER RELEVANT GUIDANCE


HSE GEIS3 - Selecting a first-aid training provider - A guide for employers.
RenewableUK - Health & Safety Training: Entry- and Basic-Level Health & Safety Training and Competence Standards: Scope and Application to Large Wind Projects identifies how first aid training fits in with other basic training requirements.

RenewableUK Approved Training Standard – First Aid Wind Turbines (FAWT) has been fully aligned to the GWO Basic Safety Training – First Aid module, and also includes specific reference to the particular requirements for delivery of training and the syllabus content within the UK.

HSE RR708 - Evidence-based review of the current guidance on first aid measures for suspension trauma.

A.17.4.3 ELSEWHERE IN THIS GUIDANCE

Emergency Response & Preparedness
Medical Fitness to Work
Reporting of Injuries Diseases and Dangerous Occurrences Regulations 2013 (RIDDOR)
Part B The Wind Farm Project Lifecycle

INTRODUCTION

This part of the guidance considers how health and safety management can be addressed over the lifecycle of a wind farm. Using a simplified lifecycle model, the key activities in each phase are addressed, in relation to:

- Future risks, that will be determined by decisions made during the phase, and which will affect health and safety in later lifecycle phases; and
- Risks arising out of activities undertaken within the phase.

The regulatory framework, and health and safety management arrangements within which all activities are to be undertaken, are described in Part A of this guidance, while the risks and regulations that relate to specific activities and hazards are described in the relevant sections of Part C.

LIFECYCLE APPROACH

The development of a wind farm will consist of a number of phases; decisions taken in one phase will affect health and safety performance in subsequent lifecycle phases. The exact lifecycle terminology will vary, depending on the nature of the project and the contracting strategy being employed, although the typical phases that can be expected are outlined in Figure 4, with the main activities in each phase summarised in Table 9 below. This diagram also highlights the major supporting activities that can span multiple project phases. In reality, project development is not a simple linear flow, and would typically involve a degree of iteration, with different parts of the development progressing through the phases at different rates.

As each phase of a project is completed, the opportunity to eliminate or reduce risks through design and selection of equipment is reduced, and once contracts are agreed for the supply of goods or services, methods may largely be defined. If changes that will be essential for health and safety are identified late in the lifecycle, the cost and schedule implications of their adoption will be greatly increased.

It is therefore critical that decisions made during all project phases, including the definition and design phases, are based on an appropriate level of risk assessment, and that the information from this is passed on effectively to subsequent activities. Each of the phases, and the project itself, should be subject to appropriate audit and review, with the learning being used to update processes and inform future projects.

Figure 4: Lifecycle phases and key supporting activities
<table>
<thead>
<tr>
<th>Project Definition</th>
<th>Project Design</th>
<th>Construction &amp; Commissioning</th>
<th>Operations &amp; Maintenance</th>
<th>Decommissioning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project concept</td>
<td>Site detail design</td>
<td>Site preparation</td>
<td>Maintenance strategies – planned / reactive / scheduled / condition-based</td>
<td></td>
</tr>
<tr>
<td>Contracting strategy</td>
<td>Balance of Plant design</td>
<td>Emergency preparedness</td>
<td>Monitoring</td>
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<tr>
<td>Resource assessment</td>
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</tr>
<tr>
<td>Site survey</td>
<td>Construction strategy</td>
<td>Construction of roads, foundations, site buildings</td>
<td>Safe systems of work</td>
<td></td>
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<tr>
<td>Consenting</td>
<td>Detailed planning for construction</td>
<td>WTG installation</td>
<td>Operational Control</td>
<td></td>
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<tr>
<td>WTG selection</td>
<td>Commissioning strategy</td>
<td>Substation construction</td>
<td>End of warranty</td>
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<tr>
<td>WTG certification</td>
<td>Contractor selection</td>
<td>Cable installation</td>
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<td></td>
<td>Contract negotiation</td>
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<td>Commissioning and handover</td>
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The EU-OSHA report [E-Facts 70 - Occupational Safety and Health in The Wind Energy Sector](#) provides an overview of occupational health and safety challenges over the lifecycle of WTGs.
B.1 PROJECT DEFINITION

At the start of this phase, the proposed wind farm is likely to be a business objective, but with limited certainty as to its size, location or type of WTG. During this phase, the concept is developed, and the initial project team is formed, so that at the end of the phase, the concept of the proposed development and the organisational arrangements to take it forward are clear, and more detailed design activities can commence. If the development is to be “safe by design”, then that approach needs to be adopted from the beginning of project definition.

The project team is likely to be at its smallest in this phase, possibly with limited resources. As the project does not yet exist in a physical form, the ability to make significant changes without incurring excessive cost is at its greatest in this phase, and so too is the effect of the decisions taken, on the safety and economic viability of the development over its entire lifecycle. Where these decisions depend on data, the quality of this data is a key input that will determine the quality of decisions and the ability to implement them, and thereby minimise the need for enforced changes in later phases of the lifecycle.

The main activities during project definition can be grouped as those relating to:

- The project concept:
  - Location, scale of development, potential WTGs to be installed;

- Understanding the site:
  - Wind resource measurement;
  - Ground conditions, past and present land uses;
  - Infrastructure such as transport and access routes, grid connection;
  - Constraints relating to risks to and from adjacent land uses;

- The WTG and balance of plant such as substations and cabling, including preliminary consideration of:
  - WTG specification and design; and
  - Conformity to standards / certification requirements;

- Planning consent:
  - Consenting requirements, including Environmental Impact Assessment (EIA) and supporting surveys;
  - Agreement with landowners, on the wind farm site and along access and grid connection routes;
  - Consultation with external stakeholders, including local communities and others who may be affected by the wind farm and associated construction activities;

- Management arrangements and key appointments for the phase:
  - Project information management;
  - CDM appointments and duties;
  - Management of subcontracted consultants / designers; and
  - Contracting strategy for subsequent phases.

The financial and technical resources available in this phase of the development can present a further challenge to developers:

- As the development will not have obtained consent until late in this phase, there is a risk that if it does not receive consent, or does not progress beyond financial close, there will be no return on the investment that is involved up to that point, which may be several years after the project was initiated;

- Where contractor resources are needed in order to progress tasks in this phase, the contracts will be of shorter duration and lower value than in later phases, which may limit the ability to build a shared safety culture.
While these challenges are acknowledged, it is important that health and safety standards are not compromised.

B.1.1 RELEVANCE AND IMPACT ON SUBSEQUENT PHASES OF LIFECYCLE

The project definition phase will determine the overall envelope within which the wind farm is to be developed; this will then be the basis for all future design and operational decisions, so it is essential that it enables a safe and viable development to be constructed and operated.

The core project team will also be formed in this phase; this will affect the health and safety culture of all subsequent activities. The processes for project and risk management that are established will also determine how effectively the project objectives are achieved.

B.1.2 KEY HEALTH AND SAFETY RISKS TO BE CONSIDERED

B.1.2.1 PROJECT CONCEPT

The location of the development is likely to be determined by a combination of feasibility studies and site availability; key considerations include:

- The wind resource at candidate sites and the estimated energy yield that candidate WTGs would deliver;
- The ability to construct the development, taking account of:
  - Site conditions, including ground conditions;
  - Constraints on the transport of large components to the site;
- The ability to operate and maintain the development, taking account of:
  - Expected maintenance requirements of the candidate WTGs;
- The ability to export energy, in terms of the:
  - Availability of a suitable grid connection; and
  - Identification of potential cable routes;
- External constraints that can affect the ability to construct, operate and maintain the development, and which will be addressed as part of the consenting process; these include:
  - Existing and historical land uses;
  - Risks to and from adjacent land uses, such as schools, housing, industrial sites (especially Control of Major Accident Hazard (COMAH) sites), roads and railways;
    - These should include probable events, such as ice throw in winter, as well as low probability, high severity events such as fires or catastrophic failures of major components or structures; and
  - Planning policies and environmental / habitat protection requirements.

Such studies are likely to take an iterative approach, starting with a “screening” stage that considers limited detail over a wide range of options, and leading to more detailed study of the most likely options. As the detail increases, these studies start to need an increased level of project-specific information, some of which will need to be obtained through on-site measurement and survey work. The technical and economic evaluation of proposed concepts should run in parallel with hazard identification and risk assessment processes, which will also increase in detail as the concept develops.

B.1.2.2 UNDERSTANDING THE SITE

B.1.2.2.1 Resources and Supporting Infrastructure

At the start of this phase, resource information is likely to consist of modelled data, validated against limited physical measurements, which may have been obtained at locations remote from the candidate sites, or from short-term measurement campaigns at candidate sites. Such data may support initial site selection, but is likely to introduce high levels of uncertainty to estimates,
and may be inadequate for use in WTG selection, so on-site wind resource measurement will be necessary.

Essential supporting infrastructure such as potential grid connection points and transport routes should also be considered.

**B.1.2.2.2 Site-Specific Risks**

The ground conditions on a site can affect design decisions and the health and safety of personnel involved in on-site activities, and may also have off-site impacts. Key considerations include:

- **Stability:** landslides involving peat or other soil types, or collapse or compression of soils, introduce health, safety and environmental risks;
- **Hydrology:** on-site activities could affect water retention and ground stability on the site, or even water out-flow from the site, affecting water supplies, quality of watercourses, or localised flooding risks;
- **Contamination:** previous land uses may have resulted in contaminants being present in the soil or groundwater; on-site activities could lead to previously stable contaminants being released, affecting the health and safety of personnel on and off the site, and the local environment;
- **Hazards from previous mining operations beneath the site, such as the extraction of coal or minerals;**
  - Note that while the locations of mines abandoned from the 1950’s onwards are well documented, records of other workings may be less accurate, requiring a risk-based approach to be taken;
- **On some sites, particularly those which have had military uses in the past, or were near to areas of heavy bombing during WW2, unexploded ordnance (UXO) may be present; and**
- **Buried services such as cables and pipelines could constrain site layout, impose special design requirements where site roads or cables are to cross existing services, or introduce risks during on-site work.**

Understanding the ground conditions generally involves a combination of desktop studies and initial intrusive ground investigation (geotechnical) work on the site, which may be supported by further geotechnical work, in more locations, at the start of the construction phase.

The extremes of weather conditions expected on the site are important design inputs, for example:

- **Maximum gust speeds and potential ice loads need to be determined, to ensure that WTGs and structures such as meteorological masts are suitable for the site conditions;**
- **Extremes of rainfall will affect the design of site drainage, including any temporary controls needed during construction to prevent discharge of silt into watercourses; and**
- **The outcomes of a site flood risk assessment may affect the location and design of site infrastructure, including access roads, buildings and substations.**

**B.1.2.2.3 On-site Survey and Measurement Activities**

These activities are likely to give rise to the first point in the development lifecycle at which people are exposed to the risks of working on the project site, during survey work, or the installation of wind resource measuring equipment. These early activities are generally undertaken before site road networks are developed, potentially resulting in difficult access conditions, limitations in the equipment that can be used, and increased challenges in emergency response. The developer therefore needs to have suitable contractor selection, procurement and health and safety management processes in operation at this stage, even though the main work on the site may not start until several years later. While environmental and site survey work generally falls outside the definition of construction work, ground investigation and meteorological mast installation may be the first on-site construction activities, so should be managed in accordance with the requirements of the CDM regulations.
At this early stage in the development, the project team’s knowledge of the site will be at its most limited; the risks that this brings can be mitigated by actions such as:

- Adopting a conservative approach to specifying equipment and planning operations, so that if conditions are found to be more challenging than expected, the safety of people and the success of the operation are not put at risk, for example, by ensuring that temporary meteorological masts are suitable for the maximum foreseeable wind speed and ice load;
- Selecting contractors with suitable experience of the operations to be undertaken;
- Engaging competent advisors on specialist technical and safety aspects; and
- Seeking local knowledge about the site and its access routes.

**B.1.2.3 CONSENTING**

Prior to a project receiving planning consent, an EIA will, in most cases, be required. The EIA enables risks to be identified at an early stage and thus presents the opportunity to design them out, thereby ensuring that risks are minimised throughout the project. The EIA process is informed by an understanding of both the project, and the characteristics of its location, and therefore makes use of design information about the development, as well as survey data on the site. Depending on the environmental risks identified, survey data may typically be required for periods of two years, or longer; this will be in addition to the time needed for consultation with stakeholders.

In the project definition phase, the WTG selection needs to provide the EIA process with sufficient clarity as to the tip height, location and number of WTGs to enable a meaningful assessment to proceed, in order to develop the Environmental Statement that is required as part of the consenting process. In some cases, this can include the use of the “Rochdale Envelope” approach, which enables the maximum adverse case scenario to be assessed, without requiring every detail of a development to be tightly defined. Subsequent phases of more detailed design and WTG selection activities will then aim to work within these constraints, and take account of any mitigation actions that are identified as being necessary during the EIA process, in order to provide the level of certainty that is needed for planning consent.

It is important to ensure that the detailed design that is consented is sufficiently well founded to ensure that it will be possible to construct and operate the development within these parameters; gaining certainty on this depends on having sufficient understanding of site characteristics and the practicalities of the construction operations involved. For example, environmental and financial objectives tend to minimise the areas of hardstanding on sites, and favour the construction of spur roads with turning heads, rather than circular roads; these preferences may affect the scheduling of WTG transport and erection, and site traffic hazards. Determining the acceptability of such constraints will be best achieved if there is effective co-operation between engineering and environmental specialists within the project team. If it were later found not to be practicable to construct and operate the development within the planning conditions, then further assessment could be required to support any application for the consent to be varied, with the potential for the project to be delayed.

**B.1.2.4 WTG AND BALANCE OF PLANT**

WTG selection is a key process in the definition of most developments.

In addition to technical performance and economic considerations, it is important that health and safety aspects are given sufficient attention in specification and subsequent tendering activities, otherwise the rest of the project lifecycle may involve applying mitigation efforts to hazards that could otherwise have been eliminated. This applies both to the WTG and the balance of plant, such as roadways, substations and cabling.

As an absolute minimum, all WTGs must conform to the Essential Health and Safety Requirements set out in the Machinery Directive, as this is a legal requirement; while the responsibility for conforming with these requirements lies with the manufacturer or supplier of the machinery, wind farm developers should assure themselves that the duties are being fulfilled.

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13 See [Infrastructure Planning Commission Advice Note Nine: “Using the Rochdale Envelope”](#)
Industry-specific approaches such as the certification of WTGs minimise the risk of technical failures, bringing a significant indirect health and safety benefit by reducing the risk exposure that recovery from failures would entail. Specific health and safety considerations in the definition of requirements for WTG and balance of plant design include:

- Implications of the proposed design for construction, O&M and decommissioning activities;
- Philosophy for survival of extreme wind conditions, in particular, the extent to which survival is passive, or dependent on the correct function of control and communication systems and actuators;
  - If survival is not passive, then the reliability of these components becomes very important, with redundant and/or fail-safe design approaches being used;
- Provision of lifts for people, and lifting equipment for components;
- Facilities for operation within safe systems of work such as the Wind Turbine Safety Rules (WTSR), such as the provision of lockable isolators in suitable locations;
- Means of emergency evacuation, and rescue of a casualty;
- Fire detection, protection and suppression; and
- Lightning protection.

As the project design is developed and defined in increasing detail, risk assessments should be carried out or updated at each stage of the design process, with the findings being used as inputs for the next phase. Under the Machinery Directive, the manufacturer or supplier has a duty to carry out a risk assessment, in order to determine the necessary protective measures, and then provide information about residual risks to users of the machinery. This information will then be used as an input to risk assessments for work on the site.

**B.1.3 HEALTH AND SAFETY CRITICAL INTERFACES AND COMMUNICATIONS**

The project definition phase involves both on-site and desktop activities, combining to produce a clear specification for the proposed project:

- As understanding of the project site increases, there may be interactions between different aspects of the project definition; for example, increased knowledge of ground conditions may affect the wind farm layout or types of road construction being considered, so it is important to co-ordinate the different work packages in order to ensure that they are working from a common and up to date data set;
- Where on-site survey and measurement activities are carried out, there may be interactions with other land users and stakeholder groups, so suitable liaison and formal notification processes should be used; and
- Much of the work in the phase will be carried out by contractors; the developer will need to ensure that the interfaces between work packages are managed effectively, and that all necessary information can be shared in order to support good decision-making and minimise duplication of activities.

**B.1.4 MANAGEMENT AND OPERATIONAL CONTROLS**

Project definition will often involve the formation of new teams, or new tasks being taken on by an existing or growing team; the composition of teams should ensure that there is sufficient competence to undertake the tasks involved in developing the project. Employers have a duty under the MHSWR to ensure that they have access to competent advice on health and safety matters; such advice will be particularly important when undertaking new activities, and may be provided by a combination of internal and external expertise.

Ensuring full conformity with applicable standards and regulations, from the definition and specification activities onwards, will help to ensure that the designs and approaches adopted later in the project satisfy legal duties.
Project definition should also make use of learning from incidents that have occurred in the renewable energy industry and other relevant sectors, in order to ensure that the potential for similar incidents to occur in future is reduced. This sharing of learning can help to reinforce the safe development of the industry as a whole, and minimise the risk to people.

**B.1.4.1 PROJECT INFORMATION MANAGEMENT**

The key deliverable from the definition phase is information, in a variety of forms, that will be used in consenting, for subsequent phases of the project, or even transferred to another entity if the project is sold on at a later stage. Effective systems for managing this information are vital to the safe and efficient development of the project:

- The definition phase is likely to involve significant work being undertaken by subcontracted consultants and designers, who will need to be working from a common project dataset that is kept up to date as the design is developed;
  - The project data should be in a form that allows it to be used effectively in subsequent phases;
- Risk assessment should be viewed as a process that operates over the project lifecycle, with information from one stage of risk assessment informing the next; for example, a risk assessment that compares different access routes will inform consultations with local communities, but will be no more than an initial input to the risk assessment of detailed transportation plans; and
- The interfaces between organisations and work packages must be clearly defined and actively managed.

Efficient processes for maintaining project registers of risks, interfaces and decisions will assist the smooth running of the project, as well as helping to demonstrate that legal duties to minimise risk are being fulfilled.

**B.1.4.2 APPOINTMENTS AND DUTIES UNDER CDM**

Project definition involves taking some fundamental design decisions, and is therefore a phase in which the Client will often be a Designer under CDM, and must be able to fulfil their duties in this respect. For a notifiable project, the CDM regulations require the Client to:

- Appoint a suitable CDM Co-ordinator as soon as practicable after initial design work has begun;
- Provide Pre-Construction Information to Contractors and Designers who may be appointed to the project; this gives potential appointees the project-specific health and safety information that they will need in order to assess their own competence, and identify hazards and risks related to the proposed design and construction work; and
- Appoint a Principal Contractor (PC) before any construction work takes place; note that this includes site investigation work or meteorological mast erection (although not survey work, as this is non-intrusive). The PC who is appointed in relation to these early site activities will not necessarily be the PC in later phases of the project; until a PC is appointed, their duties default to the Client.

The requirements for Pre-Construction Information are described in detail in Appendix 2 of the CDM ACOP, with the key principle being the provision of "the right information for the right people at the right time"; an information package that is overloaded with generic information, and which does not make the key project-specific information sufficiently clear, is little better than an information package that omits key information.

Appointments should follow from a robust process of assessing the competence of potential contractors, in accordance with the guidance given in Appendices 4,5 of the CDM ACOP.

CDM imposes a legal duty on the Client to ensure sufficient time and resources for all stages of a project; this is also consistent with good project management practice. In the early stages of a project, business pressures can conflict with this, for example:

- Financial constraints before the project is consented can encourage resource levels to be constrained, for example by minimising survey work or giving undue weighting to price when selecting contractors;
• If early work packages overrun, it can be tempting to compress the schedule for later tasks in order to maintain target dates, but this should only be done if such acceleration is based on genuine changes in approach, or evidence that less time will be required, rather than on optimistic scheduling; and

• Capital or revenue support schemes for renewable energy generation may have fixed qualifying dates, which if not met, could jeopardise the economics of the development.

Making sufficient investment in the early stages of a project minimises the risk of changes being required at later stages, which would be likely to lead to far greater costs and delays.

B.1.4.3 Contracting Strategy

The contracting strategy to be used for subsequent phases of the development will usually be defined during this phase. A variety of approaches exists, with the selection being influenced by characteristics of the developer and potential contractors, such as:

• Their capabilities to undertake the range of activities involved in the scope of the project, considering areas such as design, project management, procurement, installation and commissioning;

• Their appetites for exposure to, and capacities to absorb, financial risk;

• The level of involvement that they wish to have in later stages, such as the provision of O&M services; and

• Whether they are seeking to establish a strategic partnership to undertake a series of developments, or are approaching the development as a one-off contract;

In broad terms, the commonest contracting strategies include:

• Multi-contract, where the client manages the project and its interfaces, and employs contractors to undertake individual work packages against detailed designs and specifications that combine to deliver the project:
  o The Client will be fulfilling the roles of a Designer and PC under CDM, may also provide the CDM Co-ordinator, and may even be a Contractor for certain activities;
  o This needs a high level of client competence, and requires the client to carry greater financial risk, but can offer the greatest flexibility on projects where high levels of novelty mean that a degree of development work is being undertaken as part of the project implementation, such as the erection of a prototype;

• Engineering, Procurement and Construction (EPC) contracting, which is the opposite extreme, where a single contracting entity (which may be a joint venture, possibly established specifically for a particular project) delivers a “turnkey” project to the client:
  o The client needs to provide a clear specification of what they want; the EPC contractor then has a high degree of autonomy as to the detailed design and delivery of the specified works;
  o The EPC contractor will generally be appointed as PC and Designer, and will appoint Contractors;
  o This approach minimises the Client’s involvement in the management of the project, and therefore minimises their need for such competencies;
  o The contractor carries greater financial risk for the project, and therefore needs to have the financial strength to cover this, and will include a risk premium in their contract price;
  o The scope of the EPC contractor’s work may be further increased by contracting for the provision of O&M services for a certain time period after commissioning;
• EPCM (Engineering, Procurement and Construction Management), which can be seen as a hybrid approach, where:
  o A Construction Management (CM) contractor manages the project on behalf of the client, and may also be the PC and lead Designer, thereby providing the competence or capacity that the client may not have available;
    ▪ The CM contractor will therefore be responsible for the preparation of the Construction Phase Plan and managing safety on site;
  o The client contracts with the individual contractors, and carries the financial risk for the execution of the project as a whole; note that in the event of problems, the pursuit of claims can become very complex.

The decisions made in this phase, in relation to contracting strategy, will therefore determine the responsibilities, resource levels and competence requirements for both the Client and contractors in subsequent project phases.

Contracts must make adequate provision for weather delay, and any contracting strategy should ensure that it incentivises the delivery of the client’s most important outcomes, in terms of safety, quality and balance of initial / whole lifecycle cost.

B.1.5 PROJECT DEFINITION PHASE DELIVERABLES

The key deliverables from the project definition phase can be summarised as:

• Design-related aspects:
  o Sufficient site information to enable design and on-site activities to proceed in subsequent phases;
  o Evaluation of a range of concepts for the project, including its location, scale, layout, candidate WTGs, O&M and transport requirements;
  o Understanding of the wind resource;
  o Availability of, and connection to, supporting infrastructure such as the grid and roads;
  o Understanding of site constraints, such as access or environmental restrictions; and
  o Selection criteria for the WTGs and balance of plant;

• Project management and related aspects:
  o Established information and risk management processes;
  o Initial appointments of CDM Co-ordinator, Principal Contractor and Designer(s);
  o Definition of contracting strategies for construction and subsequent phases, and preparation for contractor selection, including provision of Pre-Construction Information;
  o Completion of Environmental Impact Assessment, and obtaining consent for the development to proceed within an agreed envelope, which will determine the constraints on subsequent design activities; and
  o Preparation of Pre-Construction information that will be provided to potential contractors, to be used in tendering, competence assessment and as a starting point for development of methods and safety management arrangements.

These combine to define both the project that is to be developed, and the approach that will be taken to achieving this.
B.1.6 **LEGISLATION, STANDARDS AND GUIDANCE**

BS EN 61400-1:2005: *Wind turbines – Design requirements* specifies design requirements applicable to all WTGs.

**IEA Wind Recommended Practice 13: Wind Energy in Cold Climates:** Chapter 8 addresses ice throw.

Further details and links to relevant regulatory guidance are given in the following sections of this guidance:

- Construction (Design and Management) Regulations 2007 (CDM)
- Electricity Safety, Quality and Continuity Regulations (ESQCR) 2002
- Leadership & Safety Culture
- Management Systems
- Risk Management
- Supply Chain Management
- Access and Egress

Information on geological and mining hazards can be obtained from:

**British Geological Survey Geosure data on geological hazards**

**Coal Authority**
B.2 PROJECT DESIGN

This phase takes the deliverables from the Project Definition phase, and works within the consented project envelope to produce a finalised design for the project, and a detailed plan for its implementation, addressing health and safety, technical and organisational aspects. A key milestone within this phase is Financial Close, which enables the signing of contracts, thereby releasing the necessary funding so that detailed project-specific work can be undertaken, and reservations made for the use of production facilities and installation resources. Major activities include:

- Selection of:
  - WTG;
  - BoP;
  - Maintenance strategies;
- Front End Engineering Design (FEED), followed by detailed design of project-specific structures and components, taking account of:
  - Site conditions;
  - Constructability;
  - Maintenance requirements;
- Selection of contractors within the defined contracting strategy;
- Preparation of the Construction Phase Plan;
- Preparation of detailed plans for construction, commissioning and handover to operations;
- Reviewing WTG certification status;
- Preparation of Emergency Response Plan for the construction phase; and
- Consideration of decommissioning activities, such as WTG and BoP removal and disposal, and site restoration, and how these can be affected by design and material specification decisions.

Many of these activities will span Financial Close, with a step change in the level of detail and extent of preparation after this point.

Fundamentally, this phase delivers a package that defines exactly what is to be constructed and maintained, how this is to be done, and by whom.

B.2.1 RELEVANCE AND IMPACT ON SUBSEQUENT PHASES OF LIFECYCLE

During this phase, the detailed design of the project will largely be completed and frozen, so the residual risk after this phase will affect all future operations. As well as addressing technical risks, this phase integrates the different parties into the project team, so effective management of organisational and interface risks is important.

The decisions made in this phase will determine:

- The tasks that will be required in installation, commissioning, O&M and decommissioning;
- Who will carry out these activities;
- The resources available;
- The safety management arrangements during construction; and hence
- The level of risk presented by these activities.
B.2.2 KEY HEALTH AND SAFETY RISKS TO BE CONSIDERED

B.2.2.1 SITE-SPECIFIC DESIGN AND SPECIFICATION

The selection process needs to consider the health and safety risks that different candidate designs of WTG may present.

The site design and layout will also affect the risks involved in constructing the site infrastructure, and in its long-term use.

Effective management of design interfaces is important, including ensuring that all necessary information is provided at the right stage, and that designers have sufficient understanding of industry-specific technical challenges, such as the transfer of dynamic loads between WTGs and their foundations.

B.2.2.2 DESIGN AND STRATEGY FOR MAINTENANCE

Decisions taken in this phase will determine the level of risk to which people are exposed during O&M activities. Where possible, hazards should be eliminated at the design stage; not only does this reduce risk to people, but it will often enable more efficient working, reducing downtime and maintenance costs. A good design also reduces the probability of errors occurring during maintenance, again protecting both people and equipment. Specific areas to consider include:

- Maintenance requirements, and the degree to which WTGs and BoP are designed for safe maintenance, such as:
  - The provision of suitable lifting equipment for foreseeable tasks;
  - Good access to components; and
  - Minimising the need to work at height without collective protection to undertake foreseeable tasks.

- Design for safety during maintenance, including consideration of isolation strategies, the status of control, communications and protective systems, and provision of essential services during maintenance activities; and

- Condition Monitoring and Predictive Maintenance systems may be used to minimise on-site interventions, and allow optimal use of planned downtime, to minimise the pressure that unplanned downtime can impose.

Addressing these areas not only minimises health and safety risks, but also reduces financial risk from lost production.

The long-term maintenance strategy should also be considered; for example, if it is the intention that the owner's personnel should assume responsibility for maintenance after the warranty period, then contracts should include requirements for training of such personnel while the WTG manufacturer is undertaking maintenance during the warranty period.

B.2.2.3 INSTALLATION STRATEGY

Given that WTG installation involves work at height, the installation sequence should seek to minimise the associated risk, for example by ensuring that:

- Work equipment that enables safe work at height, such as safe working platforms, anchor points and fall arrest systems, is available for use as soon as possible after erection;
  - This could include carrying out inspections at ground level, prior to WTG erection, which may both be safer and quicker than carrying out the same inspections after erection;

- Personnel lifts inside towers are put into service at the earliest opportunity, to minimise ladder climbing; and

- Rescue kits are always readily available when people are working at height, noting that the nacelle rescue kit will not be present until the nacelle has been assembled onto the completed tower.
Other safety equipment, such as fire extinguishers, should also be available from the earliest possible stage of assembly. In any cases where permanent safety equipment cannot be used in a given stage of assembly, suitable temporary alternatives should be put in place.

**B.2.2.4 COMMISSIONING STRATEGY**

Increasing the extent of commissioning work that is carried out before delivery can reduce the need for later site work, and particularly work at height, thereby reducing risk exposure for people. The ability to achieve this depends on both the WTG design and the provision of suitable testing facilities; if individual WTGs have completed a full range of functional tests prior to installation, then this should minimise faults and spurious trips in sensors and control systems, and give the assurance that the WTGs were fully functional. If problems are subsequently experienced after installation, the potential causes would be more limited, which should reduce the potential scope of work to resolve the problems. While carrying out full-load testing of mechanical and electrical systems increases time and cost during manufacture, it can pay back by allowing more repeatable testing and analysis, enabling swifter rectification of any problems, avoiding the secondary damage that could result from defects, and reducing the potential for delays in commissioning.

Design of substations and site cabling should also consider the potential for a phased handover from construction to operation, and provide the necessary segregation of systems if this approach is to be adopted. Construction contracts and project interface management arrangements should ensure that the approach to be taken, and the responsibilities of the different parties involved at the handover from construction to commissioning and operation, are clearly defined from the start.

**B.2.2.5 CONTRACTOR SELECTION**

All appointments need to be made on the basis of an assessment of competence, as outlined in the CDM ACOP, Regulation 4, Competence and Training, which states that:

“Assessments should focus on the needs of the particular project and be proportionate to the risks, size and complexity of the work.”

The duty to assess competence applies to any party who engages another party to undertake work; it is not restricted to the Client or Principal Contractor, and applies to every level of subcontracting in the supply chain. Effective competence assessment requires sufficient understanding of the work that is being contracted, and of any evidence of competence that is to be evaluated; depending on the employer’s areas of competence and experience, it may be necessary to obtain support from competent advisers when assessing potential contractors for specialised and high risk areas of work.

**B.2.3 HEALTH AND SAFETY CRITICAL INTERFACES AND COMMUNICATIONS**

The interfaces can be considered in terms of inputs and outputs to / from the phase, together with the interfaces that will be present amongst the activities within the phase:

- Inputs from the Project Definition phase:
  - Information on the site conditions: normal operation, maintenance; survival;

- Design Phase Activities:
  - Building the project team, consisting of the developer, contractors (who may include designers and consultants) and suppliers;
  - Financial close, which enables signing of contracts, and increased commitment of resources thereafter;
  - Integration of site characteristics, design, and external stakeholder / regulatory requirements for consenting;
  - Integration of design packages, such as the WTG and BoP, enabling the preparation of detailed plans for construction;
  - Integration of health and safety management systems from different participants, to give a consistent approach and clear responsibilities in both planned and emergency situations;
Risk assessments should be conducted in increasing detail as the project design is developed, with particular attention being given to interfaces between work packages;

- **Design Phase Outputs:**
  
  - The detailed design of the wind farm is fit for purpose and in accordance with applicable standards, regulations and conditions relating to the consent for the development;
  
  - A realistic programme for the development, with appropriate resources, agreed responsibilities and clear interfaces;
  
  - Future lifecycle requirements have been considered in the project design; and
  
  - An initial decommissioning and site restoration plan has been agreed with the planning authorities.

### B.2.4 Management and Operational Controls

Established design codes should be used where applicable; novel designs may require more individual modelling and analysis. This may apply both to physical equipment and operating systems.

Interface management is essential to the safe and efficient management of complex projects; research carried out for the HSE highlighted effective communication and interface management as being vital in minimising the risk of catastrophic events occurring in construction projects. Various tools exist, such as Responsibility Charting, which builds a matrix showing the actions that different parties are Responsible for, Accountable for, Consulted on, or Informed of. Such an approach should also take account of external stakeholders, should be in place prior to tendering, and thereafter be managed actively over the project lifecycle.

#### B.2.4.1 Construction Phase Plan

Where projects are managed under CDM, the Principal Contractor is responsible for preparation of the Construction Phase Plan (CPP) which will:

- Define how the construction phase will be managed, and the key health and safety issues for the particular project;

- Set out the organisation and arrangements that have been put in place to manage risk and co-ordinate the work on site, but should not contain detailed generic risk assessments, records of how decisions were reached, or detailed method statements;

- Define the emergency response arrangements, including the responsibilities of the Client, Principal Contractor and Contractors; and

- Specify requirements for the preparation of method statements.

Above all, the CPP should be well-focused, clear and easy for contractors and others to understand – emphasising key points and avoiding irrelevant material.

The CPP should also identify where project activities, that are not actually construction work, occur, and ensure that interfaces with such overlapping activities are addressed. For example, wildlife survey and monitoring work may have started well in advance of construction, continue while construction is in progress, and extend into the operational phase; while construction is in progress, this work would have to interface with the safety management arrangements defined in the CPP, but would still not become part of the construction work.

Sufficient time and resources need to be committed to preparation of the CPP, in the period between contractor appointment and the start of construction.

As the CPP defines the overall safety management arrangements for the site, Contractors working on the project will generally be required to integrate their safety management systems with those defined in the CPP, with bridging documents being used to manage these interfaces. There may also be interfaces between projects; for example, construction of the grid connection might be managed as a separate project from the on-site works.
**B.2.4.2 Pre-Construction Planning**

While the CPP defines the safety management issues and arrangements for the construction phase, it does not define how the actual construction work is to be carried out; this should be described in a detailed project plan.

Construction of a wind farm is a complex process, that in addition to the on-site construction and commissioning activities, relies on the supply chain and logistics functions to deliver components. Progress of installation activities will be affected by weather, as well as other potential factors such as ground conditions and equipment performance, so the project construction plan should be reviewed to determine sensitivity to such events, and appropriate contingency measures identified in advance, so that these can be thoroughly assessed prior to being needed.

The high level project construction plan will be supported by more detailed plans for specific activities, and ultimately by method statements for particular tasks. The PC is likely to be the owner of the project construction plan, with Contractors managing their work packages in detail, and ensuring that their work interfaces with the overall plan.

**B.2.5 Legislation, Standards and Guidance**

HSE Research Report RR834 - Preventing catastrophic events in Construction addresses the causes of low probability, high severity events in construction, and provides guidance on approaches that can be taken to avoid such events.

Further details and links to relevant regulatory guidance are given in the following sections of this guidance:

- Construction (Design and Management) Regulations 2007 (CDM)
- Interfaces with Electricity Distribution and Transmission Systems
- Risk Management
- Supply Chain Management
- WTG Certification, Safety and Product Standards
- Safe Systems of Work
- Emergency Response & Preparedness
- Access and Egress
- Asset Integrity
- Aviation
- Fire
- Lifting
B.3 CONSTRUCTION & COMMISSIONING

The start of the construction phase represents a step change in the level of activity and risk exposure; the effectiveness of the preparations undertaken in the earlier phases of the project will be revealed.

The construction phase typically involves:

- Construction of:
  - Site infrastructure, including access and internal roads, and buildings;
  - WTG foundations;
  - Any necessary improvements to highways on the transport route to site;

- Logistical operations relating to the equipment to be installed, including:
  - Receipt from manufacturing locations or ports;
  - Transport to construction site;

- Installation activities, including:
  - WTG installation;
  - Substation and site network / grid connection cables; and
  - Electrical Balance of Plant, such as cabling and substations;

- Initial inspections of safety equipment, after it has been installed, and before being put into use for other activities later in the construction or subsequent phases.

Many of these activities involve transport and lifting of heavy, awkward and relatively fragile loads, and the use of construction plant, in a challenging environment, and often in close proximity to people; any error or failure could put people at risk.

During commissioning, checks are carried out to confirm correct assembly and installation, after which systems can be powered up, and operation can commence. The nature of the commissioning activities will vary, depending on the WTGs and other equipment being commissioned; a prototype or early production model is likely to be subject to an extended programme of testing to confirm that it is functioning as intended, whereas series-manufactured equipment would undergo a standard programme of checks before commencing normal operation, albeit with greater monitoring during initial operation than might be undertaken once performance has been demonstrated.

While it is usually intended that commissioning will follow almost immediately after construction, this may not always occur, particularly if cabling or grid connection works are not completed in time for the WTGs to commence operation. In the event of such delays, it may be necessary to implement measures to maintain the condition of the WTGs, possibly including the provision of temporary power supplies, usually by means of portable generators, in which case, the health, safety and environmental risks of this approach will have to be managed effectively.

B.3.1 RELEVANCE AND IMPACT ON SUBSEQUENT PHASES OF LIFECYCLE

As the wind farm is actually built during the construction phase, the combination of the quality of the equipment installed, and the work undertaken on site, will affect the rest of the life of the asset.

Commissioning is a key stage, as it prepares the wind farm for operation; thorough checking of mechanical and electrical completion, SCADA configuration and the operation of safety-related systems will minimise the risk to people in subsequent activities.

The handover of accurate as-built information from construction and commissioning to operations and maintenance is also vital to enabling safe and effective working in subsequent phases.
B.3.2 **KEY HEALTH AND SAFETY RISKS TO BE CONSIDERED**

The construction and commissioning phase can involve all of the activities and hazards addressed in Part C of this guidance; in broad terms, the phase involves:

- Large numbers of people working on site on a diverse range of tasks;
- Numerous lifting operations, ranging from very heavy and awkward loads such as nacelles and rotors, to routine lifts of tools and consumables, any of which could put people at risk if not carried out safely;
- Intensive operation of a wide range of heavy plant;
- Executing weather-sensitive tasks within the available weather windows;
- Potential for interaction between tasks and with other land users;
- Commissioning of all parts of the wind farm, which includes initial energisation of electrical systems, and start-up of mechanical systems; and
- Managing interfaces with parts of the wind farm that have been handed over to operation;

The risk from these hazards can be increased by the financial pressure that delays in construction and start of generation may create, and the need to achieve a pre-determined schedule.

B.3.3 **HEALTH AND SAFETY CRITICAL INTERFACES AND COMMUNICATIONS**

**Inputs from earlier phases:**

- Construction Phase Plan, which defines the safety management arrangements;
- Detailed project design and execution plans;
- Project team, with competent contractors and personnel appointed in all necessary roles; and
- Site information to enable activities to be planned in a manner that is suitable for the location.

**Construction and commissioning phase activities:**

- Establishment of temporary site facilities and management arrangements;
- Co-ordination and management of numerous simultaneous and interdependent operations, carried out by a workforce distributed across the site, including both permanent and temporary works;
- Preparation, review and revision of task-specific risk assessments and method statements;
- Emergency preparedness – interfaces within project team, and with external emergency services;
- Multi-contractor operations – clear project team structure, under the control of the PC;
- Use of heavy construction plant and cranes;
- Safety-related work equipment items, such as those for lifting and work at height, need to be fully tested and commissioned prior to use, so initial inspections will be required during the construction phase;
  - Risk exposure from work at height can be reduced by inspecting items such as nacelle roof anchor points prior to WTG erection;
  - If it is necessary to use equipment such as temporary fall arrest systems on ladders, these should conform to the relevant standards, and be installed and inspected by competent persons;
• If the ergonomics of use of such systems are inferior to the permanent system, then the aim should be commission the permanent system at the earliest opportunity;

• Managing the safety of interfaces between construction, commissioning and normal operation of WTGs and BoP; and

• Maintaining project information, for example recording the as-built details of roadways and cable routes, and the progress of assembly and commissioning checks to ensure that essential checks are all completed as and when required, and that any necessary follow-up or snagging actions are tracked.

Phase outputs:

• The physical output of this phase is a fully operational wind farm, with any temporary limitations due to outstanding snagging actions being formally communicated as operational restrictions;
  o In many cases, there will be a phased handover, with some areas of the wind farm being complete while others are still under construction;
  o Handovers must be carefully controlled, to ensure that safety management responsibilities and safe systems of work are always clear;

• The phase also provides information to the O&M phase:
  o The extent, format and location of information should be agreed between the Client, PC and equipment suppliers;
  o Ensuring that this information is accurate and accessible will help O&M activities to be established safely; it is not simply a matter of handing over the completed project health and safety file.

B.3.3.1 SAFETY DURING PHASED HANOVERS

Given that a typical wind farm comprises multiple WTGs, and one or more substations, construction is likely to involve an extended time period, during which the installation of WTGs and Balance of Plant is completed in sequence. This will generally be followed by commissioning and then handover to operation, with the result that the wind farm may simultaneously include incomplete WTGs, others undergoing commissioning, and others that are capable of normal operation. There are clear technical and economic benefits from bringing WTGs into normal operation at the earliest opportunity; however in order for it to be safe to have WTGs in these different states at the same time, it is necessary to implement measures such as:

• Designing the cabling, control and isolation systems so that construction, commissioning and operation can proceed safely in parallel in different areas of the wind farm;
  o The construction project plan will then have to match the way in which the design segregates the different areas;

• Maintaining clear boundaries between areas that are construction sites, and those where commissioning and operation are in progress;
  o Even if areas of the site are segregated in this way, there are likely to be some common access routes and facilities, such as substations and SCADA systems;

• Having a clear management structure that can maintain control of the different activities involved in a phased handover, taking account of;
  o Physical interfaces, such as:
    ▪ Grid connection to site substation;
    ▪ Site HV network; and
    ▪ Individual (or groups of) WTGs;
  o Activity interfaces:
    ▪ Construction;
• Commissioning; and
• Operation.
  o Different sets of safety rules being in simultaneous use according to the type of activity, such as
    • Construction Permit to Work (PTW);
    • Wind Turbine Safety Rules (WTSR); and
    • High Voltage Safety Rules (HVSR)),

There is no single “correct” approach to managing the interface between the different sets of safety rules; various options include:

• The Principal Contractor remains in control of the site, with any activities relating to operational WTGs being managed as Contractor work, within the safe systems of work established by the PC.
  o Once all construction activities on the site are complete, the entire site would then transfer to the operator, and the PC would cease to be involved – indeed, the situation could effectively reverse, if the PC or Contractor personnel had to return to site for any “snagging” activities, then these would be managed under the operator’s safe systems of work;

• Moving a boundary, so that some areas of the site are handed over from the PC to the operator;

• A change of PC between the construction and commissioning phases;

• Appointing the WTG supplier or installation contractor as PC for the whole of the construction and commissioning phase.

Decisions about the approach to take will depend on factors such as:

• The size and complexity of the site;

• The competence and willingness of different contractors to fulfil the PC role, and to manage and work within different sets of safety rules.

Whichever approach is taken, it must always be clear as to who is in charge of a location or activity, and which safety rules apply. The potential complexity is illustrated in Figure 5 below. The challenges of handover should be considered at the time of contractor selection, to ensure that an approach is agreed in advance, and that the necessary competence is available to implement the solution.
Figure 5: Example of Construction & Commissioning Phase Activity Profile

Note that this is only an illustration, and each project will have its own profile; the key point is to recognise the complexity and potential span of responsibility for a PC. In the early stages, if the PC is the main civil contractor, the majority of work will be within their scope and core competence, however, later in the construction phase, the civil contractor may still have the responsibility as PC, but the majority of work will be outside their scope, and other work may be taking place on the wind farm, but outside their control.

### B.3.4 MANAGEMENT AND OPERATIONAL CONTROLS

#### B.3.4.1 CONSTRUCTION

The safety of construction activities should be assured by operating in accordance with the safe systems of work defined in the Construction Phase Plan (CPP), prepared by the PC before commencement of construction activities, and updated as required during the construction phase. The PC has specific responsibilities during the construction phase, including:

- Managing and monitoring construction activities;
- Informing contractors of requirements under the CPP;
- Checking competence of appointees; and
- Provision of welfare facilities, site inductions and security.

Contractors working on the project are required to integrate their safety management systems with those defined in the CPP, to ensure that a common approach is adopted for all activities on the site. Auditing should be undertaken while work is in progress, both to monitor compliance with the CPP, and the sufficiency of the measures defined in it.

Individual tasks will be subject to Risk Assessments and Method Statements (RAMS), the preparation of which is likely to involve the PC together with the contractors involved in the task, and key equipment suppliers such as WTG manufacturers, particularly where installation operations can affect warranties. RAMS need to cover the entire operation, from transport from ports or manufacturing sites to completion of installation and handover of information to the next
stage of work, with the level of effort in their preparation being proportional to the level of risk in the activities to which they relate.

In addition to the work within the wind farm, construction of the grid connection may either be undertaken as contractor work within the wind farm project organisation, or as a separate project, with a different Client and PC; in such a situation the two PCs will have to co-ordinate the interfaces, such as where cables cross the site, entry into site compounds and buildings, and any shared access routes.

B.3.4.2 COMMISSIONING AND HANDBOVER TO OPERATION

The extent of on-site commissioning requirements will be influenced by decisions made during design and procurement; the scope and thoroughness of factory acceptance testing may affect the scope of on-site commissioning work, although some on-site work will always be necessary.

The quality of work completed during design, manufacture and installation will determine the level of follow-up “snagging" work that is required during or after commissioning; in critical areas, this may delay handover to operation. Where a phased approach is being taken to construction and commissioning, effective feedback of issues experienced during commissioning of the earliest WTGs to be handed over, can allow these to be addressed in subsequent areas, thereby reducing the need for rework at a later stage.

Commissioning of any given system is generally carried out in stages, with clear testing and acceptance criteria to be fulfilled and recorded, and precautions to be put in place, prior to moving on to the next stage. Typical stages include static / unpowered checks, then initial energisation and functional checks, followed by initial operation; thorough static and functional checks are vital to ensuring that equipment is safe to energise and operate. Initial energisation of some systems may make use of temporary power supplies; their use should be carefully controlled, to ensure that systems are only energised when it is safe to do so, in terms of their level of completeness, outcomes of testing, and other work taking place.

The formal commissioning and acceptance process should not be limited to WTGs and electrical infrastructure, but should also ensure that site infrastructure such as roads and drains, ancillary buildings and amenity facilities have been constructed in accordance with the specification, and that all necessary checks have been carried out.

Where defects are identified during commissioning, decisions need to be made as to whether these defects:

- Prevent operation of the equipment, due to unacceptable risk to people, or the risk of equipment damage;
- Allow operation of the equipment, but with an operational restriction in place to mitigate the risk that a defect introduces; or
- Allow operation of the equipment, without restriction, but with snagging actions to be completed at a suitable opportunity.

The effective management of these handover conditions is critical to enabling safe operation in subsequent phases; the use of operational restrictions requires particular care, as this introduces a temporary procedural measure to compensate for a shortcoming in equipment, at the same time as handing management control from one organisation to another.

On completion of commissioning, any temporary measures, such as temporary power supplies, control system parameters or trip / override settings that were used to enable commissioning, must be safely removed or reset so that the equipment will operate normally when handed over to operations.

The Project Health and Safety File should be updated to reflect the as-built asset, and handed over to the Client; for the file to be of value, its content and format should be agreed in advance with those who will be involved in operating the asset, so that the relevant information will be available to them.

B.3.4.3 QUALITY ASSURANCE

The quality of work undertaken during this phase, together with the suitability of the WTG and BoP designs for the site conditions, and the quality of manufacture the equipment, combine to determine the future reliability and maintenance needs of the wind farm.
Attention to detail during construction and commissioning is vital, for example, even minor paint damage on the exterior of a tower section can lead to corrosion that will subsequently need rectification involving work at height, and it is seldom possible to achieve the same quality in a field repair as during original application in a controlled environment.

B.3.5  LEGISLATION, STANDARDS AND GUIDANCE

Further details and links to relevant regulatory guidance are given in the following sections of this guidance:

Construction (Design and Management) Regulations 2007 (CDM)
Interfaces with Electricity Distribution and Transmission Systems
Leadership & Safety Culture
Management Systems
Workforce Engagement
Occupational Health and Medical Fitness to Work
WTG Certification, Safety and Product Standards
Emergency Response & Preparedness
Access and Egress
Confined Spaces
Ergonomics
Construction
Lifting
Noise
Vibration
Welfare
Work at Height
B.4 OPERATIONS & MAINTENANCE

The O&M phase will have the longest duration of any phase of the wind farm lifecycle. The O&M activities can relate to the WTGs, electrical and civil Balance of Plant, and work equipment. In all areas, the overriding aim should be to ensure that deterioration of assets does not jeopardise their continued availability and safe operation. An optimised maintenance strategy achieves these aims, while avoiding unnecessary interventions; not only do these expose people to health and safety risks, but they also have the potential to introduce faults to equipment that was previously operating reliably.

A variety of maintenance philosophies can be applied to different elements of a wind farm, including reactive, condition-based and scheduled maintenance; the most appropriate strategy is likely to involve a combination of these different approaches. The approach may also change over the operating lifetime of the wind farm, with the WTG manufacturers leading maintenance while the WTGs are under warranty, then the operator or another contractor taking over after the warranty period has expired.

The O&M phase activities can occur both on site and remotely:

- Remote monitoring techniques can be used to monitor WTG performance and component condition, as well as weather conditions, in order to support the planning of safe and efficient on-site work;
- Certain items of equipment are subject to time-based inspection schedules; these include:
  - Lifting equipment and lifts;
  - Pressure systems;
  - Equipment for work at height, such as fall arrest systems and anchor points;
  - Fire detection and suppression systems; and
  - Emergency equipment, such as:
    - Rescue and evacuation equipment;
    - Fire detection and suppression;
    - Emergency lighting; and
    - First aid equipment;
- Asset integrity needs to be assured, especially in areas of the structure where a failure could result in a hazardous situation occurring; this may include major structural elements such as blade root connections, as well as secondary elements that support ladders, anchor points and lifting equipment;
- Some maintenance work may be planned as seasonal campaigns, which aim to make the best use of expected lower wind speeds in summer; such an approach may be preferred where major maintenance tasks, such as rectification of serial defects, have to be undertaken on a large number of WTGs;
  - Such campaigns may need a different management approach, more akin to the management of a construction project than routine daily activities;

A challenge for WTG maintenance is the fact that as its energy source is the wind, it may not be possible to undertake a full load test run immediately after completing maintenance activities; achieving high rates of successful repairs in a single visit depends on having sufficiently clear understanding of faults on the basis of remote monitoring data, combined with good diagnostic work by technicians, to be certain that the fault will not recur once the WTG is back in full operation.

The maintenance activities will be supported by operations management functions, including the provision of safe systems of work, planning of work, co-ordination of different contractors, and recording the outcomes of inspections and maintenance work.
B.4.1 **Key Health and Safety Risks to be Considered**

During maintenance activities, people will be working in areas of the wind farm that are normally unattended, in particular inside WTGs. In general, this will only occur with the WTG having been handed over to the local control of the technician, and then isolated from sources of energy in accordance with the safe system of work that is being operated at the location. Even after the application of these measures, residual risks may remain, such as:

- Certain tasks may require isolations to be in place, that disable essential services such as internal lighting, lifts and communications;
- Maintenance activities often involve transitions between equipment states, such as release of rotor lock or restoration of motive power:
  - It is important to ensure that the equipment will behave in a predictable manner during such transitions;
  - The risk assessment should also consider whether safety relies on people not making mistakes, or if there are additional safeguards, for example, to ensure that WTG blades are pitched to stall before releasing the rotor brake to rotate the hub, in order to ensure that an uncontrolled overspeed cannot be initiated;
- Even with good remote diagnostic systems, there will be occasions where, after starting work on the WTG, it becomes clear that different or additional work has to be undertaken. The safe systems of work need to be capable of managing such situations without undue delay, and without compromising the safety of the technicians involved.

Work inside WTGs also presents a range of ergonomic and welfare risks, such as:

- Tasks may involve awkward working positions or work at height, and while the frequency of the task may be low on any given WTG, technicians are likely to undertake similar tasks on many WTGs, giving repeated exposure; and
- While technicians may only spend a few days each year on some sites, they will spend the majority of their working time on sites, so need to have access to appropriate welfare facilities.

Certain tasks may involve additional hazards such as work at height or in confined spaces, requiring specific safeguards to be in place.

Maintenance of site infrastructure, such as roads, drainage and culverts can involve several high risk activities, including the use of construction plant, excavation and working of borrow pits. Keeping the site infrastructure in good condition also supports the safe execution of all other work on the site.

**B.4.2 Health and Safety Critical Interfaces & Communications**

Inputs from earlier phases:

- The design of equipment will determine the scope, ease and safety of subsequent maintenance activities;
- The specification, design and initial quality of construction of site infrastructure will determine its suitability for foreseeable use over the lifetime of the wind farm, and affect the extent of maintenance that will be necessary;
- The effectiveness of monitoring and diagnostic systems will determine the ability to identify problems before downtime occurs, and to diagnose the cause of downtime, thereby enabling the most efficient use of working time, and minimising the pressure that unplanned downtime imposes on maintenance teams; and
- The reliability and coverage of communication systems (within and beyond the site) will affect the safety and efficiency of working on the site.
O&M phase activities:

- Maintenance activities range from routine minor inspections to periodic major maintenance campaigns, covering the WTGs, electrical balance of plant, and site infrastructure, with each category requiring appropriate management approaches;

- Various parties may be directly involved in maintenance activities, such as the operator, WTG manufacturer, electrical balance of plant specialists, civil contractors, third party inspectors and specialists;
  - Some of these personnel may work regularly on a particular wind farm, while others may only visit occasionally;

- Other parties will perform essential supporting roles, such as Operational Control;

- Where a change of responsibility occurs, such as a change of maintenance contractor, it is important that suitable handover arrangements are implemented;
  - Where such handovers are envisaged, this should be reflected in the requirements of contracts, for example by including provisions for training of the owner’s maintenance personnel by the WTG manufacturer; and
  - The condition of the assets at the expiry of warranty periods should be clearly defined in contracts, together with agreed processes for inspection and remedial work.

Outputs:

- As the end of the useful life of equipment is approached, the maintenance effort is likely to be reduced, however sufficient attention should still be given to ensure that the wind farm remains safe to decommission;
  - The integrity of areas such as secondary steelwork, access structures, ladders and anchor points for work at height will be particularly important;
  - Safety-critical systems such as overspeed protection, pitch control and brakes must remain functional until the WTG is finally shut down; and
  - Site infrastructure such as roads and crane pads will be subject to intensive use during decommissioning.

B.4.3 MANAGEMENT AND OPERATIONAL CONTROLS

O&M activities need to take place within a safety management system that covers all necessary areas of work. These include:

- Establishing and operating safe systems of work, which will typically include the Wind Turbine Safety Rules, High Voltage Safety Rules or other appropriate permit to work systems, according to the activities that they cover;
  - Such systems are operated by competent personnel fulfilling defined roles, such as the Operational Controller;
  - The systems need to be able to manage non-standard situations, such as temporary operational restrictions that may affect the safety or performance of equipment;

- Ensuring that all personnel involved have the necessary training, competence and supervision to fulfil their roles and enable safe working;
  - The long-term nature of O&M activities is such that, in addition to ensuring initial competence, measures should be in place to maintain and further develop workforce competence; these will include arrangements for developing the competence of new employees;
    - This should be complemented by effective processes for inducting visitors or temporary personnel, and providing appropriate supervision;
  - Development of a wide range of competencies, particularly in relation to inspection tasks, can reduce the number of different people that will be required
to climb WTGs to perform routine tasks, thereby improving the efficiency with which downtime can be used, and minimising exposure to the risks of WTG access;

- Competence assessment should consider both normal work tasks, and the arrangements for response to emergencies;
- Work parties will typically be small self-managed teams; these can be backed up by the provision of a level of on-site supervision to audit the operation of safe systems of work, ensure that technical standards are maintained, and provide technical support on complex tasks;
- Selection of contractors should consider whether they are simply providing labour, to work under supervision within the site safe systems of work, or if they are to provide their own competent safety management and task supervision, with an appropriate level of audit by site management;

Suitable welfare facilities should be provided on the site, and maintained to an appropriate standard;

- At times of peak activity, such as major maintenance campaigns, permanent site facilities may need to be supplemented by temporary accommodation;
- On large sites, mobile facilities can be positioned close to where work is taking place, reducing time lost to driving around the site;

Emergency preparedness should be considered in the management of work:

- Personnel locations should be monitored, both in terms of which site people are working on, and which location on the site;
- Authorisation for a task to be undertaken should only be given if the necessary support will be available in the event of an emergency affecting the working party;
  - For example, the number of rescuers that would be needed to evacuate a casualty may depend on the location of the casualty; a person should not be working in a location from which there are insufficient personnel and equipment available to carry out a rescue without undue delay.

In addition to the safe management of discrete tasks, long term integrity management and effective planning of periodic maintenance campaigns enable the wind farm to be maintained in a safe and reliable state.

**B.4.3.1 MAINTENANCE ACTIVITIES AND CDM COMPLIANCE**

Some maintenance activities will fall within the definition of Construction as given in the CDM regulations, and are therefore subject to the duties that these regulations impose, including notification of the project to the HSE if it exceeds the thresholds for duration or total level of effort. General maintenance activities that do not involve “substantial dismantling or alteration of fixed plant which is large enough to be a structure in its own right” are not classed as construction.

**B.4.4 LEGISLATION, STANDARDS AND GUIDANCE**

Further details and links to relevant regulatory guidance are given in the following sections of this guidance:

Interfaces with Electricity Distribution and Transmission Systems
Leadership & Safety Culture
Ergonomics, Human Factors and Behavioural Safety
Management Systems
Workforce Engagement
Occupational Health and Medical Fitness to Work
Supply Chain Management
WTG Certification, Safety and Product Standards
Safe Systems of Work
Emergency Response & Preparedness
First Aid
Access and Egress
Asset Integrity
Confined Spaces
Ergonomics
Construction
Fire
Hazardous Substances
Lifting
Remote and Lone Working
Vibration
Waste and Spillage Management
Welfare
Work at Height
B.5 DECOMMISSIONING

As a standard condition of planning consent for wind farms, at the end of their operating life, the WTGs have to be removed, and the site restored to an agreed state, taking account of habitat, landscape, land use and economic factors. The decommissioning plan itself is usually only required to be submitted prior to decommissioning, rather than as part of the initial planning process; the exact scope of work for decommissioning and site restoration will determine the potential hazards. Typical expected activities include:

- Dismantling and removal of WTGs, which would then either be sold for further use elsewhere, or scrapped and recycled / otherwise disposed of;
- Breaking down and removal of foundations to an agreed depth below ground level;
- Removal of substations and some or all of the site cabling;
- Demolition of site buildings; and
- Restoration of site roadways, drainage and hardstandings.

Decisions made during the design phase, subsequent modifications and upgrades, and the maintenance of the wind farm over its operating life, will determine the hazards that have to be addressed during decommissioning.

Decommissioning of individual WTGs may also be necessary in the event that a failure during their planned operating life puts them beyond economic repair.

B.5.1 RE-POWERING

Some sites may obtain consent for re-powering, in which case some of the site infrastructure may be retained and / or upgraded as necessary to accommodate new WTGs, while redundant infrastructure would be treated as described above. It is unlikely that the original foundations would be used in repowering; the re-use of other site infrastructure would depend on its suitability for use with the replacement WTGs.

Despite these challenges, re-powering may offer a safe and cost-effective approach to maximising the value of earlier investments in infrastructure, and could allow continued wind energy generation without moving onto previously undisturbed locations.

B.5.2 KEY HEALTH AND SAFETY RISKS TO BE CONSIDERED

B.5.2.1 DISMANTLING WTGs

Work equipment for safe access, such as anchor points for work at height, should be maintained and inspected throughout the lifetime of the WTG; this includes ensuring that it is within its inspection period when used for decommissioning. Ladder climbing can be minimised by maintaining operation of tower lifts for as long as possible; this may include providing an electrical supply from a portable generator, after site cabling has been disconnected from the WTG.

In many cases, the same operation may be more hazardous in reverse than during original assembly: for example, in the apparently simple case of a bolted joint:

- During initial assembly:
  - Components are lifted in accordance with manufacturer’s instructions, often under the supervision of the manufacturer’s own specialist personnel, using lifting points of known strength, and are then lowered into place (sometimes with the assistance of bumpers and guides), the holes aligned, the bolts inserted and tightened to the specified torque;
  - Specialised lifting attachments, which are optimised for use in assembly operations, may be used;
- During disassembly:
  - The integrity of lifting points or components such as blades may have deteriorated:
Their condition will need to be assessed prior to lifting, and if the lifting points are no longer suitable, an alternative lifting plan will be needed;

- The initial design, location and ongoing maintenance of lifting points will affect the probability that they will still be serviceable when required for decommissioning;

- Fasteners are loosened and removed:
  - These may break or need to be cut if corrosion has caused seizure of threads or loss of shape from the heads, preventing the safe application of sufficient torque;
  - Such failures can cause sudden release and movement of tools, introducing a hazard to people working nearby;
  - If fasteners have to be cut, then techniques such as burning or grinding introduce a fire risk, and/or high noise and vibration levels;

- Flanges are separated and components are lifted:
  - Flanges may adhere to each other due to the effects of corrosion, or the application of paints and sealants;
  - Sudden release may shock-load lifting equipment, or lead to sudden swinging of loads, both of which can be hazardous to people;
  - The provision of jacking points as part of the original design can provide a safe means of separating flanges from each other prior to lifting operations being undertaken;
  - Specialised lifting attachments may have been optimised for assembly operations, but may be less suitable for the reverse operation, for example rotating a tower section from vertical to horizontal may require different attachments compared to the assembly lift from horizontal to vertical;

**B.5.2.2 LIFTING AND TRANSPORT OF COMPONENTS**

Additional care is needed in transport and lifting operations late in the wind farm lifecycle: in the construction phase, site roads will be newly made, whereas at the end of the wind farm life, the condition of roads and hardstanding will depend on how well they have been maintained; their condition should be investigated, and any necessary remedial work carried out before intensive use during decommissioning.

Once dismantled, the components will need to be transported from the site. If equipment is to be scrapped, there is a choice as to whether to transport it intact, or reduce component size on site:

- Cutting up of tower sections or blades on site may be more hazardous than doing the same work in a dedicated facility, due to greater difficulty in handling the parts and wastes arising, and undertaking the cutting operations; however

- Intact transport of large components from site will involve similar challenges to those of initial transport to site;
  - A detailed transport study will be necessary, as the original route may have new obstructions, or structures and surfaces along the route may have deteriorated during the operating life of the wind farm.

In the event of a WTG being damaged during its operating life, decommissioning may be more hazardous; for example, the centre of gravity and structural integrity of a broken blade will be different to those of a complete blade, affecting lifting operations, while access inside a fire-damaged WTG would not be able to rely on the lift or ladder being in a safe condition to use. In such cases, additional task-specific planning and risk assessment will be necessary, prior to starting decommissioning activities.
B.5.2.3 BALANCE OF PLANT

Decisions will have to be taken as to whether to remove or retain site infrastructure, depending on a range of site-specific factors, for example:

- For underground cables:
  - Cost of removal, versus scrap value;
  - Health, safety and environmental impacts of removal work and remediation;
  - Risk that if cables are left in-situ, this may encourage future metal theft, which would not include remediation, and could also be highly unsafe;

- For civil infrastructure, such as roadways, hardstandings and drainage:
  - Whether there is a continuing need for the roadways to be used and maintained for other land management purposes;
  - Relative environmental and landscape impacts of removal or other restoration operations such as covering with soil; and
  - Technical challenges of removing different types of roadway, in particular floated roads over peat.

B.5.3 HEALTH AND SAFETY CRITICAL INTERFACES AND COMMUNICATIONS

Inputs from earlier phases:

- The risks that decommissioning will present should first be considered during project definition and detailed design phases. While planning conditions may not require a decommissioning plan to be prepared prior to construction of the wind farm, Designers and manufacturers have specific legal duties with respect to decommissioning:
  - Under CDM, the Designer’s responsibilities include considering “the health and safety of those who will maintain, repair, clean, refurbish and eventually remove or demolish all or part of a structure.” The Designer must therefore consider how to reduce risk during decommissioning, taking account of the materials involved, and foreseeable methods that could be used; and
  - Under the Machinery Directive, the Essential Health and Safety Requirements aim to “eliminate any risk throughout the foreseeable lifetime of the machinery including the phases of transport, assembly, dismantling, disabling and scrapping”. The manufacturer should therefore take measures that contribute to this aim, such as avoiding the use of construction techniques or materials that increase hazards during dismantling or scrapping.

Decommissioning phase activities:

- A decommissioning plan should be prepared, taking account of:
  - Condition of the structures and equipment to be decommissioned, and their intended future use;
  - The agreed level of site restoration, or any future uses for site infrastructure;
  - Interfaces with other parts of the site, or external infrastructure such as electricity distribution and transmission networks, which will remain in operation;
  - Any systems that have to remain live until completion of a particular phase of decommissioning, such as aviation warning lights on WTGs, which should remain in operation until the WTGs are dismantled;
    - This may also affect the sequence of removal, if aviation lights on certain WTGs are used to indicate the extent of the wind farm;
  - In many cases, decommissioning of parts of a wind farm will take place while other parts are still in normal production. In order for such phased activity to be managed safely:
o Clear boundaries and protocols will need to be established to avoid the risk of interference between parts of the site that are operational and those that are being decommissioned;

o Suitable isolations and eventual permanent disconnection of electrical systems will be required;

- Any WTGs that are seen not to be in operation may attract metal thieves, as they may be perceived as easy targets, and be assumed to be “safe” to remove metal from; suitable site security arrangements should be in place, particularly as metal theft may introduce unexpected hazards in later decommissioning work;

- Decommissioning will give rise to large quantities of equipment and structures that will need to be subject to suitable processing, with the aims of maximising recycling and minimising environmental impact. The ability to achieve these aims will be influenced by material selection decisions made at the design stage, together with the availability of information on these at the time of decommissioning.

Outputs:

- On completion of decommissioning, the site should be restored to the agreed state, and should not present any additional risks to people or the environment;

  o Third party surveys may be required by planning authorities to demonstrate that this has been achieved, or that suitable arrangements are in place for the continuing maintenance of any remaining infrastructure.

B.5.3.1 LEGAL DUTIES RELATING TO THE SALE OF REDUNDANT WTGS AND OTHER PLANT

B.5.3.1.1 Sale for Further Use

In the event that second hand equipment, such as a redundant WTG, is to be sold for further use, the seller has duties under Section 6 of the HSWA to ensure, so far as reasonably practicable, that the equipment will be safe and without risks to health. Fulfilling this duty may involve:

- Undertaking or arranging for any necessary testing and inspection; and

- Providing adequate and up-to-date information about the operation and maintenance of the equipment.

The HSWA allows for the seller and purchaser to enter into a written agreement that the purchaser will accept responsibility for taking specified steps to ensure the safety of the purchased equipment; this is known as a Section 6(8) waiver.

The Supply of Machinery (Safety) Regulations (SMSR) only apply to the sale of new machinery, however, PUWER places a duty on the employer (in this case, the purchaser of the second hand equipment) to ensure that work equipment is safe, before it is put into use. The health and safety requirements of the SMSR take account of the “state of the art” at the time that the machine was first placed on the market, therefore if safety standards have improved over the operating life of the machine, it may be reasonably practicable for a purchaser to upgrade safety-related aspects of the machine before putting it into service.

B.5.3.1.2 Upgrading and Life Extension

If a machine is totally refurbished and upgraded prior to sale, such that the way in which it operates, and the ways in which risks are controlled, are changed, then it would effectively be a new machine, and would need to have a new CE marking, on the basis of a new conformity assessment. However, if the same modifications were carried out, but the WTG was not sold, the SMSR would not apply; the duty to ensure that it was safe would still apply under PUWER.

B.5.3.1.3 Sale for Spares

If a redundant WTG is to be used as a source of spares, the seller should obtain a Section 6(8) waiver from the purchaser, stating their intentions for the WTG. Purchasers intending to use a redundant WTG in this way should also ensure that any recovered spares are of suitable quality for further use, and are fully compatible with the WTGs on which they are to be re-used, noting that WTG designs are subject to regular revision during the production phase.
B.5.4 MANAGEMENT AND OPERATIONAL CONTROLS

The activities involved in decommissioning fall within the definition of construction work under CDM. During the initial construction project, the CDM Co-ordinator will have prepared a Health and Safety file that is then passed on to the Client, and should include "information regarding the removal or dismantling of installed plant and equipment". Provided that this file has been kept up to date by the Client, it will be an important source of information when preparing detailed decommissioning plans, and for provision of Pre-Construction Information to potential contractors. Contractors should also be made aware of any known defects, damage or deterioration that could affect the safety of decommissioning.

The Client has a duty under the CDM regulations to appoint a CDM Co-ordinator and Principal Contractor to undertake the decommissioning project. The management arrangements for the decommissioning project will then be similar to those for a construction project.

Prior to decommissioning starting, there should be a formal handover from operations, and the equipment to be decommissioned should be permanently disconnected. If partial decommissioning is to take place, as may be the case on sites that are developed in a number of phases, there must be absolute clarity as to which systems are live and under operational control, and which systems are handed over.

B.5.5 LEGISLATION, STANDARDS AND GUIDANCE

HSE CIS65: Avoiding concealed services and overhead power lines

HSE CN4: Crushing and screening demolition material is relevant to the breaking out of concrete foundations

Supply of Second hand machinery – duties of suppliers

Further details and links to relevant regulatory guidance are given in the following sections of this guidance:

Construction (Design and Management) Regulations 2007 (CDM)
Risk Management
WTG Certification, Safety and Product Standards
Emergency Response & Preparedness
Access and Egress
Confined Spaces
Construction
Fire
Hazardous Substances
Lifting
Noise
Vibration
Work at Height
B.6 MODIFICATIONS & UPGRADES

Over the lifecycle of a wind farm, a wide range of types and scales of change can be expected; these include:

- Technical changes to the design of equipment, or changes to software, that can affect its operation;
  - These range from minor component changes, to complete re-powering with new WTGs;
- Procedural changes, affecting the actions to be taken by people in a given situation; and
- Organisational changes, affecting the deployment of people to different activities, and the management arrangements relating to their work, ranging from gradual change over time, to formal handover between organisations.

Changes may be sought by a number of different parties, for example:

- The manufacturer may identify a defect that requires rectification, or withdraw support for equipment deemed obsolete;
- The operator may identify an opportunity to implement an upgrade in order to improve performance; or
- Technicians may identify a change that would improve the safety or quality of their work.

B.6.1 DESIGN CHANGES

The pace of WTG development is such that many current production designs have relatively short operating histories, and the detail of designs is constantly being developed in order improve performance, and reduce the cost of energy. Over the design lifetime of a wind farm, typically around 25 years, it is foreseeable that upgrades will become available, or may be required if components, particularly those in electronic and SCADA systems, become obsolete. Other modifications may be needed much earlier in the lifecycle, for example if design details present unacceptable risks to people, or if serial defects are revealed in early operation; the probability of such situations occurring can be reduced by undertaking detailed assessment of prototypes before commencing series production, supported by subsequent careful control of design and supply chain changes that deviate from the prototype.

Any change from an established design needs to be controlled and assessed carefully, as even relatively minor changes in design or component sourcing can introduce reliability or safety problems.

The priority should be to minimise the need for modifications, through thorough design review, incorporation of learning from early installations before commencing series manufacture, and study of installation requirements. The risk of obsolescence forcing changes later in the lifecycle should be assessed as part of the tendering process; at the very least, the manufacturer's support strategy should be clearly understood, as this may influence future decisions on procurement of critical spare parts. If the original manufacturer is no longer involved in maintenance, any changes in the source or specification of replacement parts should be properly assessed.

The process for managing such changes is described in more detail in Section A.14.

B.6.2 ORGANISATIONAL CHANGES

Organisational changes are a key human factors issue that can contribute to causing incidents to occur, or increasing the severity of incidents if those involved do not respond correctly.

Organisational changes can arise from various causes, such as:

- Transfer of ownership of an organisation or wind farm, or transfer of contracts from one organisation to another;
- Gradual turnover of personnel;
• Changes to the structure of an organisation, sometimes as a consequence of growth, or integration of new sites to an existing organisation; and

• Changes in the allocation of safety-related responsibilities.

Such changes can have a range of effects:

• Some are a direct consequence of the change, such as
  o The loss of experienced personnel;
  o Changes to procedures, or new people being unfamiliar with existing procedures; and
  o Increased pressure on staff, as a consequence of a reduction in staff numbers, or taking on additional work; however

• Indirect consequences of changes can also affect the safety of operations:
  o Where an organisation’s contract is expiring and not being renewed, there is a risk of short-term thinking prevailing in the period leading up to the end of the contract; and
  o Concerns about job security and future opportunities can distract people from their normal work activities, or if people leave before a contract expires, their skills and experience will be lost.

While most major organisational changes are obvious, others may not be so; for example, a gradual loss of experienced personnel, combined with additional workload and responsibilities could go unnoticed until an incident occurs, and reveals the weaknesses; having an effective internal audit process should reveal such drift before it affects the safety of an organisation’s activities.

B.6.2.1 MANAGING MAJOR ORGANISATIONAL CHANGE

The risks arising from organisational change should be assessed, considering both the risk that will arise from the new arrangements, and from the manner in which the change is to be introduced. If a phased approach is adopted, rather than all changes being carried out simultaneously, then this avoids the total unfamiliarity that can otherwise occur; this is balanced against the extended period during which the organisation passes through a number of temporary states, each one of which must be capable of safe operation.

Major organisational changes can occur in any phase of the lifecycle. In early stages, a developer may take a project as far as consenting, or end of construction, and then sell some or all of their stake in it to another investor, who will then be involved with later stages in the lifecycle. In addition to standard technical and commercial due diligence, it is important that the health and safety implications of such a transfer are recognised and managed:

• There needs to be an effective handover of information, such as risk assessments and registers, as-built drawings and commissioning records;
  o In addition to the actual data, it is essential that its context, purpose and level of detail is understood; for example, a risk assessment or survey that may be suitable and sufficient for developing an outline design, will be inadequate for preparation of more detailed construction plans.

Where organisational changes affect established operations, such as the sale of a wind farm that has been in operation for several years, changes in safety systems and cultures need to be recognised, and future objectives agreed. Various approaches may be used:

• It may be possible to combine systems, retaining the strengths of both the old and new owners’ approaches; or

• The new owner may manage the development as an autonomous business unit, retaining its existing systems, and either maintaining them for the long term, or making a gradual transition to new systems; or
• The new owner may seek to maintain consistent approaches across their business; while this minimises complexity at a corporate level, it can result in major dislocation to an established operation.

There is no single correct approach to these situations; the most important point is to recognise that major organisational changes can have direct operational effects on health and safety, and ensure that they are properly managed.

Organisational changes are most likely to be implemented in a safe and successful manner if they are subject to thorough consultation with those who will be affected, both amongst staff and contractors, including meaningful opportunities to contribute to the development of the new arrangements.

B.6.3 LEGISLATION, STANDARDS AND GUIDANCE

HSE Human Factors Briefing Note No. 11 - Organisational Change gives examples of how organisational changes can affect the safety of an organisation’s activities, and approaches to adopt during change management in order to maintain safe operations.

Further details and links to relevant regulatory guidance are given in the following sections of this guidance:

Management of Change
Electricity Safety, Quality and Continuity Regulations (ESQCR) 2002
Ergonomics, Human Factors and Behavioural Safety
Risk Management
WTG Certification, Safety and Product Standards
**B.7 MANUFACTURING**

The developers and owners of most onshore wind projects are not involved in the manufacture of WTGs or other major equipment items, in which case the health and safety aspects of manufacturing will only be relevant as a corporate social responsibility issue. However, the manufacture of WTGs involves a wide range of potentially hazardous work processes, which must be managed appropriately by those who are responsible for these activities.

**B.7.1 KEY HEALTH AND SAFETY RISKS TO BE CONSIDERED**

WTG and tower manufacture involves processes such as:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Typical Hazards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metalworking, such as thermal and mechanical cutting, welding, blast cleaning, forming, machining</td>
<td>Cutting tools or sharp edges&lt;br&gt;Debris and swarf&lt;br&gt;Entrapment in moving machinery or presses&lt;br&gt;Metalworking fluids&lt;br&gt;Dust and vapours&lt;br&gt;Noise&lt;br&gt;High temperatures&lt;br&gt;Welding arc</td>
</tr>
<tr>
<td>Paint spraying</td>
<td>Inhalation of hazardous substances from paints or solvents</td>
</tr>
<tr>
<td>Mechanical lifting and handling of large components</td>
<td>Dropped loads&lt;br&gt;Crushing between load and other objects</td>
</tr>
<tr>
<td>Fit-out, such as installation of wiring and small components</td>
<td>Ergonomics – repetitive work in stress positions&lt;br&gt;Trips and falls</td>
</tr>
<tr>
<td>Manufacture of composite components, such as blades, nacelles and spinners, involves:</td>
<td></td>
</tr>
<tr>
<td>Activity</td>
<td>Typical Hazards</td>
</tr>
<tr>
<td>Moulding, joining and painting of components</td>
<td>Substances such as resins, adhesives and paints</td>
</tr>
<tr>
<td>Placement of fibre sheets into moulds</td>
<td>Ergonomics – repetitive work in stress positions;</td>
</tr>
<tr>
<td>Mechanical handling of moulds and blade parts</td>
<td>Dropped loads, crushing between load and other objects</td>
</tr>
<tr>
<td>Cutting / grinding / sanding during surface finishing and defect repair</td>
<td>Inhalation of dust and vapours&lt;br&gt;Noise&lt;br&gt;Hand-arm vibration&lt;br&gt;Ergonomics of work positions&lt;br&gt;Trips and falls</td>
</tr>
</tbody>
</table>
B.7.2 MANAGEMENT AND OPERATIONAL CONTROLS

Design of products should take account of how they are to be manufactured, such as:

- The materials to be used, and the hazards that they present during manufacture;
- The detail design of components, considering how they will be handled;
- The location of components, considering how they will be installed; and
- Modularisation, which can allow subassemblies to be prepared in dedicated facilities, which may provide a better working environment than final assembly areas.

Such approaches are also likely to improve the ease and safety of maintenance over the operating life of the WTG, as mitigating hazards outside the factory environment may be more challenging, due to limited access or constraints on work equipment.

The design of manufacturing systems should consider both the health and safety and efficiency of the process, for example:

- Ensuring that workstations have good ergonomics, adequate lighting, clean surfaces, clean air and suitable work equipment for the activities to be completed can help to support high productivity and quality, as well as the health and safety of workers; and
- Organisation of workplaces, with clearly-defined storage areas for tools and components, and avoidance of trailing hoses and leads, can reduce the risk of slips, trips and falls, and avoid errors in assembly;

Management of manufacturing sites can take a range of measures to ensure the safety of their operations, such as ensuring that:

- Protective measures that are part of the design of the workplace and work equipment are properly maintained and used, such as ensuring that suitable guards are in place on machinery, and local exhaust ventilation is working efficiently and used where necessary;
- Employees have the necessary competence to undertake their assigned tasks, with sufficient understanding of relevant hazards, protective measures and the potential consequences of deviating from approved procedures;
- Any necessary monitoring of workplace conditions and the health of employees is carried out, and corrective actions implemented as required; and
- A positive safety culture is developed, in which concerns regarding health and safety are openly shared, and properly addressed.

B.7.3 LEGISLATION, STANDARDS AND GUIDANCE

Several sets of regulations are highly relevant to manufacturing; links to HSE Approved Codes of Practice are provided below:

- **PUWER** covers the use of all work equipment, ranging from hand tools to integrated production lines;
- **LOLER** covers lifting operations and lifting equipment;
- **COSHH** applies to any activities involving substances that may be hazardous to health, including both those used as part of the WTG (such as paints and resins) and those used in manufacturing process (such as metalworking fluids and cleaning solvents).
- The **Workplace Regulations** define the requirements for the working environment and amenity facilities in factories;
- The **Control of Noise at Work Regulations** define the requirements for the assessment and control of workplace noise;
- The **Manual Handling Operations Regulations** define the requirements for assessment and control of risks from manual handling of any kind, not just lifting, considering factors such as the weight of loads, and the frequency, duration, distance and task-specific challenges of the required movement; and
• The Control of Vibration at Work Regulations define the duties relating to the control of risks from Hand Arm Vibration

HSE HSG129 – Health and safety in engineering workshops provides guidance targeted at typical manufacturing activities.

B.7.3.1 ELSEWHERE IN THIS GUIDANCE

Supply Chain Management
Part C Key Hazards and Activities

INTRODUCTION

SCOPE
This section of the guidelines addresses some of the key activities and hazards that are likely to arise over the lifecycle of a wind farm, with the greatest emphasis being given to those that are most relevant, in terms of the level of risk, the degree to which they are specific to wind farms, and where guidance from existing sources is least adequate.

Within the scope of these guidelines, it is not possible to address every hazard in detail; the guidelines therefore aim to:

- Highlight some of the key risks to consider, and mitigation approaches that might be adopted:
  - This could be used to trigger consideration of other relevant risks, but is not a substitute for suitable and sufficient risk assessments, which must be undertaken as part of the safe management of any activity;
  - Where examples are given, they are neither exhaustive nor mandatory, and do not alter the duty-holder’s responsibility to manage the unique combination of risks and resources on their own development;

- Signpost existing sources of guidance that provide more detail:
  - The referenced sources have been selected with care, and every effort has been made to ensure that they are relevant, with specific sections being identified where possible; however
  - Duty-holders must make their own assessment of the relevance and sufficiency of referenced sources for the activities that they are considering.

REGULATORY CONTEXT
All of the activities described in this part of the guidance take place within:

- The overall legal framework, described in Section A.1;
- The safety management systems that an organisation operates, as outlined in Section A.6; which will include:
  - Requirements for risks to be managed, as described in Section A.7; and
  - Control of individual tasks within a Safe System of Work, as described in Section A.9.

As these regulations and systems are addressed in more detail in Part A, they are only mentioned in this Part if they have specific implications for an activity or hazard; the regulatory references in this Part are focused on those that are specific to the topics addressed here.

STRUCTURE OF THIS GUIDANCE
Each topic in this Part of the guidance is addressed in a similar manner:

- An overview of the activity or hazard is given;
- Potential hazards and risks are outlined;
- Regulatory requirements, that are specific to the topic, are summarised;
- Risk management approaches are discussed; and
- Sources of further guidance, from regulators and industry bodies, are signposted.
For topics where the size of the site, or the scale of the WTG technology being used (i.e. small / medium / large) involve specific challenges that differ significantly from those of other developments or technologies, these are addressed in separate sub-sections.

**Costs and Benefits**

Throughout these guidelines, the aim is to support early identification of hazards, as this offers the greatest opportunity to eliminate hazards; not only does this minimise risk, but it can also reduce lifecycle costs, by avoiding ongoing mitigation actions being required. There are many areas in which the measures needed to achieve high standards of health and safety can also reduce commercial and operational risks, and hence the cost of energy:

- Early identification of hazards, effective planning of work, and subsequent communication, co-operation and co-ordination between contractors during construction is:
  - Essential for safe working; and
  - Helps to avoid delays to the construction programme;

- Ensuring that construction work is properly controlled helps to minimise the risk of incidents causing adverse effects beyond site boundaries, such as interruptions to utilities or contamination of watercourses, all of which can disrupt local communities, harm public acceptance of a wind farm, and may result in enforcement action by regulators;

- Proper planning, appropriate supervision and safe execution of lifting operations is a legal requirement, which can also:
  - Minimise the risk of problems during lifting operations causing damage to components and delay to projects; and
  - Avoid having expensive hired cranes standing idle while plans are revised;

- Thorough quality checks at appropriate stages of the commissioning process help to:
  - Avoid hazardous incidents occurring;
  - Minimise the risk of premature component failure; and thereby
  - Avoid the cost, downtime and risk exposure involved in carrying out repairs;

- Consideration of ergonomic issues, when selecting equipment and determining layouts, can:
  - Reduce the risk of employees developing long term musculoskeletal disorders, which can shorten their working lives and cause a loss of experienced personnel from technician roles; and
  - Enable technicians to achieve a higher standard of work in a shorter time, thereby reducing labour costs and downtime;

- Effective management of asset integrity helps to:
  - Avoid catastrophic component failures;
  - Allow a planned response to signs of deterioration; and
  - Avoid lengthy shutdowns while waiting to replace failed components;

- Achieving a high standard of transport and driving risk management helps to:
  - Minimise incidents involving vehicles, keeping people safe, both on and off the site; and
  - Reduce the risk of delays to deliveries or temporary closure of access routes;
• Effective fire risk management:
  o Minimises risk to people;
  o Avoids high remediation costs and downtime, or even the potential loss of an asset; and
  o Can reduce insurance costs;

• Eliminating the need to work in confined spaces
  o Avoids exposing people to hazards from oxygen depletion or hazardous atmospheres; and
  o Avoids the greatly increased effort in preparation, supervision and overall resource levels, compared to undertaking the same work in a safe location;

• Provision and maintenance of suitable welfare facilities on sites is a legal duty, and can also help to support retention of skilled staff in site-based roles, ensuring that their knowledge and experience, and the benefits of investments made in their training, remain available to their employer; and

• Minimising the need to work at height is a legal duty; given that any work at height must be undertaken by a competent team who can effect a rescue in the event of a fall, the additional cost and complexity that working at height adds to a task can be avoided if work at height is minimised.
C.1 ACCESS AND EGRESS

C.1.1 OVERVIEW

WTGs and site buildings need to provide safe access to, and egress from, locations where people may be required to work during the operating life of the wind farm. In addition to providing safe access, unauthorised access needs to be prevented, without impeding emergency access and egress. The control of access involves both physical measures, such as barriers, locks and interlocks, and procedural measures, such as checks on competence before permitting people to access locations on a site, and ensuring that all personnel working on a site are either authorised to work under site rules, or are under the supervision of an authorised person.

C.1.1.1 POTENTIAL HAZARDS AND RISKS

The design and condition of access arrangements in a WTG will affect a range of risks including ergonomics, slips, trips and falls, falls from height and falling objects. Any failures in the control of access to hazardous locations can expose people to mechanical and electrical hazards. In the event of a person being incapacitated due to injury or illness while they are in a WTG, any difficulties in their rescue could lead to further harm if treatment is delayed or injuries are aggravated.

C.1.1.2 RELEVANCE TO KEY LIFECYCLE PHASES

The provision of safe access is determined during WTG design, and should be considered during WTG selection. The design of site buildings should provide suitable access and emergency egress, in accordance with building regulations (where applicable) and the outcomes of risk assessments.

During construction, the programme should ensure that safe access is available at all times, ideally by ensuring that permanent access equipment is installed at the earliest opportunity; for example, if the external access steps to the tower door are erected as soon as the first tower section is in place, this avoids the use of less safe temporary options such as ladders.

Procedures for control of access to specific locations on a site are especially important at the handover between construction and commissioning, for example, a switch room may change overnight from being accessible to building contractors to carry out minor snagging works on one day, to being locked as a live HV area in preparation for energisation on the next day.

After construction, the planning of work should take account of provision for access, and ensure that safe methods of work are adopted where access involves risk from residual hazards; for example, if access involves work at height, techniques such as work restraint can be used to prevent falls from occurring.

C.1.1.3 REGULATORY REQUIREMENTS

Several sets of regulations affect access and egress, including:

- Risk assessments required by the Management of Health and Safety at Work Regulations should consider access and egress to/from places of work;
- Where access and egress involve work at height, the Work at Height Regulations apply;
- The Essential Health and Safety Requirements of the Machinery Directive (enacted in the Supply of Machinery (Safety) Regulations) include measures to prevent slips, trips and falls, and to provide safe access to operating positions and service points;
- The Workplace Regulations apply to all workplaces, which include WTGs and site buildings, and require that all floors and traffic routes are of suitable construction, kept in a safe condition, and provided with necessary guardrails;
- CDM imposes a duty on the PC to take reasonable steps to prevent access by unauthorised persons to the construction site; and
- The MHSWR impose a duty on employers to ensure that only employees who have the necessary competence are permitted to access danger areas.
C.1.1.4 MANAGING THE RISKS

C.1.1.4.1 Approaches to Risk Assessment

During WTG design and selection, and wind farm design, risk assessments should consider the locations where people will need to work, and from which a rescue could be necessary, and also identify hazardous locations to which access needs to be restricted. Once construction starts, and throughout the operational phase, access and egress should be considered as part of the risk assessment process when planning work activities.

C.1.1.5 RISK MITIGATION MEASURES

C.1.1.5.1 Design

Design decisions will determine the level of risk associated with access and egress to locations where people will have to work over the life of the wind farm, and the ease with which residual risks can be mitigated; key considerations include:

- Ergonomics of the design, such as the sizes and shapes of access routes;
  - These need to be suitable for a person to use, while wearing necessary PPE, and for the rescue of an incapacitated casualty on a spine board or stretcher;
  - There should also be sufficient space for the movement and storage of tools and materials that will be needed in a location;
- The location, surfaces and detailing of walkways, steps and handholds;
  - If people are to move between levels, then suitable handholds should generally be provided, even if the height difference is only a few steps;
  - Surfaces should provide good grip, taking account of foreseeable contamination such as oil leaks;
    - The ability to contain and clear up spillages should also be considered;
  - The detail design of walkways and platforms should minimise the risk of people falling to a lower level, or objects dropping through gaps;
- Control of access to WTGs, considering measures such as:
  - Ensuring that tower doors can be securely locked, with sufficient strength to resist foreseeable methods of gaining unauthorised entry;
    - Depending on the location, additional security measures such as CCTV and fencing of the base may be necessary;
    - Any perimeter fencing should be located so that it does not interfere with hoisting of loads using the nacelle hoist, or emergency descent from the nacelle; and
  - Protecting external ladders against unauthorised use, theft or vandalism;

Within WTGs, access to hazardous areas should be controlled through a combination of technical and procedural measures, which ensure that these areas are not accessed unless they are in a safe condition, for example:

- HV electrical equipment is normally physically segregated from other working areas by interlocked doors or hatches, which cannot be opened until the equipment is isolated, earthed and secured against re-energisation;
- Other access doors and hatches may be locked, with keys held by people who are competent to manage the risks in the restricted areas; and
- Clear information and markings should be provided to warn personnel of specific hazards in areas where physical access controls are not in place.

C.1.1.5.2 Procedures

Procedural measures can provide further risk reduction, particularly in relation to any residual risks that are not fully mitigated by design.
Access to WTGs in general, and specific hazardous areas within them, should be limited to personnel who are authorised to be there, and have the necessary training and competence to work safely; in most cases, this will include formal authorisation under the WTSR.

The planning of work in any location should consider potential requirements for rescue of a casualty, and for emergency access and egress. Considerations include:

- How an incapacitated casualty would be rescued from a working location, taking account of the personnel and equipment available on the site, and policies such as whether harnesses are to be worn at all times, or if rescue harnesses are provided;
- When technicians are working in a WTG, the access door will generally be locked, to prevent unauthorised access, however:
  - The design of the door needs to enable emergency egress, with a panic bar or similar opening mechanism that does not require a key to operate; and
  - Personnel who may need access in an emergency must be able to unlock the door from the outside; this can be achieved by ensuring that spare keys are held by other personnel on site, or can be obtained by emergency services from secure locations such as a coded key box.

Site procedures should ensure that WTGs, buildings and the site itself are properly secured before being left unattended; particular care is needed when multiple teams are working, to ensure that no areas are inadvertently left in an insecure state on completion of work. A failure to secure hazardous areas of a site could lead to a breach of duties under the HSWA, or a civil claim under Occupiers’ Liability acts if a person visiting the site were injured as a result.

C.1.6 Monitoring, Review and Change Management

While the design of access facilities determines the residual hazards that will have to be mitigated over the lifecycle, continuing safe use depends on maintaining access ways in suitable condition, including measures such as:

- Periodic inspection for signs of damage or deterioration;
  - External access equipment, such as WTG entrance steps, should be checked for signs of vandalism;
- Ensuring that they are not obstructed by tools and materials; and
- Thorough cleaning of any spillages, such as oils, that could lead to slips.

The effectiveness of procedural measures for control of access, such as induction and authorisation processes, competence checks, adherence to site safe systems of work, and signing in and out of a site, should be subject to periodic audit; this is particularly important when there are significant changes in site personnel.

C.1.2 Codes of Practice and Guidance

C.1.2.1 Regulations and Standards


BS EN 50308-2004: Wind turbines – protective measures specifies access and egress requirements. (Note that attempts have been made to update this standard to reflect the current state of the art, but no agreement has been reached on the content of a revised standard).

BS EN ISO 14122-1:2001+A1:2010: Safety of machinery - Permanent means of access to machinery. Parts 1-4 cover the choice of means of access, and detailed design requirements, although do not reflect the approach to safe ladder use that has been adopted in the wind industry.

BS EN 547:1996: Safety of machinery. Human body measurements: Parts 1-3 provide data and principles for designing openings access into machinery.
C.1.2.2 ELSEWHERE IN THIS GUIDANCE

Work at Height
Supply of Machinery (Safety) Regulations and Harmonised Standards
Access to Land, in particular Occupier’s Liability describes the limitations and responsibilities with respect to control of public access to sites.
C.2 ASSET INTEGRITY

C.2.1 OVERVIEW

The safe and reliable operation of wind farms over their design life depends on the long term integrity of the assets, both WTGs and BoP, being assured.

C.2.1.1 POTENTIAL HAZARDS AND RISKS

Functional or structural failures of key components of a wind farm could result in risks to the health and safety of people on the wind farm at the time of failure, or involved in subsequent rectification work. Examples of such components include:

- Critical structural connections, such as between the WTG blades and hub;
- Equipment provided to ensure the safety of people, such as:
  - Ladders, platforms and hatches;
  - Anchor points for work at height;
  - Lifting equipment;
  - Rescue equipment;
  - Internal lighting and emergency backup;
  - Fire protection systems;
- Lightning protection and earthing systems;
- Automatic safety and shutdown systems, such as:
  - Sensors, switching and actuation mechanisms, particularly for critical systems such as overspeed protection and pitch control on WTGs;
  - Wind speed monitoring equipment;
- Electrical equipment, especially HV and high powered LV components such as:
  - Converters, transformers and capacitors;
    - This includes protective systems, such as overload / high temperature trips, and essential safety components such as insulation and interlocks;
  - Security of terminations and cable support.
- WTG foundation and connection to tower;
- Site infrastructure:
  - Roads, hard standing, drainage, embankments / cuttings and security;
- Project-specific risk mitigation equipment such as:
  - Ice detection and removal systems;
  - Aviation obstruction warning lights.

Deterioration has many potential causes, such as:
- Normal operation and weather exposure;
- Extreme weather, such as high wind, heavy rain and lightning;
- Latent defects, such as inadequacies in specification, design, manufacturing or commissioning;
- Theft and vandalism;
- Damage by livestock or other animals;
C.2.1.2 RELEVANCE TO KEY LIFECYCLE PHASES

Management of asset integrity is a key activity in the O&M phase, however the ability to do so effectively depends on decisions and actions taken in earlier phases.

During Project Design, contracts for WTG and BoP supply and installation should include requirements for the provision of information to enable long-term integrity management, including:

- Data for inclusion in asset registers;
- The recommended scope and frequency of inspections;
- Clear decision-making criteria as to the tolerability of different levels and types of defect; and
- Maintenance and repair procedures.

This information can be particularly important for BoP, as suppliers are less likely to be involved in long-term maintenance than for WTGs.

Maintenance contracts should ensure that all required integrity maintenance work is undertaken, including defined scopes and frequencies of activities, and reporting requirements; particular attention should be given to interfaces between work scopes.

For the O&M phase, the owner of a wind farm needs to ensure that they have the necessary competence available, either in-house or through a contractor, to manage long-term integrity, including:

- Ensuring that statutory and other inspections are carried out as scheduled, and remedial actions identified are implemented in an appropriate timescale;
- Updating of specifications and schedules;
- Maintaining records of inspections; and
- Managing reporting from contractors.

Equipment manufacturers should be contacted periodically, to find out if there are any updates to schedules or maintenance requirements, or relevant safety alerts that could affect the function or maintenance of equipment.

When an asset is approaching the end of its operating life, there will generally be an increased pressure to minimise expenditure, however maintenance should still ensure that the asset remains safe to operate and decommission, even if the asset is to be run until it is deemed to be beyond economic repair.

C.2.1.3 REGULATORY REQUIREMENTS

Certain items of equipment, such as lifting equipment, pressure systems and PPE, are subject to specific inspection requirements. More broadly, under PUWER, employers have a duty to ensure that:

- “work equipment is maintained in an efficient state, in efficient working order and in good repair” and
- “work equipment exposed to conditions causing deterioration which is liable to result in dangerous situations is inspected at suitable intervals; and each time that exceptional circumstances which are liable to jeopardise the safety of the work equipment have occurred”

These duties apply to all work equipment, and not just specific categories; the inspection and maintenance of work equipment should also be recorded.

C.2.1.4 MANAGING THE RISKS

C.2.1.4.1 Approaches to Risk Assessment

Planned preventive maintenance should be risk-based, taking account of factors such as:

- The manufacturer’s service manual, and any alerts or updates issued;
• The consequences of potential failures;
• The ability to detect the early stages of failure in real time, and take actions to minimise risk of total failure occurring, such as detecting high temperatures or elevated levels of vibration and shutting the WTG down before a catastrophic failure occurs;
  o In some cases, installation of additional sensors may allow more effective monitoring, with fewer visual inspections;
• Historical data on failure rates and failure modes of similar components; and
• The risks involved in carrying out the inspection.

Risk assessments should consider foreseeable abnormal operational situations, such as:
• Loss of communications with the site, which may require more frequent inspections until communications have been restored; or
• Extended shutdown of a WTG, which may require additional checks before restarting.

Such a risk assessment can consider both the economic and health and safety consequences of the identified failure modes.

C.2.1.5 Risk Mitigation Measures

Based on the above risk assessment, a planned preventive maintenance programme should be put in place, covering all parts of the wind farm, including WTGs, civil and electrical BoP, and related structures such as meteorological masts.

In addition to the risk-based maintenance, statutory inspections should be carried out on relevant equipment, such as pressure systems and lifting equipment.

Additional non-routine inspections and maintenance may be necessary at certain times, such as:
• Following extreme weather events;
• Prior to bringing cranes and LGVs to site for major component replacement work, if such vehicles have not used site roads and hard standing for some time;
• Where an issue has been identified, such as an unusual mode or unexpected rate of deterioration, on similar components or systems elsewhere.

The safety and effectiveness of any programme of maintenance or inspection depends on factors such as:
• The competence of the people managing and undertaking the work;
• Understanding the criticality of components and potential failure modes so that work can be prioritised effectively;
• Basing the programme on knowledge and experience of the WTGs and site characteristics;
• Effective communication and record-keeping, such as ensuring that:
  o Manufacturers’ alerts and technical advice are received by the relevant people, and all necessary actions are completed;
  o SCADA and condition monitoring data is used to target maintenance work; and
  o The status of equipment on completion of maintenance work is recorded, and any follow-up actions completed.

Regular visual inspection of WTGs from the ground can assist in early detection of problems, and can also help to identify any components that are coming loose, which could subsequently fall from height. This is particularly important on sites with high levels of public access, or adjacent to occupied areas. Having continuity in the workforce helps technicians to get to know their sites, and can increase the effectiveness of monitoring

Site inspections should also check the condition of site roads and other infrastructure, and any signs of vandalism of attempted forced entry.
The scope and complexity of the planned preventive maintenance programme, and the competence standards for those undertaking it, should be proportionate to the scale of a site, and the level of risk that it presents.

**C.2.1.6 Monitoring, Review and Change Management**

Procedures and checklists should be established to cover reasonably foreseeable events, both routine and non-routine, detailing:

- Visual inspections of the physical state of equipment;
- Functional checks and tests; and
- Clear criteria for follow-up actions, based on the outcomes of tests and inspections.

Maintaining effective communications between manufacturers and owners / maintainers can help to ensure that the right maintenance work is done, and allow manufacturers to address recurring problems. Maintenance and inspection programmes should be reviewed periodically, to determine if:

- Inspections are targeting the right areas, and providing information that can help to avoid unexpected failures;
- New learning from the manufacturer or other sites indicates the potential for improvements in the scope or methods of maintenance;
  - New methods may reduce the risk to people involved in carrying out inspections;
- Any non-statutory checks or routine tasks are not delivering safety or operational benefits, and may be giving rise to unnecessary risk exposure;
- The scope and frequency of statutory inspections is appropriate, given the conditions of use, and findings from inspections.

**C.2.2 Codes of Practice and Guidance**

**C.2.2.1 Regulations and Standards**

BSI PAS 55-1:2008 *Asset management - Specification for the optimized management of physical assets* and BSI PAS 55-2:2008 *Asset management - Guidelines for the application of PAS 55-1* provide a management system specification for asset management, and are relevant for organisations that manage the long term integrity of wind farms. PAS 55 is expected to form the basis of the new ISO 55000 series of standards.
C.3 AVIATION

This section relates to hazards that wind farms present to civil, military and recreational aviation.

C.3.1 EFFECT OF WIND FARMS ON AVIATION

Due to the height of the structures involved, WTGs and meteorological masts can present a number of hazards to aviation, including:

- Physical obstruction, resulting in potential conflict with low-flying aircraft, such as:
  - Military low-flying, which can take place over most of the UK, down to a height of 250ft (76m) minimum separation distance (height above ground level, or other obstructions such as buildings), and down to 100ft (30m) above ground level during scheduled exercises in designated Tactical Training Areas, which occupy large areas of northern and southern Scotland, and Wales;
  - Helicopters involved in Search and Rescue (SAR) and civilian operations;
  - Commercial, leisure or military aircraft taking off or landing, which will be at low altitude close to aerodromes;
  - Leisure activities such as parachuting and gliding; and

- Effects on radar systems, including those used for air traffic management, which may be affected by the creation of false radar returns, and masking (known as “shadowing”) of genuine radar returns from aircraft.

While a wind farm may present a large physical obstruction to aviation, meteorological masts (and especially temporary masts), which may precede the development of the actual wind farm, are much less conspicuous to aviators. This therefore needs to be taken into account when assessing the requirements for lighting or marking of masts to increase visual conspicuity.

C.3.1.1 RELEVANCE TO KEY LIFECYCLE PHASES

Wind farms may affect aviation safety at any lifecycle stage during which tall structures, such as meteorological masts or WTGs, are present. The risk is likely to be highest in the early stages of a development, when pilots may not be familiar with the presence of the structures.

Aviation safety issues need to be addressed early in the consenting process, to minimise the risk of objections from aviation stakeholders. Thereafter sufficient time needs to be allowed for the implementation of aviation safety mitigation measures, which may include upgrades to radar systems, otherwise construction may be delayed until the necessary measures have been commissioned.

C.3.1.2 REGULATORY REQUIREMENTS

Civil aviation is regulated under the Civil Aviation Act 1982, under which the Air Navigation Order and subsidiary regulations are made; these specify the requirements for obstruction lighting of structures.

The Civil Aviation Authority is an independent regulator, responsible for provision of advice on aviation safety; its published policy and guidelines should be used by developers, and will also be referred to by planning authorities. Aerodrome operators have the responsibility for safeguarding their approach airspace.

National Air Traffic Services (NATS) provides air traffic navigation services for all UK airspace, and at most major UK airports, and is both a statutory consultee in its own right, and a technical advisor to airport authorities.

The Ministry of Defence regulates military aviation, and is therefore the consultee for any matters affecting its safety.

C.3.1.3 MANAGING THE RISKS

C.3.1.3.1 Risk Mitigation Measures

Effects on radar are assessed as part of the planning process, with detailed consultation being necessary in defined areas around different types of radar and communication stations; note that these are not only located at aerodromes.
Onshore obstructions must be marked with aviation warning lights if they exceed 150m (492ft) above ground level. Aviation lighting, or other visual warning devices, may also be required in other circumstances.

The positions and heights of obstructions should be notified to the Defence Geographic Centre, who maintain the Digital Vertical Obstruction File (DVOF), which lists all obstructions over 150ft. This notification should take place even if it is not a planning condition. The DVOF data is shared with NATS Aeronautical Information Service (NATS-AIS) and other parties as required. NATS-AIS maintain the UK Aeronautical Information Publication, which lists all en-route obstructions exceeding 91m (300ft).

While initial notification will take place as an outcome of the planning process, it is important to provide accurate and timely notification of the actual date on which a structure will be erected, rather than the date when planning consent was granted. This helps to avoid “phantom” structures being indicated long before they are erected, and then suddenly appearing without further notification.

Consideration should be given to other forms of conspicuity, such as aeronautical marking or infra-red illumination (to provide visibility to military pilots flying at night), in addition to conventional obstruction lighting.

C.3.1.3.2 Monitoring, Review and Change Management

In the event of an aviation warning light failure, the wind farm operator is required to restore the operation of the light as soon as reasonably practicable; if the failure is expected to last for more than 36 hours, the NATS-AIS should be informed, in order to issue a Notice to Airmen (NOTAM). In order to ensure that the information is communicated as quickly as possible to the relevant people, the operator is also recommended to have arrangements in place to notify local aviation interests, such as the relevant Air Traffic Service unit, local airports and helicopter operators.

C.3.2 Codes of Practice and Guidance

C.3.2.1 Regulations and Standards

CAA CAP393 – Air Navigation: The Order and the Regulations: Part 28, Article 219 specifies the requirements for lighting of en-route obstacles such as WTGs.

CAA CAP764 – CAA Policy and Guidelines on Wind Turbines provides detailed technical and policy guidance on the interactions between WTGs and aviation.

C.3.2.2 Other Relevant Guidance

The National Air Traffic Services Wind farms webpage provides access to advice, tools, maps and services for assessment of wind farm effects on aviation.

RenewableUK Guidance on Low Flying Aircraft and Onshore Tall Structures Including Anemometer Masts and Wind Turbines, July 2012 provides detailed guidance on good practices in relation to notification and marking of structures, and relevant contact details.

MOD Specification for IR & Low Intensity Red Vertical Obstruction Lighting.

Information on current restrictions to airspace can be obtained from NATS-AIS.
C.4 BALANCE OF PLANT

C.4.1 OVERVIEW

The Balance of Plant (BoP) on a wind farm can be taken to include every asset related to the site, excluding the WTGs. This section focuses on issues relating to the electrical BoP and site facilities; this includes equipment such as site HV cabling, switchgear and substations, up to and including the site HV breaker, and site facilities such as buildings and communication systems. The work involved in providing a grid connection is outside the scope of this section, as it is often undertaken under separate contract by a regulated connection provider.

Other closely related topics in these guidelines include:

- Electrical safety (C.8);
- Construction (C.6);
- Roadways are considered in sections on Driving (C.7) and Transport (C.15); and
- The role of the BoP contractor as Principal Contractor is considered in the sections on CDM (A.1.4) and Safe Systems of Work (A.10).

C.4.1.1 POTENTIAL HAZARDS AND RISKS

The electrical BoP includes site HV systems, which are potentially hazardous, and must be appropriately designed, installed, commissioned, operated and maintained.

The adequacy of site facilities will affect the welfare of people working on the site, over its operating life, while the provision of a suitable working environment for critical equipment such as switchgear and SCADA systems will affect the safety and reliability of their operation. The ability to communicate effectively within the site, and off site, supports safe and efficient working, and is critical to the management of any emergencies on the site.

C.4.1.2 RELEVANCE TO KEY LIFECYCLE PHASES

The peak of work on the electrical BoP occurs during the construction and commissioning phase; its safe and reliable operation is determined by a combination of its design, the quality of components and their installation, and how they are maintained over the lifetime of the wind farm. If electrical BoP has sufficient capacity, and is in suitable condition, then it could potentially be re-used if the site is repowered.

C.4.2 REGULATORY REQUIREMENTS

Electrical BoP is subject to the Electricity Safety, Quality and Continuity Regulations 2002 (ESQCR), which impose duties relating to the design, specification and inspection of HV electrical networks, and the reporting of incidents. The connection point between the site HV network and the local distribution / transmission network involves both a physical interface, and the point where the wind farm will have to comply with the utility network code, including interfaces between safety procedures to enable systems to be shut down and made safe for working on.

Provision of welfare facilities is a requirement of the Management of Health and Safety at Work Regulations (MHSWR). Building Regulations also apply to site facilities, other than buildings into “which people go only intermittently and then only for the purpose of inspecting or maintaining fixed plant or machinery”.

C.4.3 MANAGING THE RISKS

C.4.3.1 APPROACHES TO RISK ASSESSMENT

The design of the site HV network should minimise the risk to people in the event of faults occurring during its operating life; it is also important to minimise the risk of damage to assets, and disruption to the utility networks. The ESQCR impose a specific duty to assess the risk of danger from interference, vandalism or unauthorised access to substations and overhead lines, and to implement the necessary safeguards against the identified risks. This may affect the design of site compounds and buildings, and decisions about whether equipment should be installed externally or within buildings.
C.4.3.2 Risk Mitigation Measures

C.4.3.2.1 Project Definition and Design

HV system design, installation and operation is a specialised area of electrical engineering, which should only be undertaken by competent personnel. The design has to be inclusive and comprehensive in order to satisfy multiple requirements, including the local electricity distribution or transmission network codes (which will be specified as part of the Connection Agreement), substation, cable and WTG characteristics, so should be undertaken as an integrated package.

At the design stage, a range of studies should be carried out, typically covering:

- Earthing system;
- System fault levels;
- Protection system philosophy and co-ordination;
- Insulation co-ordination;
- Fault-ride through requirements, in accordance with transmission or distribution codes;
- Lightning protection; and
- Provision for secure isolation and earthing of the network, in accordance with HV Safety Rules, taking account of foreseeable future requirements for phased energisation or selective isolation of parts of the network;
  - This should also include consideration of interlocking, to control access to HV locations;

Design of the earthing system will require soil resistivity data from ground investigation work.

The design of interfaces between cabling and fixed plant such as switchgear (both in BoP and WTGs) should consider the ergonomics of installation, such as ensuring that there is sufficient:

- Space for cables to be routed, allowing for limits on bend radii, and avoiding the need to apply undue forces to cables;
- Space for people to work;
- Support to take the weight of cables, so that electrical terminations are not stressed in normal service;
- Support to withstand electro-dynamic loads that can occur in fault conditions; and
- Safe access and egress to locations where cables have to be pulled and terminated.

The cable specification should consider the potential working temperatures during cable installation, to ensure that cold weather will not delay this work. These considerations are all specific to the cable type being used, so will vary between projects.

The design of cable routes on sites should minimise the risks to and from other site activities:

- If overhead lines are to be used, then road crossings should be avoided where practicable;
- Underground cable routes should provide sufficient protection for the cable, taking account of vehicle movements and land use;
  - If cable routes cross land drains, such as in forestry or agricultural areas, then the depth and protection of the cable should take account of foreseeable drainage maintenance activities, and additional cable marking may be necessary.

The installation method should also be considered; typical approaches include:

- Excavation of trenches, laying of cables and back-filling;
- Installation of the cable using a cable plough; and
- Directional drilling and insertion of tubing, in order to create cable routes under obstacles where surface excavation is not appropriate, such as major roads, railways or waterways;
  - This is more common for grid connection cables than site networks.

The design of site facilities should take account of foreseeable demands over the life of the wind farm, such as the expected numbers of people who will use welfare facilities, and the extent of storage requirements for spares and materials, with the aim of minimising the long-term use of supplementary storage such as shipping containers.

The BoP design should also provide the permanent site communications facilities, both within the site and off site; this would be supplemented during the construction phase by temporary communications systems, established by the PC.

**C.4.3.2.2 Construction and Commissioning**

Construction and installation work should be carried out under the safe systems of work in place for construction work, with particular attention to the safety of excavations. Attention to detail in the quality of installation reduces the risk of future hazards and lost production due to cable faults occurring; any loose terminations, crushing of cables or routing over sharp edges could create latent defects on the installation. Underground cables may either be laid in ducts, or trenches backfilled with fine material to avoid the risk of crushing by rocks.

As cables are laid on the site, drawings should be marked up to enable the issue of accurate as-built drawings, to ensure that the precise position and depth of cables is recorded for future reference. Cable routes should also be marked; this typically involves measures such as:

- Surface route marker posts; and
- Overlaying the cable with marker tiles or warning tape.

Correct identification of both ends of a cable is vital to safe and efficient installation and commissioning.

Effective co-ordination between the BoP and WTG contractors will be necessary, in order to ensure that work at interfaces, such as provision of earth connections, communications, and connection to the site network can proceed without creating risks to people or delay to the programme.

HV systems should be commissioned in accordance with a comprehensive plan, some aspects of which will be determined by the connection agreement between the wind farm and the utility network. Following cable installation, tests are carried out to confirm the integrity of cable insulation and sheaths, prior to energisation as part of the network. Testing processes involve the application of high voltages, so safe systems of work should control and restrict access to equipment being tested. Prior to energisation, safety signage should be in place, and HV switchrooms and compounds should be secured against unauthorised access; this is particularly important as contractors may have become accustomed to working in these areas during construction, and may still have snagging work to complete, but could be put at risk by live HV systems.

Installation of communications systems for off-site connections to phone and data networks is often undertaken by communications infrastructure providers, potentially introducing an additional interface to be managed by the PC.

**C.4.3.2.3 Operation and Maintenance**

Periodic inspections should be carried out on the basis of defined checklists and test specifications, which should reflect the risk of failures, and typically include checks such as:

- Thermographic inspection, to identify “hot spots” created by poor connections;
- Visual and physical checks of tightness of terminations and joints;
- Looking for signs of leakage of transformer oil;
- Ensuring that cooling fins, louvres, mesh and filters are free from obstructions or damage; and
- Inspecting the condition of security and interlocking systems, and ensuring that they do not show signs of forced entry having been attempted.

Many of these checks can only be carried out safely when the system has been isolated and earthed.

Cable routes should also be inspected periodically:

- Routes of underground cables should be checked for signs of disturbance to the ground (such as from land management operations or flood damage) and completeness of marking; and
- Overhead lines should be checked for signs of damage or deterioration, particularly after extreme weather events.

C.4.4 CODES OF PRACTICE AND GUIDANCE

RenewableUK H&S Guidelines: Wind Turbine Switchgear.

RenewableUK H&S Circular: ESQC Regulations

HSE INDG372 - Electrical switchgear safety - A guide for owners and users provides a summary of advice for non-specialists on keeping switchgear safe, with more detailed advice for specialists provided in HSE HSG230 – Keeping electrical switchgear safe.

HSE HSG47 – Avoiding danger from underground services provides guidance to those involved in commissioning, planning, managing and carrying out work on or near underground services.

C.4.4.1 ELSEWHERE IN THIS GUIDANCE

Electricity Safety, Quality and Continuity Regulations (ESQCR) 2002
Construction (Design and Management) Regulations 2007 (CDM)
Interfaces with Electricity Distribution and Transmission Systems
Electrical Safety
C.5 CONFINED SPACES

C.5.1 OVERVIEW

Under the Confined Spaces Regulations 1997, “a ‘confined space’ must have both of the following defining features:

(a) it must be a space which is substantially (though not always entirely) enclosed; and
(b) one or more of the specified risks must be present or reasonably foreseeable”,

noting that “A place not usually considered to be a confined space may become one if there is a change in the conditions inside or a change in the degree of enclosure or confinement, which may occur intermittently”.

The implication of this is that while some places will always be confined spaces, with permanent measures in place to restrict entry, other places may only require to be managed as confined spaces when certain operations are to be carried out, such as the use of solvents within a WTG nacelle; safe systems of work therefore need to identify when a confined space entry may occur. If in doubt, it is best to treat a space as a potentially hazardous confined space, until it is known to be safe.

C.5.1.1 POTENTIAL HAZARDS AND RISKS

Typical hazards that may endanger people in confined spaces on wind farms include:

- Loss of consciousness due to an increase in body temperature, as a result of working in a hot environment such as a transformer compartment;
- Loss of consciousness, or asphyxiation, due to the presence of hazardous substances, or lack of oxygen, in the atmosphere of a confined space:
  - Hazardous substances may be present in the confined space prior to work commencing, or may arise as a result of work activities;
  - Oxygen depletion can occur due to corrosion, work activities such as grinding, or workers’ breathing using up available oxygen in a confined space with inadequate air exchange;
    - Inhaling an atmosphere that contains no oxygen can result in loss of consciousness within a few seconds;
    - Inert gases such as nitrogen, which is often used in hydraulic accumulators on pitch systems in WTG hubs, can cause dangerous oxygen depletion if released; and
- Injury arising from fire or explosion of substances.

Due to the limited exchange of air in a confined space, a hazardous concentration of a substance can occur from a relatively small release, that would not endanger people in an open air situation.

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14 The definition quoted is from guidance in HSE L101 - Safe Work in Confined Spaces - Confined Spaces Regulations 1997: ACOP and Guidance (3rd Edition, 2014). The regulations define a confined space as “any place, including any chamber, tank, vat, silo, pit, trench, pipe, sewer, flue, well or other similar space in which, by virtue of its enclosed nature, there arises a reasonably foreseeable specified risk”, with the specified risks being “a risk of –

(a) serious injury to any person at work arising from a fire or explosion;
(b) without prejudice to paragraph (a) –
  (i) the loss of consciousness of any person at work arising from an increase in body temperature;
  (ii) the loss of consciousness or asphyxiation of any person at work arising from gas, fume, vapour or the lack of oxygen;
(c) the drowning of any person at work arising from an increase in the level of liquid; or
(d) the asphyxiation of any person at work arising from a free flowing solid or the inability to reach a respirable environment due to entrapment by a free flowing solid";
C.5.1.2 TYPICAL EXAMPLES

Potential confined spaces should be identified at the design stage, and also through the operation of safe systems of work. The risks relating to proposed work in a confined space must be assessed, and appropriate precautions implemented if such work cannot be avoided.

If construction work takes place on certain types of contaminated land, hazardous gases, fumes or vapour may accumulate in trenches and excavations; such risks should be assessed in project design, and clearly identified in Pre-Construction Information, in order to allow the contractor to mitigate them.

In WTGs, there is the potential for several areas to constitute confined spaces; these include the tower, nacelle, or hub, depending on the substances present, the work to be carried out, and the level of ventilation;

Substations, switchrooms and locations within WTGs that house gas-insulated switchgear containing Sulphur Hexafluoride (SF₆) can present confined space hazards. In the event of any leakage, the SF₆, which is heavier than air, will tend to collect in the lowest part of the structure, such as basements or cable trenches. While SF₆ is non-toxic, repeated switching operations can lead to formation of decomposition products that are hazardous to health, even at extremely low concentrations.

C.5.1.3 RELEVANCE TO KEY LIFECYCLE PHASES

The Confined Spaces Regulations impose a legal duty that “no person shall enter a confined space to carry out work for any purpose unless it is not reasonably practicable to achieve that purpose without such entry”. The design stage offers the greatest scope to reduce the hazards presented by confined spaces over the lifecycle of a WTG, by means such as:

- Design of equipment and structures to minimise the existence of confined spaces;
- Location of equipment to minimise the need to enter any confined spaces; and
- Selection of materials and systems to avoid the use or release of hazardous substances.

This reinforces the Designer’s duties under CDM to avoid foreseeable risks to people over the whole lifecycle of a structure.

The duty to avoid entry to confined spaces applies throughout the rest of the lifecycle, including Construction and Operations & Maintenance, requiring thorough consideration to be given to alternative approaches to achieve an objective, before confined space entry is adopted as the method.

C.5.2 REGULATORY REQUIREMENTS

Work in confined spaces must be managed in accordance with the Confined Spaces Regulations 1997, and the associated ACOP.

The duties under the Confined Spaces Regulations combine with duties under other regulations, including:

- Under the MHSWR, employers must:
  - Make a suitable and sufficient assessment of the risks to which they are exposed whilst they are at work; and
  - Appoint competent persons to provide assistance in undertaking the measures that are needed to comply with health and safety duties;

- Under the PPE regulations, employers must:
  - Provide suitable PPE to protect employees from the risks to which they may be exposed at work; and
  - Ensure that such PPE is used, maintained and / or replaced as necessary;

- Under PUWER, employers must:
  - Ensure that work equipment is suitable for the purpose for which it is to be used, and assess any additional risks that such equipment introduces; and
Ensure that work equipment is properly maintained in an efficient working state.

The key duties under the regulations are to:

- Carry out a risk assessment, with the priority being to identify measures that avoid the need to work in the confined space;
- If it is shown that it is not reasonably practicable to carry out the necessary work without entering the confined space, then it is necessary to determine the measures that are needed in order to provide a safe system of working in the confined space;
  - The priority is then to eliminate sources of danger to people who will enter the confined space; and thereafter to:
  - Determine the necessary precautions for entry.

**C.5.3 Managing the Risks**

The risks of a proposed operation must be assessed, first of all to determine if there is a reasonably practicable alternative to confined space entry, and if not, to manage the risks of such entry. This is achieved by a combination of design measures, to reduce the risk that a confined space presents, and then by adoption of a safe system of work to manage entries.

**C.5.3.1 Design of Unavoidable Confined Spaces**

In cases where, at the design stage, it is identified that it will not be reasonably practicable to eliminate the need for work to be carried out in a confined space, and especially in cases where repeated entry to the confined space will be necessary over the operating lifetime of a WTG, then consideration should be given to design measures that can reduce the risk that these unavoidable entries will entail.

Design measures could include:

- Provision of monitoring systems to detect:
  - Hazardous conditions prior to entry, such as release of gases or liquids, fire or smoke; and
  - The presence of hazardous substances, or oxygen depletion while work is in progress;
- Physical separation of compartments that may contain identified hazards, such as oxygen-depleted atmospheres, from those where work will be undertaken;
- Provision of internal lighting, with due consideration to how it is to be maintained;
- Provision of robust isolations, to provide safety from hazards such as substances, electricity and movement of equipment;
- Ensuring that access and egress routes have suitable dimensions and characteristics for use when wearing all necessary PPE (which may include a breathing apparatus set), and for the rescue of a casualty; and
- Provision of appropriate anchor / mounting points in suitable locations for rescue equipment and PPE.

**C.5.3.2 Risk Assessment for Confined Space Entry**

The potential for tasks to involve entry into a confined space, and the presence or potential introduction of hazards that may endanger people in a confined space, must be assessed. Where a need to enter a confined space has been established, the ACOP lists factors to be assessed; these include risks arising from:

- The conditions of the space itself, such as:
  - Substances that may previously have been present in the space;
  - Residues, including rust and corrosion;
  - Contamination, which may have entered the confined space from adjacent equipment or other sources;
o Oxygen deficiency or enrichment;
o Physical dimensions and layout of the space;

- The operation to be carried out, such as:
  o Chemicals to be used or handled during the operation;
  o Sources of ignition; and

- Ingress of substances, such as water or gases.

The potential requirements for emergency rescue must also be assessed, and suitable rescue plans prepared, including the availability of the necessary equipment and personnel to extract an unconscious casualty safely.

C.5.3.3 RISK MITIGATION MEASURES

The ACOP specifies in detail the precautions to be included in a safe system of work for confined space work. These include:

- Arrangements for training, supervision, and the required competence of workers, which should be in proportion to the risk, and are necessary both for those workers who will enter the confined space, and those who will support them;

- Communication systems, between workers within the confined space, with supporting personnel outside, and to summon help in an emergency;

- Arrangements to test and monitor the atmosphere within the confined space;

- Means of purging hazardous gases or vapours from the space;

- Ventilation, whether natural or forced;

- Arrangements for removal of residues;

- Isolation from hazards, including materials, electrical and mechanical equipment, and sources of stored energy;

- Methods of fire prevention, and response in the event of fire;

- Selection and use of work equipment, PPE and Respiratory Protective Equipment (RPE);

- Arrangements for the use of gases, such as for welding, whether supplied from portable cylinders or hoses;

- Physical arrangements for, and control of, access and egress, for all situations including planned operations, escape and rescue;

- Provision of suitable lighting, taking account of the intended task and working environment;

- Protection against static electricity;

- Arrangements for rescue of personnel, including:
  o Selection of suitable rescue equipment, training of users, and bringing the equipment to the required location;
  o Notification of others, beyond the immediate work group, that a confined space entry is in progress, in case assistance is required for evacuation after initial rescue;

- Assessment of the need to limit working time; and

- Use of a Permit to Work system.

C.5.3.4 MONITORING, REVIEW AND CHANGE MANAGEMENT

Any work in a confined space will require ongoing monitoring during the task. If there is any change of intent, or conditions, from those envisaged when the Risk Assessment and Method Statement (RAMS) for the task were prepared, then arrangements will have to be reviewed before the task can continue.
RAMS for work in confined spaces should include a plan for rescue of personnel from inside the confined space. In an emergency, a dynamic risk assessment should be carried out prior to undertaking a rescue, to check that the risks that the situation presents are adequately controlled in the pre-prepared rescue plan, and identify any additional precautions that may be necessary.

The effectiveness of emergency arrangements will depend on all personnel involved being fully familiar with their roles and responsibilities; this can be achieved through a combination of training and exercises, with the learning from exercises being reviewed in order to identify any necessary improvements. Confined space rescue plans should also interface with more general emergency response plans, such as ensuring that arrangements are in place for evacuation of casualties to hospital after rescue.

**C.5.4 Codes of Practice and Guidance**

**C.5.4.1 Regulations and Standards**


A similar ACOP is published by HSENI for work in Northern Ireland.

**C.5.4.2 Other Relevant Guidance**

HSE INDG258 - *Safe work in confined spaces*, provides a less detailed overview than the ACOP.
C.6 CONSTRUCTION

The construction phase will generally involve the highest number of people on site, out of all phases of the wind farm lifecycle, undertaking a wide range of potentially hazardous tasks, often with significant time and cost pressures.

This section focuses on the key hazards relating to work on construction sites.

Many other hazards, activities and approaches to safety management which are relevant to construction work are covered in more detail elsewhere in these guidelines:

- Other relevant sections of Part C include:
  - Balance of Plant - C.4
  - Driving - C.7
  - Ergonomics and manual handling - C.9
  - Hazardous substances - C.11
  - Lifting - C.12
  - Transport, both on and off site - C.15
  - Vibration - C.16
  - Work at height - C.17

- The Construction and Commissioning lifecycle phase - B.3;

- Aspects of safety management are covered in Part A:
  - CDM regulations - A.1.4;
  - Provision and Use of Work Equipment Regulations (PUWER) - A.1.8;
  - Safe systems of work - A.10;
  - Site management - A.11;
  - Occupational health and medical fitness to work - A.5;
  - Training and competence - A.8;
  - Emergency response and preparedness - A.16; and
  - First Aid - A.17

C.6.1 OVERVIEW

The main activities considered in this section are those relating to the civil BoP:

- Construction of site roads, drainage and hardstanding;
- Construction of WTG foundations; and
- Erection of site buildings.

Erection of WTGs is considered in more detail in section C.12, Lifting, while electrical BoP is covered in section C.4.

C.6.1.1 POTENTIAL HAZARDS AND RISKS

HSE data\(^{15}\) indicates that in the construction industry as a whole, the most common causes of fatal injuries are:

- Falls from height;
- Mobile plant;

\(^{15}\) HSE HSG150 - Health and safety in construction
• Falling materials and collapses of permanent or temporary structures;
• Electricity; and
• Trips.

The most common adverse health effects from construction work are caused by:

• Asbestos;
• Manual handling;
• Noise and vibration; and
• Chemicals.

With the exception of asbestos, all of the above hazards are likely to exist on wind farm construction sites.

C.6.1.2 RELEVANCE TO KEY LIFECYCLE PHASES

C.6.1.2.1 Project Definition

Site selection and layout will determine some of the challenges to be managed during construction, such as ground conditions and access issues. Micrositing decisions need to take account of both environmental impacts and potential effects on the safety of construction activities.

C.6.1.2.2 Project Design

Preparation for construction includes:

• The detail design of the site and the works to be constructed, which should include consideration of how construction will be carried out, and any hazards that can be eliminated or mitigated by design;
  o In many cases, detail design of some parts of the site will continue in parallel with initial construction work, so the phasing of design and construction must be carefully co-ordinated;
• Selection of contractors, which should be based on a thorough assessment of their competence to undertake the scope of work safely;
• Setting up of site safe systems of work for the construction phase, with particular attention to interfaces with between work packages, and the transition from construction to commissioning and operation.
  o More detailed guidance on the handover between construction and the WTSR is given in Section B.3.3.1.

The contracting strategy also offers opportunities to minimise site hazards, by adopting measures such as:

• Maximising the use of off-site fabrication;
  o This may also benefit cost and quality, by allowing a greater proportion of work to be carried out in a factory environment, rather than on a construction site;
    • Due to the constraints of the size of load that can be transported to a site, prefabrication may be limited to the preparation of kits for assembly on site, rather than complete packages; or

• Using trenchless techniques to reduce the need for excavations.

C.6.1.2.3 Operations and Maintenance

The O&M phase will receive the assets as constructed, so the quality of construction work will affect the scope of O&M activities. For example, the standard of road and drainage construction will determine whether future maintenance is limited to keeping the surface free from potholes, and keeping the drains clear, or if sections will need to be rebuilt from the foundations up.
The Project Health and Safety File is handed over from construction to the Client, and should be made available to those involved in O&M; it should contain relevant and accurate information to assist in future O&M work, and be in a format that is useful to the O&M team.

C.6.2 REGULATORY REQUIREMENTS
The principal regulations for the management of construction work are the CDM regulations; other regulations pertain to specific activities on sites.

C.6.3 MANAGING THE RISKS

C.6.3.1 APPROACHES TO RISK ASSESSMENT
The CDM regulations define a formal process that supports risk management in construction work:

- The Client provides Pre-Construction Information to prospective Principal Contractors (PC); this should focus on site-specific hazards that a competent contractor would not be expected to know about, and allows contractors to take account of site hazards when preparing their tenders for work;
- The PC prepares the Construction Phase Plan, which sets out overall health and safety arrangements for the work;

This project-level process is typically supported by:

- Preparation of Risk Assessments and Method Statements (RAMS) for the specific activities within the project; RAMS should:
  - Be relevant, clearly addressing the scope of work;
  - Identify hazards, control measures and precautions;
  - Define roles, responsibilities and interfaces for undertaking, monitoring and controlling the work;
- A final “dynamic” or “point of work” risk assessment should be carried out by the personnel involved in carrying out a task, before starting work, and if unexpected conditions are encountered;
  - This should determine whether:
    - The RAMS adequately address the actual hazards at the location of work; or
    - Additional safeguards need to be put in place to allow the work to proceed; or
    - The work has to be suspended until revised RAMS are agreed;
  - The expectations and limits on point of work risk assessments should be clear, and competent persons should be involved in decisions about additional safeguards and revisions; if in doubt, the work has to stop until safety is assured.

The Client will commonly select the WTGs to be used on a site, and the WTG installation method and contractors will be determined by the WTG supplier. As the Client has a duty to ensure that those they appoint are competent and adequately resourced to carry out the work that they have to do, they should assure themselves that the WTG supplier will appoint competent subcontractors, and ensure that the PC and WTG contractor can work together effectively, to enable the PC to fulfil their duties to:

- Plan, manage and monitor the construction work; and
- Co-ordinate and manage the construction phase to ensure the health and safety of all those undertaking or affected by the work.
C.6.3.2 Risk Mitigation Measures

C.6.3.2.1 Organisational Measures

Construction work typically involves large numbers of people from a wide range of organisations, including the Client, CDM Co-ordinator, Designers, Principal Contractor (PC), and Contractors. The CDM Regulations impose a legal duty to co-operate and co-ordinate their activities in the interest of health and safety, and to communicate hazards of which they become aware. The formal duties are outlined in Section A.1.4; at a site level, their practical implementation typically involves:

- Undertaking work in a suitable sequence, to minimise hazardous interactions between work activities;
- Site management ensuring effective communication of progress and hazards, both through formal meetings and real-time updates when necessary;
- Appropriate site rules and safe systems of work being established and enforced;
- Work being undertaken in accordance with agreed risk assessments and method statements (RAMS), with appropriate levels of supervision, and point of work risk assessments being carried out to ensure that the RAMS adequately reflect the actual hazards at the work site;
- Procedures being in place for high risk activities, such as
  - Excavations;
  - Work at height;
  - Energisation and handover, including tracking status across the site and informing site personnel;
  - Lone / remote working; and
- Ensuring that work equipment is properly maintained, taking account of statutory requirements and its conditions of use, and is used by competent people.

The site safe systems of work will normally be established and operated by the PC, who will generally be the main civil contractor. By the time that WTG erection is in progress, the majority of the civil work will generally be complete, but the duties as a PC continue until the site is handed over to operation. The competence of the PC to operate safe systems of work beyond normal civil construction work, together with clear interface arrangements with the WTG contractor’s systems, will be vital to ensuring safe completion of the construction phase. Other work may also take place on a site, outside the scope of standard construction work, such as wildlife monitoring and archaeological investigation; the PC should ensure that such work is carried out in accordance with the site safe systems of work.

C.6.3.2.2 Construction Plant

The inherent risks in the use of heavy mobile plant can be minimised by a wide range of measures, such as:

- Design decisions, which affect the work to be done, the plant that can be used, and the layout within which the plant will be used;
- Selection of suitable plant for the task and site conditions, such as:
  - Choice of wheeled or tracked plant;
  - Reach and capacity, which can affect the positioning of plant, and the loads that it imposes;
  - Maximum safe operating slope angle;
  - The extent of tail swing on excavators, which can be a hazard if working in restricted areas;
- Ensuring that plant is used properly;
operators should walk round plant before setting off, to check for any hazards that could not be seen from the driving position;

- Plant should not be overloaded, as this affects stability and / or visibility;

- Operating procedures should be followed, and speed limits respected;

- Aids to vision, such as mirrors and CCTV to minimise blind spots, should be properly maintained, adjusted and used, to minimise risk to people and vulnerable structures in the vicinity of the plant;
  - People working alongside plant should also be aware of blind spots, and be trained in even apparently simple activities such as gaining the attention of the driver, and knowing when it is safe to approach;

- Ensuring that plant is in good condition:
  - Regular safety checks (daily / periodic) should be carried out and recorded;
    - These include both basic checks by the operator, and periodic specialised tests such as instrumented brake testing;

  - Adjustments, such as changing buckets on an excavator, should be carried out in a safe location, by a competent person, in accordance with the manufacturer’s instructions;
    - Errors in fitting or adjustment could either result in injury to the person involved, or create a latent defect in the plant, putting others at risk when it is used;

- Ensuring that plant is only used where the ground has sufficient bearing capacity, particularly when working beyond made roads, or next to excavations or edges of roads;

- Ensuring that plant has functional reversing warning signals – but noting that people can become used to these, at which point these signals just become part of the background noise of the site;

- Ensuring that plant drivers / operators, vehicle marshellers and other workers who will be in vicinity of plant are:
  - Trained and competent for the equipment and task;
  - Medically fit for their roles; and

- Considering the potential for interaction with other users of site roads, such as other land management work and recreational users, to ensure that plant drivers and other users proceed with sufficient awareness of vehicles and people who may be present.

C.6.3.2.3 Forestry Operations

Initial site preparation work may include timber harvesting, tree pruning and mulching of brushwood and forestry waste. As site preparation is within the definition of construction work under CDM, such activities should take place under the control of the PC.

Tree felling, use of chainsaws, forwarders and mulchers are high risk activities, which should only take place within an effective exclusion zone, which takes account of the risks of materials being ejected at high speed from machinery:

- In the event of a chainsaw chain breaking, “chain shot” can occur, in which a chain fragment is ejected at the speed of a bullet;

- The risk from chain shot can be controlled through a combination of:
  - Site planning, to identify and implement the necessary exclusion zones;
  - Machine guarding, to minimise potential chain shot ejection routes;
  - Chainsaw inspection and maintenance, to minimise the risk of chain breakage; and
  - Machine operation, including correct positioning and speed control.
C.6.3.2.4 Underground and Overhead Services

Damage to underground services, such as pipelines and cables, can present a serious risk to people; such damage can either occur directly as a consequence of excavations, or indirectly due to movement of heavy vehicles over inadequately-protected services. Contact with cables can be fatal, most commonly due to severe burns from arc flashes, in addition to the risk of electric shock. Several precautions should be applied to avoid such events, including:

- The Pre-Construction Information (PCI) provided by the Client should identify the presence of underground services; these include:
  - Electricity cables;
    - Both LV and HV – the most common cable strikes in the construction industry are at 415V;
    - Both utility and private networks – there can be private supplies to railway lines and telecommunications infrastructure;
  - Pipelines;
    - Gas transmission and distribution;
    - Petrochemical refinery products, such as fuels and various gases;
    - Water and sewage pipelines;
  - Telecommunications cables do not present a major health and safety risk, but can lead to costly repairs and public inconvenience if damaged;
- Plans of buried services should be checked, although cannot be relied upon for precise positioning;

The PC should make use of information on underground services from the PCI, but should not assume that the absence of information about the presence of services in a particular location guarantees that there are no underground services in that location. Site rules should be implemented to ensure that excavations only take place in accordance with a safe system of work, which will typically require that:

- Prior to undertaking excavations, detailed utility plans are checked, and instruments such as a Cable Avoidance Tool (“CAT Scanner”) are used to check for cables and metal pipes; note that many gas and water pipes are plastic, so cannot be detected by this method;
  - The results of scanning should be marked on the ground, to identify the areas where mechanical excavators and power tools should not be used;
- Hand-digging of trial holes may be necessary, in order to identify precise positions of services;
  - While insulated tools protect against electric shock, they do not reduce the risk of major burns from a short circuit, so hand-digging near to cables should be carried out with extreme care and suitable methods to minimise the risk of cable damage;

Brownfield sites may contain redundant underground services; these should be assumed to be live until proven otherwise, and, depending on the site history, redundant buried pipes can contain hazardous residues.

Overhead lines present a hazard when using high vehicles, such as excavators, cranes, MEWPs and tipping trailers. HV electricity can arc through air to an earth conductor, so a fatal accident can occur if vehicles or their loads pass too close to such lines, even if no contact is made.

Site design should avoid installing new overhead lines across access routes, and ideally avoid locating access routes and work areas beneath existing overhead lines. Where this is not reasonably practicable, “goalpost” arrangements should be used to indicate the maximum safe vehicle height that can pass beneath the lines. It may also be necessary to erect barriers, to ensure that drivers do not attempt to bypass the goalposts. The risk is particularly great for vehicles whose height can vary depending on usage: for example, a lorry might pass safely
under overhead lines, but if its lorry-mounted loader crane is then extended to unload materials, the safe height could be exceeded.

Emergency procedures should be in place to respond to incidents involving underground or overhead services, in order to minimise further harm to people. Note in particular that even if an overhead line trips and is initially dead in the aftermath of an accident, such lines can be reset remotely or automatically, so the scene of the accident should not be approached until the operator of the overhead line confirms that the line has been made safe and will not become live.

C.6.3.2.5 Excavations

Excavations should be planned in order to minimise the risk from several different hazards, such as:

- Collapse of the sides of excavations should be prevented;
  - This may be done by the use of supports;
    - The type of support system, and its method of installation, should be planned in advance; however
    - People should not be put at risk during installation or removal of the supports; and
    - Supported trenches should be inspected by a competent person at the start of each shift, and at any other time when stability could be at risk, and the inspection reports recorded; alternatively
  - The edges of the excavation can be “battered back” or profiled to a stable angle, taking account of the soil conditions, however, this increases the volume of excavated material (with a corresponding increase in the size of spoil heaps) and the width of the trench, increasing the overall disturbance to the site;

- People or vehicles should be prevented from falling in:
  - The sides of excavation should be protected with suitable barriers – either a fixed guardrail with toeboard at the edge of the excavation, or fencing to keep people back from the edge;
  - Vehicles should be kept at a safe distance from excavations, both to prevent driving into the excavation, and the weight of the vehicle causing collapse;
    - If vehicle movements take place at night, marker lights may need to be provided on barriers;
    - Note that most barriers only make excavations more visible, but will not physically stop a vehicle;
  - If vehicles are tipping material directly into excavations, then it may be necessary to install stop-blocks, so that vehicles cannot get too close to the edge;

- Materials should not be placed where they can fall into excavations:
  - The locations of spoil heaps, and parking of plant or vehicles, should ensure that materials cannot fall or slide into the excavation;
  - The potential for boulders to roll down steep slopes, if disturbed, should be considered, to ensure that they cannot be dislodged above areas where people are working;

- Adjacent structures or ground should not be undermined;
  - Consideration should be given to whether the excavation could affect the foundations of adjacent structures, such as farm walls and existing buildings on a site; temporary supports should be installed if necessary;
  - If access routes pass through forests, trenches should be kept at an appropriate distance from trees, to avoid severing main roots, as this could increase the risk of the trees later being blown over in strong winds;

- Water ingress to excavations needs to be managed;
It may be possible to channel surface water away from excavations;

- Side supports of excavations may reduce water ingress;

- Pumping of water from excavations may be necessary, but can also cause instability, and create volumes of silt-laden water, which will need to settle or be filtered before it reaches a watercourse.

While it is preferable for people not to have to enter excavations, it is essential for some tasks, such as assembling reinforcing cages in foundations. The importance of the above precautions is increased by the presence of people in the excavation; additional considerations include:

- Safe access and egress to and from the excavation;

- Safe movement within the excavation, considering hazards such as obstructions from side-supports and the presence of water in the excavation;

- Safe means of lifting equipment and materials in and out of the excavation, ensuring that lifting equipment is on stable ground, and people are not beneath suspended loads;

- Safe means of moving equipment and materials within the excavation, as this may involve manual handling in a restricted location; and

- The presence of hazardous fumes in the excavation, such as exhaust fumes from adjacent plant.

### C.6.3.2.6 Borrow Pits

It is often desirable, on economic and environmental grounds, to obtain stone for road construction from a borrow pit on the site. Where stone is extracted solely for on-site use, these activities are not subject to the Quarries Regulations 1999, however the hazards are the same, therefore it is good practice to apply the principles and guidance relating to those regulations. These provide a clearly defined approach to the safe management of borrow pits, including competence standards for those involved in their management and operation, assessing risks, and implementing a co-ordinated plan for the operation of a quarry. Specific considerations include:

- Safe management of blasting operations, including the storage, handling and use of explosives, and ensuring that people are not put at risk by debris;

- The faces of a borrow pit may be unstable, depending on the type and properties of the rock, and the height and angle of the face; safe working depends on:
  - Having sufficient geotechnical understanding to assess the risks of collapse or slippage; and
  - Implementing suitable protective measures, such as rock traps at the base of faces;

- Borrow pits are often worked with construction plant that is very similar to plant used elsewhere on the site, but as the hazards are different, operators need additional competence;

- Piles of extracted or processed materials may be unstable;

- The edges of a borrow pit may create a risk of falling, so should be suitably protected, taking account of any instability in the ground adjacent to the edges;
  - The form and position of protection will depend on whether people, livestock or vehicles could be put at risk;

- The bottom of a borrow pit may fill with water, creating a risk of drowning;

If a borrow pit is to remain open after completion of construction, such as for future working by civil maintenance contractors or the landowner, then:

- Long-term protection of edges may be needed, particularly when public access or livestock grazing on the site is foreseeable; and
• Health and safety responsibilities must be clearly agreed between the different parties involved.

Extracted material may have to be processed in stone-crushing machines; these can be very hazardous:

• In normal operation, crushers can emit high levels of noise, vibration and dust (including hazardous silica dust); suitable measures should be taken to suppress dust emissions;
  o This is particularly important at temporary locations, which may not have all of the facilities, such as water supplies, that would be present at an established quarry;
• Materials can also fall during loading operations, or from conveyors, so people should not be in their vicinity when in operation;
• Blockages can be particularly hazardous, therefore operating procedures should:
  o Minimise the risk of blockages occurring, by preventing overloading, or the feeding of oversize or contaminated material into crushers; and
  o Provide safe methods by which competent persons can clear blockages, including the isolation of energy sources (also taking account of the potential for stored energy in hydraulic systems), and ensuring that people are not put at risk by ejected material – especially metal fragments.

Concrete batching plants are often set up adjacent to borrow pits;

• These require a firm foundation, space for vehicle movements for deliveries of materials and collection of mixed concrete;
• Hazardous materials, including cement and additives, will be present, and must be contained effectively;
• Refilling is usually done by pneumatic conveying of sand or cement from road tankers to silos on the plant; the safety of this is dependent on the efficient operation of filters, pressure-relief valves and level sensors; and
• Operating procedures should include safe procedures for dealing with any blockages that may occur, to avoid hazards such as overpressure or sudden release of materials;

Borrow pits and batching plants should only be operated by trained and competent people, working under competent supervision, such as those holding Mineral Product Qualifications Council (MPQC) qualifications, of an appropriate level for their role.

Both borrow pits and batching plants will have high volumes of heavy traffic at peak periods in the construction process, so a traffic management plan should be in place, which takes account of site hazards and supports the safe movement of vehicles.

**C.6.3.2.7 Weather**

Adverse weather can present various risks to people working on a site; a policy should be put in place to address risks such as:

• Effects of high winds, which can be mitigated by specifying wind speed limits for lifting operations, transport of components such as blades, and closure of the site;
  o When high winds are forecast, additional checks should be undertaken to ensure that materials and stored components are secured against being blown away or blown over;
• Effects on access, such as:
  o Being snowed in, or public and site roads being affected by ice;
    • Note that snowfall can also conceal unmarked edges of roads, and limit visibility;
  o Localised flooding affecting access roads;
• Fog or low cloud giving poor visibility;
• Lightning strikes, particularly for work involving tall structures such as WTGs or cranes, or on open hills;
  o In addition to obtaining forecasts, lightning detectors can be used to provide early warning of approaching thunderstorms;
• Prolonged periods of dry weather, which increases the risk of heath, moorland or forest fires;
  o Grass fires in upland areas commonly occur in late spring, before the new growth has covered the old dry grass from the previous year;
• Extreme or prolonged periods of rainfall can affect safety:
  o Partially-completed infrastructure, such as roads and drains, may be damaged, and can also give rise to environmental risks, if suspended sediment reaches watercourses;
  o Open trenches, such as cable trenches, can effectively become drains, which can destabilise their sides and also wash out fine material;
  o The risk of landslips is increased;
  o Safe movement of people and vehicles can be impaired, particularly if any activities have to take place away from finished roads;
• Hot and / or sunny weather can give a risk of sunstroke, sunburn, hyperthermia or dehydration; sunburn increases the long term risk of skin cancer;
• Cold weather can give a risk of frostbite or hypothermia;
  o It also complicates emergency response, as an immobile casualty in very cold conditions will be at high risk of hypothermia; and
• Ice formation on WTG blades may require WTGs to be shut down, to reduce the risk of ice throw, and exclusion zones being put in place where ice could fall;

PPE should be suitable for the prevailing weather conditions, ensuring that wearers remain dry and at a comfortable temperature, while still performing its essential protective functions.

C.6.3.2.8 Temporary Works

The term “temporary works” refers to a wide range of engineered solutions, used to provide support or access to structures, equipment, excavations or slopes during the construction, alteration or demolition of permanent structures. Typical temporary works during wind farm construction include excavations for trenches and foundations, temporary slopes and stockpiles of material, and temporary crane foundations. In order to ensure that people are not put at risk by temporary works, their correct design and implementation is important.

Temporary works procedures generally include the appointment of a competent Temporary Works Co-ordinator (TWC), who is responsible for ensuring that suitable designs for temporary works are prepared, checked, implemented, used, maintained and dismantled in a controlled manner across the site, with an appropriate level of independent design verification and inspection of the works. The scope of work for the TWC will depend on the scale and complexity of the temporary works on the site; on a small site with low risk temporary works, a designer may fulfil the TWC function, whereas on large sites, or where there are high risk temporary works, the TWC may require the support of Temporary Works Supervisors, designers, engineers and inspectors.

C.6.3.2.9 Temporary Facilities

Construction sites generally require a range of temporary facilities to accommodate the people and activities involved in the work. Considerations for temporary facilities include:

• Ensuring that temporary structures are located on firm ground, and secured / anchored against high winds;
• Provision of safe access to working areas, which might include pedestrian routes and site transport;
• Provision of communication links on and off site, such as temporary landlines, mobile phones and radios;
• Areas for safe unloading, secure storage and laydown of materials;
• Adequate and safe installation and maintenance of temporary services, such as electricity (from generators or site distribution network), liquefied petroleum gas (LPG) and other fuel supplies;
  o Particular attention should be given to any gas appliances (and associated flue systems) that are provided for the use of workers, such as water heaters, cookers or space heaters;
• Keeping the facilities functional in cold weather, such as ensuring that water supply pipes do not freeze overnight;
• Arrangements for waste collection and disposal; and
• Provision of suitable lighting, within the constraints of any planning conditions.

Facilities should be kept clean and regularly maintained, and adequately secured against theft or vandalism, particularly for high risk functions such as fuel or component storage, and parking areas for vehicles.

**C.6.3.2.10 Welfare Arrangements**

Under the CDM regulations, the PC has a duty to provide suitable welfare or amenity facilities; the Client is responsible for ensuring that PC provides them. The facilities should include:

• Protection against extremes of weather;
• Toilets and washing facilities, including hot water;
• Mess facilities, including drinking water, means of boiling water and heating food;
• First aid facilities;
• Storage for personal protective equipment; and
• Changing / drying rooms;

The PC should ensure that the facilities are properly looked after, so that they are in a hygienic state for users.

On large sites, it may be beneficial to provide some mobile facilities, in order to minimise time spent travelling on the site, as this is an inconvenience to workers and a cost to employers.

**C.6.3.2.11 Control of Access**

Temporary fences, signage and / or barriers and security personnel may be required to:

• Segregate vehicles from pedestrians;
• Restrict or control access to members of the public where this is necessary for public safety or site security;
• Avoid construction encroachment on areas containing crops or livestock; and
• Indicate rights of way, safe walking routes or landowners’ boundaries.

It may also be necessary to liaise with neighbouring land managers to avoid hazardous interference between construction activities and land management operations such as forestry and agricultural work.

**C.6.3.2.12 Ground and Biological Hazards**

Ground conditions and contamination can present a range of hazards to construction work, such as:

• The ground may be unstable, particularly if steep slopes or peat soils are present;
  o Stability assessments may need to be carried out;
Site design may be able to avoid works in areas with a risk of instability;

- Monitoring should be carried out as appropriate, particularly when the ground has become saturated with water;

- Response plans should be in place for actions to take if slippage appears to be imminent, or if a slide happens;

- Land may be contaminated by previous uses, particularly on brownfield sites or adjacent to industrial sites;
  
  - Contamination could include chemicals in groundwater, spoils from former industrial uses, areas of landfill, and asbestos in demolition debris;
  
  - The Pre-Construction Information provided by the client should indicate any known areas of contamination, so the Construction Phase Plan can include suitable safeguards;
    
    - Workers should be trained to recognise potentially hazardous materials uncovered in excavations, and stop work to allow investigations to be undertaken and precautions implemented;
    
    - Excavations should be treated as confined spaces, if there is a risk of contamination by hazardous substances;
  
  - Previously undeveloped sites may also have localised contamination if fly-tipping has occurred; this is most common where road access is available;
    
    - Site security should minimise the risk of fly tipping occurring during the development of the wind farm;
    
    - Practical measures such as the positioning of fences and gates at site entrances can ensure that these do not unintentionally create lay-bys that would be attractive to fly tippers;

- Unexploded ordnance (UXO) may be present on some sites;
  
  - This is most common on sites that were subject to wartime bombing or previous use as a live firing range, and especially where soft soils could allow ordnance to sink into the soil without trace;
  
  - The site history should be reviewed, and risks assessed, followed by any necessary survey and remedial work;

Biological hazards may also exist on some sites:

- Watercourses may contain water-borne diseases such as Leptospirosis;
  
  - Contact with canal and river water should be minimised, particularly in areas where rats or cattle may be present;
  
  - Workers should use protective clothing, and maintain good personal hygiene, in particular washing hands before eating, drinking or smoking;

- During the earliest stages of construction, when workers may have to work on vegetated land, such as when setting out the line of access roads, they can be at risk of tick bites, which can cause Lyme Disease;
  
  - The risk of tick bites can be minimised by avoiding exposing skin to grass and moor / heathland vegetation, such as by wearing gaiters or tucking trousers into boots or socks;
  
  - Workers should check themselves for tick bites, know how to remove ticks safely, and be aware of symptoms, as early treatment minimises severity.

**C.6.3.3 Monitoring, Review and Change Management**

Site management and supervision of work need to ensure that work is carried out in accordance with site rules, safe systems of work, and task RAMS. Adherence to such policies is likely to be highest on sites where:
• There is a strong safety culture, with management demonstrating commitment to safety as the highest priority;
• RAMS specify realistic and practical methods and precautions;
• Hazardous observations are followed up, and improvements implemented; and
• If a particular task cannot reasonably be completed in accordance with approved RAMS, management support is available to identify safe and practical methods, and revise RAMS accordingly, or to stop work if the task cannot be completed without unacceptable risk.

C.6.4 CODES OF PRACTICE AND GUIDANCE

C.6.4.1 REGULATIONS
HSE L144 - Managing health and safety in construction - Construction (Design and Management) Regulations 2007 - Approved Code of Practice.
HSE L118 - Health and safety at quarries. The Quarries Regulations 1999. Approved Code of Practice. Note that on-site borrow pits are not subject to the Quarries Regulations, therefore this ACOP should be used as guidance on how to reduce risk ALARP, but is not a legal requirement.

C.6.4.2 OTHER RELEVANT GUIDANCE - REGULATORS
HSE HSG150 – Health and safety in construction
HSE HSG144 – The safe use of vehicles on construction sites
HSE CIS52 - Construction site transport safety: Safe use of site dumpers
HSE HSG47 – Avoiding danger from underground services
HSE GS6 – Avoiding danger from overhead power lines
HSE Website - Asbestos on brownfield sites
HSE Website – Temperature – Outdoor working addresses the risks presented by working in very hot or cold conditions.
HSE A38 - Asbestos Essentials - How to deal with asbestos in fly-tipped waste
HSE INDG84 – Leptospirosis
HSE Data Sheet – Lyme Disease
HSE CIS26 – Construction Information Sheet, provides information on hazards and precautions relevant to the use of cement-based materials.
CDM Red, amber and green lists give examples of procedures, products and processes to be avoided or encouraged in construction.

The HSE website includes a brief overview of the management of temporary works, and detailed guidance on the HSE’s expectations of how temporary works will be managed, and compliance enforced.

C.6.4.3 OTHER RELEVANT GUIDANCE
CIRIA C733 - Asbestos in soil and made ground: a guide to understanding and managing risks (Priced publication).
CIRIA C716 - Remediating and mitigating risks from volatile organic compound (VOC) vapours from land affected by contamination (Priced publication).
United Nations Mine Action Service IMAS_09.30 - Explosive ordnance disposal provides specifications and guidelines for the safe conduct of Explosive Ordnance Disposal (EOD) operations.

Scottish Executive - Peat Landslide Hazard and Risk Assessments - Best Practice Guide for Proposed Electricity Generation Developments

RenewableUK H&S Bulletin - Winter Working (available for RenewableUK members to download).

CITB Construction Site Safety GE700 is widely used as a reference source, covering Legal and Management, Health and Welfare, General Safety, High Risk Activities, Environment and Specialist Activities, and also forms the syllabus of the Site Management Safety Training Scheme. (Priced publication).

Forestry Industry Safety Accord publications include: Flails and mulchers in tree work, Mechanical harvesting and Firefighting.

The Strategic Forum Plant Safety Group (hosted by the Construction Plant-hire Association) has published guidance on MEWPs, telehandlers, medical fitness, competence and ground conditions.

Good practice during wind farm construction, a joint publication of Scottish Renewables, Scottish Natural Heritage, Scottish Environment Protection Agency, Forestry Commission Scotland and Historic Scotland, is aimed at the post-consent / pre-construction phase of development, and is intended to support developers in minimising environmental and heritage impacts during wind farm development. While it does not specifically address health and safety impacts, early consideration of its recommendations can enable an integrated approach to be taken, and avoid conflict between environmental protection and health and safety objectives.

The Temporary Works Forum publishes guidance and news releases on a range of issues relating to temporary works.

C.6.4.4 STANDARDS

CEN CWA 15464:2005 defines competence standards for operators and supervisors involved in EOD work; this should be backed up by specific training on the types of munitions likely to be present at a site.

BS 5975:2008 Code of practice for temporary works procedures and the permissible stress design of falsework – note that the harmonisation of European structural design codes has led to a change in design approach, resulting in a state of transition in the design of temporary works.
C.7 DRIVING AT WORK

This section considers driving, in the context of personnel travelling between and on sites. Transport and unloading of loads is covered in Section C.15, while hazards relating to moving construction plant are covered in Section C.6.

C.7.1 OVERVIEW

At the start of 2015, the UK onshore wind industry consisted of over 700 sites in operation or under construction, distributed throughout the country. As most wind farms are relatively remote from major population centres and transport infrastructure, support personnel may have to travel significant distances to reach sites, particularly in the case of specialist personnel providing occasional support to a large number of sites, or construction personnel who may work at any project location.

C.7.1.1 POTENTIAL HAZARDS AND RISKS

Risks associated with driving can relate to the driver, the vehicle and the location, and include:

- The driver:
  - Competence in relation to the type of vehicle in use, and the nature of the journey;
    - Different skills are needed for driving a large four wheel drive vehicle (4WD), compared to a conventional car;
  - Attitude;
  - Fitness, considering both health and levels of fatigue;

- The vehicle:
  - Design / selection – stability, all round-visibility, safety features such as anti-lock braking, suitability for the journey, fitting of appropriate tyres;
  - Condition – efficiency of safety-critical components such as brakes, tyres, suspension, lights, cleanliness of windows; and

- The location
  - Class of road, road conditions, traffic.

Particular challenges for driving in association with wind farms include:

- Vehicles that are most suitable for use on site roads may not be ideal for long journeys between sites;
- Project construction and commissioning schedules, or the cost of downtime on operational sites, may create pressure to combine long journeys with long working days;
- The last part of a journey to a wind farm is likely to be on rural roads:
  - Many rural roads were not designed for modern traffic, so may have tight bends, poor sight-lines, limited opportunity for safe overtaking, no footways for pedestrians, and lack safety features such as crash barriers above drop-offs;
  - Drivers may also encounter livestock or deer on the road;
  - Rural areas may have limited mobile phone network coverage, particularly in valleys that do not have “line of sight” to a mast, increasing the difficulty of obtaining help in an emergency;
  - Rural roads generally have a lower priority for winter services, such as snowploughing and gritting, than trunk roads and motorways, so are more likely to be affected by snow and ice than the rest of the network;
    - This is exacerbated where roads pass over high ground, where there are likely to be lower temperatures, more snowfall and drifting than in lower areas;
• Personnel from other EU states will be accustomed to driving on the right hand side of the road; errors are most likely when tired, or driving on minor roads with light traffic and limited road markings.

C.7.2 REGULATORY REQUIREMENTS

Driving on public roads is subject to the Road Traffic Act 1988 (RTA), which sets legal minima for aspects such as:

• Standards of driving and testing;
• Medical fitness of drivers;
• Standards for the construction and use of vehicles; and
• Tests of vehicle condition.

The RTA does not apply to driving on site roads, although employers generally adopt its principles into site rules. Driving as part of work activities is subject to the HSWA and MHSWR, therefore employers are subject to duties to identify hazards, assess risks, and reduce risk so far as is reasonably practicable. Fulfilling this duty may result in the adoption of rules and standards that go beyond the requirements of the RTA, for example:

• Possession of a valid driving licence fulfils the legal requirements to drive specified categories of vehicle, but does not necessarily mean that a person is trained and competent to do so. For example, a person who gained their UK car driving licence before 1997 is legally entitled to drive a medium-sized vehicle with a trailer, with a total weight of up to 8250kg, but may not have had any training, assessment or recent experience in driving such vehicles, or reversing with a trailer;
• Additional training may be necessary in order to reduce risk from particular types of driving, such as off road or in winter conditions; and
• Site speed limits will generally be lower than the limits on public roads.

The entitlement to drive different categories of vehicle on a standard EU driving licence changed in January 2013, and on several previous occasions, so individual entitlements should be checked before employees are assigned to driving duties other than light vehicles (defined as those having a Maximum Authorised Mass (MAM) of up to 3.5te.) If a 4WD pickup is used to pull a trailer on public roads, and the MAM limit of 3.5te is exceeded as a result, not only will some drivers not have the necessary entitlement to drive it, but the vehicle will also be required to have a tachograph.

Site roads are subject to the Workplace regulations, which impose duties in relation to their design and maintenance.

C.7.2.1 HOURS OF WORK

The hours of work for drivers of goods vehicles are defined in GB and EU regulations; the limits depend on the category of vehicle, and the nature of the journey.

The provisions of the Working Time Regulations 1998 do not apply to travel from home to work, or between places of work, in relation to limits on night work, daily and weekly rest periods, and breaks during the working day; however employers have a duty to:

• Wherever possible, allow the employee an equivalent period of compensatory rest; and
• If that is not possible, afford the worker “such protection as may be appropriate in order to safeguard the worker’s health and safety”

The effect of these duties is that, while there can be some flexibility in the combination of work and driving time on a daily and weekly basis, workers should not be put at risk by fatigue.

C.7.3 MANAGING THE RISKS

In all phases, it is important that the planning of work allows adequate time for journeys.

The training and competence of drivers should be assessed, with the thoroughness of the assessment being proportionate to a driver’s level of risk exposure. This will not necessarily be
limited to drivers of special vehicles such as 4WDs, but should also be considered for ordinary car drivers travelling between sites, noting that the standard qualification for car driving is a 40 minute test at age 17, possibly outside the UK.

Within wind farms, the safety of the site road network will depend on factors such as:

- The quality of the roads, in terms of:
  - Initial design and construction;
  - Provision of passing places and turning areas;
  - Subsequent maintenance;
- The standard of driving of all site road users;
  - Suitable training and assessment should be undertaken;
  - Consistent expectations should be set, both for site personnel and visiting drivers, and performance monitored;
- Site rules, including requirements such as:
  - Site speed limits, which may need to be lower in areas adjacent to site compounds, compared to other areas of the site;
  - Rules for passing / giving way to other vehicles, to ensure that vehicles do not overload the edges of roads;
  - Rules for parking, such as requiring reverse parking, or “drive-through” approaches to parking bays; and
- The selection and condition of vehicles, noting that off-road use may lead to accelerated wear of safety-critical components such as tyres, brakes and suspension.

C.7.3.1 Project Definition

The access routes to and within the site should be considered, and initial risk assessments carried out; this can be supported by initial community engagement work, so that local knowledge can help to identify areas of concern. While there may be little choice of access points for small wind farms, large wind farms may be accessible from more than one public road, so the location of the access point will determine the final part of the route to the site, potentially also influencing the effects on local communities.

C.7.3.2 Project Design

The detail design of site roadways and parking areas will affect the safety of users over the life of the project, for example:

- The layout will determine where site roads can operate as one-way systems, and where two-way traffic, turning heads and passing places are required;
  - The size and position of passing places will affect the ease and safety of their use; sight-lines should aim to avoid the need for vehicles to reverse back to a passing place;
  - The detail design of site entrances, and their location, will affect the safety of their use, such as the ability to see oncoming traffic
- Steep drop-offs and deep ditches can increase the risk of overturning, if a vehicle gets too close to the edge of a road;
  - Edge markers can assist in identifying the limits of the running surface of a road, which may be significantly narrower than its apparent width, while berms can provide physical protection against vehicles leaving the road;
- Parking areas should be located to provide safe pedestrian access to site offices / stores etc., where possible avoiding the need to cross site roads. Ensuring sufficient space for vehicles to manoeuvre, and minimising the need to reverse, will reduce risk to pedestrians.
Peak levels of activity on sites may involve many more vehicles than during normal operation; site design may involve additional temporary parking areas being available during the construction and commissioning phase, and then removed or reduced in size on completion.

- The selection of contractors should include assessment of their policies on managing driving risk; the assessment could consider factors such as:
  - Training and competence standards for drivers in different roles;
  - Policies on working time, journey planning and health surveillance;
  - Arrangements for inspection and maintenance of company vehicles; and

- Contracts should ensure that responsibilities for general and winter maintenance of roads are clearly set out, and that the costs of delay caused by adverse road conditions are clearly apportioned.

**C.7.3.3 Construction and Commissioning**

This phase will generally involve the most concentrated period of vehicle movements, on and off site, and with a mixture of light and heavy vehicles, therefore it is important to ensure that the associated risk is managed effectively, in accordance with the policies agreed in the project design phase.

The project plan should ensure that the site roads are completed before they are needed for intensive vehicle access, and that they are maintained as required during the phase. Mud from excavations can cause a skid hazard, affecting public safety if highways are contaminated; the use of wheel-washing facilities is often stipulated in planning conditions in order to minimise this risk.

If construction activities take place in winter, work may have to be suspended if snow and ice prevent safe access to, from and within the site.

If work is to take place during hours of darkness, the need for lighting should be assessed – although on some sites, planning conditions may restrict lighting. Any lighting should be set up to avoid dazzling drivers (considering the angle, colour and intensity of lights), or creating strong contrasts of light and shadow, which could conceal hazards.

Site traffic management plans should address factors such as:

- Speed limits, which should be:
  - Appropriate to the location and road conditions, but not unreasonably slow; and
  - Effectively enforced;

- Locations and operation of parking areas, including procedures to ensure that parked vehicles are left in a safe and secure condition, such as handbrake applied and keys removed from ignition to prevent movement;

- Segregation of pedestrian and vehicle routes;

- Priorities for light and heavy vehicles;

- Communication of information on site layout, approved routes and significant hazards;

- Control of any temporary roads on the site, including ensuring that they are constructed to an appropriate standard, and any restrictions on use implemented effectively, particularly if running surface condition or gradients prevent safe use by certain types of vehicle;

- Procedures for hazardous activities such as turning and reversing;

- Procedures for winter working, including:
  - Vehicle checks and equipment;
  - Winter service of site roads and access routes;
  - Decision-making criteria for when work has to be suspended; and
- Procedures for inspection and maintenance of site vehicles, and for recovery of failed vehicles.

C.7.3.4 OPERATIONS AND MAINTENANCE

During the O&M phase, wind farms will generally operate with limited presence of workers on the site.

Off-site driving can be minimised if locally based staff can be deployed to sites; when staff from further afield are required, the planning of their work should take account of their travelling times.

Maintenance of site roads is important to ensuring that they can be used safely, when required; effective maintenance takes account of expected seasonal effects of weather, such as checking that drains are clear before winter, or carrying out additional inspections after periods of extreme rainfall. For light vehicles, the quality of the running surface and its drainage will be the key issues to consider, whereas the underlying structural state of the road will be important when heavy vehicles have to be brought to site.

Site driving should be managed in a similar way to in the construction phase, although extra caution should be exercised on roads that are infrequently used, particularly after periods of extreme weather, which may introduce new hazards.

C.7.4 CODES OF PRACTICE AND GUIDANCE

C.7.4.1 REGULATIONS AND STANDARDS

Vehicle & Operator Services Agency - Rules on Drivers’ Hours and Tachographs - Goods vehicles in GB and Europe


C.7.4.2 OTHER RELEVANT GUIDANCE

HSE INDG382 - Driving at work - Managing work-related road safety

DVLA leaflet - Tiredness can kill – Advice for drivers

C.7.4.3 ELSEWHERE IN THIS GUIDANCE

Health surveillance: Fitness for Driving
C.8 ELECTRICAL SAFETY

C.8.1 OVERVIEW

The scope of this section is to consider the risks to people from electrical hazards in the course of work on wind farms, and therefore does not address issues such as grid codes, standards and procedures. However, suitable interface arrangements are needed with the transmission or distribution network, in order to ensure that these do not introduce risks to people on the wind farm.

Wind farms utilise a wide range of electrical systems, including:

- HV systems for power collection and export, such as transformers and switchgear within individual WTGs, substations, and cabling within the wind farm and for export;
- LV systems in generators and for ancillary functions within WTGs;
- Temporary installations, such as the use of generators during commissioning and major maintenance; and
- Portable equipment used by technicians.

C.8.1.1 POTENTIAL HAZARDS AND RISKS

Any technical or procedural failures relating to electrical systems can expose people to a variety of hazards including:

- Electric shock, which has a range of adverse effects on people, including involuntary muscular contraction (which could indirectly lead to injury, for example by falling from height), respiratory failure, cardiac arrest and death;
- Internal burns due to heating when an electrical current passes through body tissues;
- Fire and smoke, which may be caused by a wide range of reasons including overheating of components that are overloaded, leakage current through defective insulation, failure of cooling systems, presence of combustible material adjacent to hot surfaces, or arcing / sparking at terminations;
- Arc flash, which releases very high levels of UV radiation, causing skin and eye damage, and potentially very severe burns if a person is enveloped by the arc; and
- Explosion, such as the rupture of switchgear or other equipment due to an internal fault, or the ignition of a flammable atmosphere due to a spark.

Even after all electrical supplies external to an equipment item have been isolated, stored energy, for example in batteries with an uninterruptable power supply (UPS), or in capacitors within converters, can still present a hazard to people.

Faults on electrical systems, even if they are not directly hazardous to people, can create consequential risks to people, for example:

- WTGs may be left without operable aviation obstruction lighting, creating a hazard to aviators; and
- Loss of power can affect the availability of systems such as communications, lifts and internal lighting that are needed to enable safe working inside the WTG.

C.8.1.1.1 Electrical and Magnetic Fields

Electrical equipment can emit power-frequency electrical and magnetic fields; exposure limits are unlikely to be reached in the course of work on wind farms. The strongest fields are likely to be in close proximity to live busbars, reactive power compensating equipment and overhead lines; in practice, these items will generally be located in restricted areas, and isolated before any work is undertaken.

Permanent magnets in generators have locally strong static magnetic fields; while these have little direct health and safety risk, they can lead to injuries such as crushing, if a magnetic tool (such as a steel spanner) being held in the hand is attracted to the magnet.
Active implanted medical devices, such as pacemakers and intra-cardiac defibrillators, are required under the Medical Devices Regulations 2002 to be designed and manufactured so as to eliminate or minimise risks associated with reasonably foreseeable environmental conditions such as magnetic fields and external electrical influences. However, the fields noted above are significantly stronger than normal environmental conditions, so the devices could potentially be affected, although no such effects have been seen, even amongst electricity company staff who work in substations.

C.8.1.2 RELEVANCE TO KEY LIFECYCLE PHASES

C.8.1.2.1 Project Design

Electrical safety should be assessed as an integral part of the overall safe design of the wind farm, and should comply with relevant British and European / IEC standards on equipment supply; note that certain key British Standards relating to electrical installations remain in force, and take precedence over European standards.

Competent electrical design is critical to safety, and has to consider many factors including:

- Appropriate capability to isolate, earth and lock off installed equipment, in order to allow maintenance activities to be carried out safely;
  - The design of isolating systems should take account of the locations of isolators, so that a safe system of work can be operated efficiently;
- Suitable interfaces, separation and / or interlocking between mechanical, LV and HV systems;
- Appropriate specification of electrical equipment and cables;
- Inherent protection from system faults, so that even during potential fault conditions, the affected equipment does not put people at risk;
  - This can be achieved through a combination of failsafe design, and protection systems as required;
    - Protection system settings should be co-ordinated with the design of the earthing system, to minimise overvoltage and achieve rapid tripping; and
- The need for backup systems or redundancy, depending on the risks that foreseeable failures would introduce.

Lightning protection requirements should also be assessed, in order to minimise risk to people and equipment – including consequential risk to people involved in repairing damaged equipment. Lightning protection should be based on risk assessment, considering both lightning strikes to the WTG, and to service lines connected to the wind farm, such as overhead HV lines; comprehensive guidance is given in the relevant standard.

The design should also specify:

- Assembly criteria and workmanship standards to be achieved; and
- Inspection, test and commissioning criteria and documentation.

The site layout design should also consider the safety of electrical infrastructure, such as by avoiding locations where site roads pass beneath overhead HV lines.

C.8.1.2.2 Construction and Commissioning

Contractor selection and ongoing management should ensure that electrical assembly and installation work is performed by appropriately qualified and competent technicians, and completed in accordance with the relevant IEE regulations and IEC standards for electrical installation. Attention to detail is required in the mounting of components and making of terminations, to ensure safe and reliable operation. On completion of construction, as-built drawings should be produced, and the accuracy of labelling of components confirmed.

During construction work, buried or overhead cables present a hazard to excavations or vehicle movements: cutting or crushing live HV underground cables, or conductive objects coming too close to live overhead lines, can lead to severe injury or death due to burns or electric shock.
The handover from construction to commissioning is a safety-critical activity, as dead systems are made live for the first time. Formal certification that systems are sufficiently complete to hand over from construction to commissioning is essential, and the isolations and earthing that form the basis of safety must be proven. There will typically be an incremental handover, starting with the grid connection being made live, and progressing through the substation systems to individual strings of WTGs; absolute clarity on responsibilities and the status of systems is essential throughout this process, which will involve the Distribution or Transmission Network Operator, the PC and the wind farm operator.

During WTG commissioning, functional testing of electrical safety systems should be carried out, together with SCADA checks, particularly in relation to remote switching operations. Any SCADA system used for switching operations must have sufficient integrity to avoid inadvertent operations; but should not be considered to be an isolation.

C.8.1.2.3 Operations and Maintenance

The safety of maintenance activities depends on the operation of safe systems of work, especially at the interfaces between LV and HV systems, where different sets of rules apply, with different people holding safety roles. The scope of individual maintenance tasks must be clearly defined, to ensure that all work is authorised in advance, and that safety from the system is assured by proven and locked isolations. All HV equipment specified must allow for normal operational requirements such as isolation and earthing to be implemented.

Maintenance programmes should take account of requirements for condition monitoring and periodic risk-based inspection / testing activities to ensure that safety systems are functional, and that components and terminations are in satisfactory condition, thereby minimising the risk of fire or arcing that may occur at defective or loose terminations, or on contaminated / damaged components. The condition of backup systems, such as UPS, should be monitored to ensure that safety systems such as aviation obstruction warning lights and pitch control / braking systems remain available in the event of an electrical fault.

Maintenance activities should be subject to risk assessment, and need to be undertaken within suitable safe systems of work. In order for maintenance work to be carried out safely, it is important to ensure that the people involved have the necessary training and competence to undertake their responsibilities, both for the maintenance tasks themselves, and the operation of the safe systems of work.

Over the life of the wind farm, electrical safety should be subject to ongoing monitoring and periodic review, so that new risk information arising out of incidents or condition monitoring can be addressed appropriately.

C.8.2 REGULATORY REQUIREMENTS

The Electricity at Work Regulations 1989 lay down principles of safety that apply to the generation, provision, transmission, transformation, rectification, conversion, conduction, distribution, control, storage, measurement and use of electrical energy.

The purpose of the regulations is to require precautions to be taken against the risk of death or personal injury from electricity in work activities. As such, these regulations impose requirements for de-energising systems prior to starting work.

The regulations impose duties with respect to systems, electrical equipment and conductors, and work activities on or near electrical equipment.

The Electricity Safety, Quality and Continuity Regulations 2002 (as amended) apply to electricity generators (including wind farms), distributors and suppliers, and their contractors or agents, with the main aim of protecting the general public and consumers from danger. The regulations impose duties regarding aspects of supply and distribution, including such topics as protection and earthing, substations, underground cables and equipment, generation, and supplies to installations and to other networks.

The Electrical Equipment (Safety) Regulations 2004 implement the requirements of the EU Low Voltage Directive, which set common safety requirements for low voltage (50-1000V AC, 75-1500V DC) equipment throughout EU member states. These requirements may be satisfied by conformity with harmonised standards, or with certain national standards, provided that the national standards themselves satisfy the safety requirements of the regulations.
Health and safety requirements regarding exposure of workers to electromagnetic fields are defined in the EU Electromagnetic Fields directive (2013/35/EU), which member states are required to transpose into national legislation by July 2016.

C.8.3 MANAGING THE RISKS

Electrical safety needs to be addressed as an integral part of the safety of the project as a whole, ensuring that the design enables safe commissioning, operation and maintenance, and that residual risks are identified, communicated and mitigated through safe systems of work. Effective implementation of the design intent and safe systems of work depends on having competent people involved at each stage.

C.8.3.1 APPROACHES TO RISK ASSESSMENT

At the design stage, studies should be undertaken to ensure that:

- The specification of all equipment is suitable for its duty, including under fault conditions such as short circuits;
- The design complies with the relevant Grid or Distribution Codes;
- Protective systems provide suitable fault clearance times and discrimination; and
- The design and layout of panels, WTGs and substations enables safe access for future inspection and maintenance requirements.

Provision of remote switching systems reduces the risk to people by minimising any requirement for people to be close to switchgear when it is being operated, given that the probability of failures occurring is highest during switching operations.

C.8.3.2 RISK MITIGATION MEASURES

Safe systems of work will be necessary to control work activities on or near live electrical systems. The Wind Turbine Safety Rules provide a basis for such a system in relation to mechanical and LV electrical systems; HV systems should be under a suitable set of HV safety rules, and clear interface arrangements must be implemented. While the rules are based on the distinction between LV and HV, the fault current levels at different locations on the system must also be considered, as these determine the hazard that a fault will present.

Lone working policies should consider the risks that electrical work presents; in general, lone workers should not undertake electrical work, although limited low-risk switching operations might be permissible, depending on task-specific risks.

Signage should be installed on all electrical generating equipment, junction boxes, switchgear panels and doors to warn of the risks to which people may be exposed; this is particularly important on equipment that can be fed from more than one source, or where internal components can remain live after external isolation. All covers, doors and panels should be locked, or otherwise prevented from being opened without the use of tools, to restrict access and prevent exposure to live electrical components and systems. The use of interlocking on doors can ensure that panels are not opened unless in a safe condition.

Where portable equipment is to be used, this should generally operate on a Reduced Low Voltage (RLV), Separated Extra Low Voltage (SELV) or Protective Extra Low Voltage (PELV) system; such systems minimise the risk of a person receiving a dangerous electric shock. The specification of the equipment should ensure that it is suitable for the working environment.

The routes of underground cables should be recorded accurately on as-built drawings, and clearly marked, in order to minimise the risk of damage. If overhead lines are present on a site, then any locations where roads pass beneath the lines should have suitable protective measures, such as “goal posts” and warning signs, to minimise the risk of a vehicle making contact with the lines.

Site emergency response plans should consider potential electrical incidents, both in terms of how to make the scene of the incident safe, and how consequential effects such as loss of LV power supplies could affect incident response, such as loss of communication systems.

The potential for electric shock and burns to occur should be considered as part of the first aid risk assessment, and appropriate training and first aid supplies provided; staff should be aware of
the correct response to an electric shock, including the measures to take to make the situation safe before attempting to render first aid. In the event of an electric shock, defibrillation may be necessary to restore a casualty’s normal heart function.

C.8.3.3 MONITORING, REVIEW AND CHANGE MANAGEMENT

Procedures for the long-term control of electrical safety throughout a wind farm should be established, and should address aspects such as:

- Maintenance activities and the use of method statements, procedures, and safe systems of work including HV Safety Rules, permits, control of isolations and earthing, and PPE;
- Control of interfaces with systems under the control of other parties, such as the distribution network or grid operator;
- The use of non-intrusive inspection techniques to monitor the condition of critical electrical equipment such as switchgear and cable terminations, in order to reduce the risk of failures that could result in arcing or explosions;
- Risk-based integrity testing of the electrical infrastructure and equipment at suitable intervals across all areas of the wind farm;
- Ensuring that all personnel have clearly defined authorisation levels for work that they can undertake, based on an assessment of their level of training and competence, and supported by continuing awareness and development training;
- Management of temporary electrical supplies, whether provided by means of connection into fixed wiring within an wind farm, or by provision of temporary generators; and
- Portable appliance testing (PAT) for all hand-held or portable electrical equipment used on site, to ensure that the equipment is safe to use. Inspections should be carried out at a frequency that reflects the likelihood of damage occurring; users should also carry out a pre-use check and arrange for repair of any damage noted.

Appropriate security arrangements for the site as a whole, and electrical infrastructure in particular, can help to reduce the risk of metal theft resulting in damage to protective systems such as earth cables.

C.8.4 CODES OF PRACTICE AND GUIDANCE

Numerous standards and regulations pertain to the design, installation, maintenance and operation of electrical systems; as with all lists of guidance in this document, the list provided below is not exhaustive.

C.8.4.1 REGULATIONS AND STANDARDS


BS7671:2008 – Requirements for Electrical Installations. IEE Wiring Regulations. Institution of Electrical Engineers 17th Edition – applicable for voltages up to 1000 V AC or 1500 V DC.

BS 7375:2010 Distribution of electricity on construction and demolition sites – Code of practice.

BS 6626:2010 - Maintenance of electrical switchgear and controlgear for voltages above 1 kV and up to and including 36 kV. Code of practice.

BS EN 62271:2008 - High-voltage switchgear and controlgear: multiple parts of this standard address different aspects of this equipment.

IEC 61140:2001 - Protection against electric shock – Common aspects for installation and equipment.

BS EN 61400-24:2010 – Wind Turbines – Lightning Protection


Energy Networks Association standards address many areas of HV electrical engineering.
C.8.4.2 Other Relevant Guidance

HSE HSG107 – Maintaining Portable and Transportable Electrical Equipment.
HSE HSG230 – Keeping Electrical Switchgear Safe.
HSE HSG253 – The Safe Isolation of Plant and Equipment.
HSE INDG354 - Safety in electrical testing at work: general guidance.
HSE EIS37 - Engineering Information sheet: Safety in electrical testing: Switchgear and control gear.
RenewableUK - Wind Turbine Switchgear Safety.


SSE Power Distribution - Safety Advice for the Fire Service outlines the hazards and appropriate responses to incidents involving electrical equipment.

HSE HSG 47: Avoiding danger from underground services
HSE Guidance Note GS6: Avoiding danger from overhead power lines

EMFs.info website is maintained by National Grid, with the purpose of providing factual, comprehensive and fair information (rather than views, comment and policies) on power-frequency EMFs. The legislative situation is described on the HSE website.

C.8.4.3 Elsewhere in This Guidance

Interfaces with Electricity Distribution and Transmission Systems
WTG Certification, Safety and Product Standards
Safe Systems of Work
Balance of Plant
C.9  ERGONOMICS AND MANUAL HANDLING

Ergonomics considers the nature of tasks to be undertaken, the equipment and information available to workers, and the working environment, in order to reduce the risks of injury, errors and inefficiency that may be caused by these factors.

This section concentrates on the physical and health risks that relate to ergonomics; the role of ergonomics and human factors in initiating and escalating incidents is covered in Section A.4.

The principal duty is that under the intended conditions of use, the discomfort, fatigue and physical and psychological stress faced by the operator must be reduced to the minimum possible, taking into account ergonomic principles such as:

- Allowing for the variability of the operator's physical dimensions, strength and stamina;
- Providing enough space for movements of the parts of the operator's body;
- Avoiding a machine-determined work rate;
- Adapting the man / machinery interface to the foreseeable characteristics of the operators.

Manual handling, slips, trips and falls, and the use of hand tools, together account for a high proportion of lost time injuries; good ergonomic design can reduce the occurrence of such incidents.

C.9.1  OVERVIEW

C.9.1.1  POTENTIAL HAZARDS AND RISKS

Many operations in WTGs present ergonomic difficulties, such as:

- In some types of WTG, access from the tower to the nacelle is obstructed by major components in the nacelle, making it difficult for technicians to undertake this transfer without putting themselves at risk by disconnecting from the fall-arrest systems; or
- Access to components for servicing can be very awkward, involving kneeling, twisting and reaching, which increase the strain involved in carrying out otherwise straightforward tasks.

Where work is carried out in the open air, such as preparing loads for lifting, the people involved may be working in cold, wet conditions, wearing PPE for weather protection. The use of gloves (or having cold hands) will reduce dexterity, making otherwise simple tasks, such as pressing the correct buttons on a handheld radio, more difficult. The selection of equipment, and design of tasks, should take account of the environment in which the work is to be carried out.

Poor ergonomics increases the risk of immediate injury or long term development of musculoskeletal disorders; these could be caused by factors such as:

- Restricted space on the yaw deck, or in the nacelle of a WTG, forcing the adoption of awkward working positions; or
- Regular ladder climbing, if servicing WTGs that do not have lifts.

The susceptibility of workers to musculoskeletal disorders may be increased by the combination of such activities, which present both repetitive and positional stresses.

C.9.1.2  RELEVANCE TO KEY LIFECYCLE PHASES

The ability to adapt WTGs, workplaces and systems to achieve good ergonomic standards is greatest at the design and prototype stage; if a need for modifications is identified later in the lifecycle, when such issues become more obvious, then the cost of adaptation will be much higher. Where poor ergonomic design is identified as introducing a risk of injury or long term adverse health effects, the ALARP principle should be applied in deciding on risk reduction measures.

Ergonomic issues should be considered during WTG selection, to ensure that foreseeable maintenance tasks can be undertaken without unacceptable risk; early consideration of these
issues can ensure the greatest benefit at a lower cost than would be possible later in the lifecycle.

The construction industry has one of the highest rates of musculoskeletal disorders. Construction work presents many manual handling challenges: while deliveries of tools and materials will generally be carried out using vehicles and cranes, the last stage of moving items to where they are needed will often involve manual effort, whether pushing, pulling or lifting. Operations such as erecting shuttering, assembling reinforcing bar in foundations, and laying cables in trenches, can all involve manual handling.

During the O&M phase, ergonomics should be considered when carrying out risk assessments of individual tasks, and mitigation such as the provision of suitable access, tools, lighting and ventilation should be implemented as required.

### C.9.2 REGULATORY REQUIREMENTS

The Essential Health and Safety Requirements (EHSR) of the Machinery Directive include requirements for machinery manufacturers to minimise ergonomic risks to operators and maintainers of machinery, including ensuring that components are designed to facilitate handling (manually or using lifting equipment, as appropriate), and that there is adequate space and lighting.

Good ergonomic design will also help to fulfil the employer’s general duty to reduce risk, under the HSWA, and ease compliance with the Manual Handling Operations Regulations (MHOR). These place a duty on employers to reduce risks arising from manual handling; this process starts with identifying and assessing manual handling risks, and then implementing measures to eliminate or reduce the identified risks.

### C.9.3 MANAGING THE RISKS

Ergonomic and manual handling issues should be considered in the design phase, as this allows the greatest potential for elimination of hazards, and can simplify subsequent installation and O&M activities. Considerations include:

- Design for construction, including ensuring that safe access is available on part-completed structures, or when temporary works are in place on a site;
- Design for maintenance and access, including:
  - Consideration of the working environment, in terms of:
    - Space to work, including lay down of components and tools during maintenance tasks, without creating undue congestion or introducing tripping or falling object hazards;
    - Workplace conditions such as temperature and ventilation;
    - The level of lighting, which not only affects the ability of technicians to move around and work safely, but, if poor, can also encourage the adoption of awkward postures;
    - Provision of safe access for foreseeable tasks, so that there is no temptation to use inappropriate means such as climbing on handrails or equipment, in order to get the job done;
    - The effects of foreseeable deviations from normal operation, such as ensuring that dropped objects can be retrieved safely, and that spills or leakage can be contained and cleaned up;
  - Provision of suitable lifting equipment in nacelle / machinery spaces to minimise manual handling;
- Design for isolation:
  - Clear and accurate labelling and identification of components and isolators to assist WTSR compliance, in convenient locations for the task;
- This can be strengthened by interlock or monitoring systems, which enforce or monitor isolation requirements in an environment where supervision is limited.

As ergonomics is about the interaction of people with equipment and systems, the range of physical and psychological characteristics of different people should be considered, as a task or workplace that suits one person may cause problems for another.

In the construction phase, there will be a great variety of manual handling operations, often with subtle differences occurring between occasions when the same task is carried out; for example, lifting a load when it is dry and easily gripped, will present lower risks than lifting the same load when it is wet or slippery, as such factors may force the adoption of a more awkward technique. Generic manual handling assessments of foreseeable tasks should be backed up by thorough training, so that site personnel can carry out a dynamic assessment of risks that a specific activity involves, supported by a culture that encourages people to identify risks and find safe methods, rather than to put themselves at risk in order to allow the work to progress.

**C.9.3.1 Approaches to Risk Assessment**

Ergonomic risks can be identified by:

- Reviewing designs and operating procedures, to assess the layout of equipment, available access, and the requirements of maintenance tasks;
  - This should be informed by the learning gained through experience on other developments;
- Observation of tasks being carried out, and discussion of ergonomic issues with employees; and
- Reviewing errors, incidents and reports of discomfort to identify where ergonomic problems may be present.

For complex ergonomic issues, specialist help may be obtained from ergonomists.

Resolution of issues should be prioritised, taking account of activities where individuals may have a high level of exposure, such as regular service activities, or construction activities where specialist teams undertake the task repeatedly.

Ergonomic risks may change over time; for example, when work is being carried out on HV systems, or following cable damage, a WTG may be entirely isolated from all sources of power; this leaves any workers on it dependent on emergency lighting systems and torches, and unable to use powered lifting equipment to move loads, or the tower lift to access the nacelle. Risk assessments for work under these conditions should address the provision of generators if access is likely to be required for longer than the emergency lighting is maintained, and consider limitations on the movement of people and loads.

**C.9.3.2 Risk Mitigation Measures**

Where ergonomic risks cannot be eliminated, workers’ exposure should be reduced ALARP by measures such as provision of suitable tools, equipment, and job rotation. Workers should have an appropriate level of training in manual handling for the work that they are to undertake; the RenewableUK / GWO Manual Handling training standard provides a common baseline.

**C.9.3.3 Monitoring, Review and Change Management**

In addition to formal consideration of ergonomics at the design stage, and within risk assessments, employees should be encouraged to identify ergonomic issues that they encounter when carrying out tasks, and propose improvements where practicable. Where residual ergonomic risks are identified, the information needs to be communicated to the people who will be affected, so that they can take account of these risks in planning their working methods.

Modifications to improve ergonomics should be subject to risk assessment, to ensure that they do not introduce other risks.

Given that the ergonomic risks are largely determined at the design stage, but encountered later in the lifecycle, effective feedback mechanisms between design, installation and service teams can enable design improvements to be identified and implemented in subsequent revisions or projects.
C.9.4  CODES OF PRACTICE AND GUIDANCE

C.9.4.1  REGULATIONS AND STANDARDS


BS EN ISO 11064:2001 Ergonomic design of control centres.

BS EN ISO 6385:2004 Ergonomic principles in the design of work systems.

HSE Leaflet INDG143 – Getting to grips with manual handling: A short guide for employers.

C.9.4.2  OTHER RELEVANT GUIDANCE

HSE Human Factors and Ergonomics webpages

HSE HSG38 – Lighting at work

HSE HSG60 – Upper limb disorders in the workplace

HSE INDG90 – Understanding ergonomics at work

HSE HSG115 – Manual handling: Solutions you can handle

HSE INDG383 - Manual handling assessment charts (the MAC tool) provides detailed guidance on assessing manual handling risk for lifting, carrying and team-lifting operations, taking account of a wide range of factors including load weight, position, posture, grip and environmental factors.

RenewableUK Approved Training Standard – Manual Handling (MH) has been fully aligned to the GWO Basic Safety Training – Manual Handling module, and also includes specific reference to the particular requirements for delivery of training and the syllabus content within the UK.

C.9.4.3  ELSEWHERE IN THIS GUIDANCE

Ergonomics, Human Factors and Behavioural Safety
C.10 FIRE

C.10.1 OVERVIEW

Fires present a range of risks to people and assets, and are particularly challenging in high structures such as WTGs.

In general, a fire requires the presence of:

- Fuel, which can be any combustible material;
- Oxygen, generally from air; and
- A source of ignition such as heat, a spark or flame.

If any of these is absent, then the chemical reactions that constitute a fire cannot be initiated or sustained.

The priority is to protect people, through a combination of technical and procedural systems for avoiding initiation of fires, fire detection, suppression (extinguishing) and containment, and by ensuring that people can escape in an emergency.

As WTGs are usually unmanned, fire suppression may consist of:

- Automatic systems, to protect the asset, and minimise the risk of secondary fires starting on surrounding land; and
- Manual fire-fighting equipment, to extinguish a small fire and / or safeguard an escape route.

Fire suppression systems that protect the asset can both protect people and introduce additional risks:

- An effective fire protection system will minimise the need for fire remediation work to be undertaken, thereby reducing potential future risk exposure; however
- Some fire extinguishing media are hazardous to people; and
- The maintenance requirements of the fire protection system should be considered, to minimise the risks to which they will expose people;

These relationships are summarised in Figure 6 below.

In addition to fires that originate within WTGs or BoP, wind farms can also be affected by other fires on the site, such as heath, moor or forest fires, which can present a direct risk to people working on the site, as well as having the potential to damage equipment and impede site access / egress.

C.10.1.1 POTENTIAL HAZARDS AND RISKS

The different areas of a wind farm, and the different activities undertaken during its lifecycle, present a range of fire risks.

WTGs and substations are unattended during normal operation, so after commissioning is complete, there is only a direct risk to people during maintenance visits:

- As the WTGs will be stopped during maintenance, the most likely initiator of fire at such times will be the maintenance activities; however
- Temporary generators may be used during construction, commissioning and some major maintenance activities, introducing additional initiators and fuel sources.

C.10.1.1.1 Direct Health and Safety Risks

Fires pose a range of hazards to people, including:

- Flames and hot surfaces can cause burns;
- Smoke inhalation may cause people to suffer asphyxiation and death, even if they are not in the immediate vicinity of a fire, particularly if the materials that are burning release toxic combustion products;
- Glowing fires release toxic carbon monoxide as a consequence of incomplete combustion; and
- Explosions and arc flashes from electrical faults can lead to immediate serious injury.

Even the smallest of fires can escalate rapidly if air and combustible materials are present, particularly if the initial fire leads to the release of further combustible material, such as gearbox oil being released if a hose or filter body fails as a consequence of the initial fire. The chimney effect created by the tower can cause smoke to spread rapidly throughout the WTG. Burning debris from a WTG can spread fire well beyond its immediate location, leading to a risk of secondary fires on the ground, particularly in dry weather; the risk is especially high in areas such as grassland, forests and moorland, where dry peat soil is also combustible.

Figure 6: Interrelationship of fire risk and protective measures during normal operation and maintenance.

### C.10.1.1.2 Consequential Risks

Fires may block normal exit routes, or these could be obscured by smoke, requiring personnel to evacuate by emergency routes, such as descending from the nacelle.

Normal services such as internal lighting of WTGs and site buildings may be affected, so evacuation will depend on the provision of emergency lighting.

After a fire has been extinguished, restoration or dismantling and scrapping of fire-damaged equipment is a specialist operation, being very labour intensive, and involving exposure to a range of additional hazards, such as:

- The fire may have caused structural damage:
  - While major components such as tower sections may still have sufficient integrity, other items such as aluminium ladders and floor plates may no longer be safe to use;
  - Fibre-reinforced plastics, as are commonly used for nacelles, spinners and blades, can be severely weakened or destroyed by fire, although long glass fibres may remain, further hindering access;
Even gaining access to the tower in order to assess the extent of damage will require thorough risk assessment;

- Cable insulation may have been damaged, requiring isolation until this has been assessed and repaired;
  - This may disable internal lighting and normal communications systems; and
- Combustion products such as hydrochloric and hydrofluoric acids may be present, introducing a hazard to people, and requiring thorough clean-up to enable equipment operation to be restored.

Fire suppression systems may introduce hazards to people, depending on the gases / substances used.

Fires on land within or adjacent to the wind farm may affect access routes, particularly if such routes pass through forests; this can prevent access to and from the site, whether for normal operations or emergency response. Smoke from such fires can also cause irritation, including potentially triggering asthma symptoms; due to the size of fires on land, the smoke can be very widespread, although fairly diffuse, and therefore more difficult to avoid inhalation than from a more localised fire.

C.10.1.2 RELEVANCE TO KEY LIFECYCLE PHASES

C.10.1.2.1 Design

An initial fire risk assessment should be undertaken at the design stage, to identify how the design can minimise the risk from fire, and the precautions that will then need to be maintained throughout the lifecycle. Selection of materials at the design stage will determine the risks that a fire may present, such as the potential for structural damage, and the presence of hazardous combustion products.

As there is no standard approach to provision of fire protection in WTGs, developers should obtain information from prospective WTG suppliers regarding:

- The fire protection philosophy of their WTGs, including:
  - Detection;
  - Local and remote warning systems, including ensuring that warnings are given in the base and nacelle of WTGs;
  - Operational philosophy, for example the training of control room staff in interpretation and response to SCADA data, such as high temperature alarms, in order to ensure that equipment problems that could eventually lead to a fire are recognised;
- Fire protection system maintenance requirements; and
- Provision for the safety of people working on the WTG.

This information should be used by developer, as an input to their fire risk assessment, which should also consider site-specific risks such as adjacent land uses that could exacerbate the consequences of a fire.

The site design should also consider whether there will be any future requirement for storage of flammable or combustible materials on the site, and provide suitable storage if necessary.

C.10.1.2.2 Construction and Commissioning

The construction phase can present additional fire risks, including ignition sources such as temporary generators and portable lighting, hot works such as grinding and welding, flammable and highly flammable fuels for mobile plant, and additional combustible materials such packaging and pallets; these risks should be considered when selecting methods and planning tasks, with residual risk being controlled through safe systems of work.

As commissioning includes the first energisation of electrical systems, fires can start as a consequence of any defects in equipment or installation, such as poor cable termination, or debris on uninsulated live components such as busbars in panels. This risk can be minimised by ensuring that equipment has been thoroughly inspected and tested before energisation, with
residual risk being managed through procedural measures such as exclusion zones around equipment that is being energised.

The commissioning plan should ensure that fire protection systems are commissioned at the earliest practicable stage, rather than being left to a late stage of commissioning, in order that they can protect people involved in commissioning activities.

**C.10.1.2.3 Operations & Maintenance**

Equipment defects, such as overheating of components in mechanical or electrical systems, can lead to fires; effective condition monitoring can reduce the risk of components overheating, while a high standard of maintenance and housekeeping can minimise the presence of hazards such as oil leakage, build-up of combustible materials such as cleaning rags, and water ingress that can lead to short circuits.

Owners should also ensure that fire protection systems are maintained as specified, and that sufficient firefighting materials are always available on the site.

**C.10.2 REGULATORY REQUIREMENTS**

**C.10.2.1 GENERAL FIRE SAFETY**

The principal regulations are the Regulatory Reform (Fire Safety) Order 2005 in England and Wales, the Fire (Scotland) Act 2005, and the Fire and Rescue Services (Northern Ireland) Order 2006; these impose more specific duties than the HSWA in the general fire safety matters that they regulate. The regulations define similar duties relating to general fire safety, including a duty on employers (or others in control of workplaces) to:

- Ensure the safety of people with respect to fire in the workplace; and
- Carry out a fire risk assessment, and implement the measures identified in it to protect people in the workplace.

General fire safety includes measures to reduce the risk of fire occurring, and if one does occur, to:

- Minimise its spread;
- Ensure that people can escape;
- Have the means to fight the fire;
- Detect the fire and warn people;
- Have arrangements in place for the actions to be taken, and ensure that employees have been trained / instructed; and
- Mitigate the effects of fire.

The regulations also establish local fire authorities, which as well as operating fire and rescue services, are the enforcing authorities for fire safety measures under the regulations, and may undertake compliance checks on wind farms.

Building regulations contain detailed design requirements for fire safety, however they do not apply to buildings “into which people go only intermittently and then only for the purpose of inspecting or maintaining fixed plant or machinery”, so would not apply to a substation or WTG. Certain small detached buildings, with a floor area not exceeding 30m², are also exempt. While such buildings are exempt, the regulations and associated Approved Documents can still be used as a basis for good design.

Other health and safety regulations impose specific duties in relation to fire, including:

- The MHSWR impose duties on employers to establish procedures to be followed in the event of serious and imminent danger (such as a fire), and to ensure that necessary contacts are arranged with external services, such as the fire and rescue service;
- The ESQCR impose duties to minimise the risk of fire associated with substations (the definition of which includes any HV switchgear and transformers) and to report any fires arising from HV electrical systems.
C.10.2.2 CONSTRUCTION SITES AND WORK PROCESSES

The HSE is the enforcing authority for fire safety on construction sites, and in relation to work processes that involve the use of plant, machinery or dangerous substances.

During construction, some small items of work equipment such as stone saws and power floats for concrete, may require the use of petroleum fuel; its storage and use is subject to the Dangerous Substances and Explosive Atmospheres Regulations.

C.10.2.3 SUPPLY OF MACHINERY (SAFETY) REGULATIONS

The Machinery Directive requires that “Machinery must be designed and constructed in such a way as to avoid any risk of fire or overheating posed by the machinery itself or by gases, liquids, dust, vapours or other substances produced or used by the machinery”. Manufacturers are therefore required to undertake fire risk assessments, take steps to avoid risk from fire, and provide warnings about residual risks, and precautions to be taken, on the equipment and in the operating instructions.

C.10.3 MANAGING THE RISKS

Fires may be initiated by a range of causes, including:

- Actions taken by people, such as inadequately controlled hot works; or
- Equipment malfunction, such as faults in switchgear and cable terminations, hot surfaces on brakes, and failures in cooling systems for electronic components;

The design should address the need for provision of high temperature alarms, while condition monitoring and scheduled inspection can provide warning of equipment deterioration. The risks will vary between different parts of a wind farm and between different lifecycle phases, therefore different mitigation approaches are likely to be needed.

C.10.3.1 APPROACHES TO RISK ASSESSMENT

Fire risk should be assessed, either as part of the overall risk assessment process for a development, or in a specific risk assessment. For complex situations, specialised competence may be necessary, and risk assessment processes such as Bow Tie can be useful, as these consider potential initiating events, safeguards to prevent potential initiators leading to an actual fire, and the systems to mitigate the consequences of a fire, whether this occurs during unattended operation, or during maintenance work. Initiating events, safeguards and mitigation can include both technical and human factors; the potential for “barrier decay”, in which the effectiveness of safeguards or mitigation reduces over time, should also be considered.

C.10.3.2 RISK MITIGATION MEASURES

C.10.3.2.1 Fire Prevention

Safe systems of work should ensure proper control of hot work that can introduce a source of ignition, such as welding or grinding; control measures could include the use of welding drapes to prevent sparks from landing on combustible surfaces, and ensuring that personnel and materials are available to extinguish any fire immediately.

Site rules should ensure that:

- Flammable substances are stored and used in a suitable manner; and
- Smoking is only allowed in designated areas; smoking should not take place inside site buildings, vehicles or WTGs, or near vegetated areas.

High standards of housekeeping avoid the build-up of combustible materials, whether on a site or in a WTG; good maintenance should also ensure that any leaks are repaired in a timely manner.

Effective inspection and condition monitoring programmes can reduce the risk of components overheating, for example by carrying out periodic visual or thermographic inspection of electrical terminations, and monitoring temperatures of mechanical components such as bearings and brakes.

The development of wind farm access roads can encourage public access into upland or forest areas, potentially increasing the risk of a fire starting on the ground; signage could be erected to
provide warnings at times when the fire risk is highest, and to provide site emergency contact numbers for use if a member of the public observes a fire.

**C.10.3.2.2 Protection of People**

The commissioning plan should ensure that fire protection systems are installed and commissioned sufficiently early that they are available to protect people involved in subsequent commissioning work.

Thorough inspection and testing of electrical systems prior to being powered up can reduce the risk of fires starting as a consequence of poor termination or short circuits; however, task risk assessments should still determine whether further precautions are needed, in order to minimise the risk to people from such faults; these could include measures such as remote operation of switchgear (provided that the design enables this), establishing exclusion zones around equipment that is being made live, and ensuring that panel doors are kept closed.

If fire suppression systems introduce a risk to people, such as from the use of asphyxiant gases, then they will need to be isolated when maintenance tasks expose people to this risk, thereby disabling the protective system, and requiring it to be de-isolated on completion of the task; the design should ensure that system status is clearly indicated, to minimise the probability of it being left in the wrong state. Where systems that do not introduce such hazards can be used, the protection of the asset can be continuous, and may also help to protect people while they are in attendance.

Fire extinguishers are generally only suitable for extinguishing small fires, or to safeguard an escape route. They should be provided in regular working areas, such as the tower entrance and nacelle. Their selection and use should ensure that they do not endanger people, if used in a restricted space such as the nacelle of a WTG. Their lifetime maintenance requirements should also be considered, to minimise the need for specialist inspections.

**C.10.3.2.3 Action in the Event of a Fire**

In the event of a fire, it is essential that all personnel know what to do; this is achieved by a combination of training, practice drills, and provision of information. Training will typically include fire detection, arrangements for firefighting, communication, team roles, escape / evacuation and assembly arrangements. Clear information should be displayed at the entrance points of buildings and WTGs, so that personnel are informed about:

- Fire protection systems, and instructions on their operation;
- Means of summoning help in the event of a fire or other emergency;
- Types, usage, limitations and locations of manual fire extinguishers; and
- Any automatic fire extinguishing systems, including any risks that they present to people, steps to be taken to control these risks, and clear indication of the status of such systems.

Emergency escape routes should be indicated, and kept clear at all times. The time needed for emergency escape from challenging locations such as the lift or the hub should be assessed, through exercises, to ensure that the fire protection measures provide sufficient time for people to escape, taking account of the maximum number of people permitted to be in the WTG. Fire escape routes should be protected against the effects of fire in adjacent locations that house high risk items, such as transformers, switchgear and combustible materials; EN 50308:2004 specifies that escape routes that involve climbing shall maintain their function for at least 30 minutes in the event of a fire.

In the event of fire in a WTG, escape from the nacelle would either be down the tower, or, if the fire / smoke is affecting the tower, by external descent. The risks involved in emergency escape from the nacelle should be assessed, for example:

- Opening hatches on the nacelle, either to dissipate smoke or enable evacuation, may intensify the fire due to the chimney effect in the tower; the risk of this occurring will depend on the location of the fire and the available routes for air flow;
- The position of the nacelle hatches should be considered, in relation to equipment that could initiate or sustain a fire, and potentially hinder use of this evacuation route;
• The descent energy rating of emergency descenders should be suitable for the maximum number of people who may be present in the WTG, and the height of descent; and

• The time that will be taken for the maximum permitted number of personnel in the WTG to escape using the descender should be assessed, and compared with the potential rate of spread of smoke and fire, to ensure that there is adequate provision for escape in the event of a fire.

The precise arrangements to mitigate these risks are likely to be site-specific, taking account of the WTG design and fire detection and suppression systems.

In the event of a fire, it is essential that all personnel on a site can be accounted for; this is enabled by having accurate records of who is on a site on a particular day, and where they are working.

C.10.3.2.4 Response to Major Fires

An established fire in a WTG or substation will generally be beyond the capability of site teams and fire-extinguishing equipment, and will require support from public fire and rescue services. Site Emergency Response Plans should include response to major fires; considerations include:

• Realistic response times and capabilities of fire and rescue services, noting that the first line of response in many remote areas is provided by retained firefighters, with a more limited remit than full-time teams;

• Measures that have to be taken before firefighting can commence, such as isolation and earthing of HV electrical systems, and how this will be communicated to the fire service;

• Limitations on the use of site roads by emergency vehicles;

• Ensuring that the fire and rescue service have accurate site maps – ideally provided in a digital format that can be uploaded into emergency vehicle global positioning systems (GPS);

• Availability of water – especially in dry conditions, in which heaths, moors and forests are particularly vulnerable to fire; and

• Liaison with landowners and adjacent land managers, such as forestry staff and farmers.

Due to the height of most WTGs, fire and rescue services cannot be expected to extinguish fires in nacelles; their priority will generally be to work at ground level to protect people and property from the effects of the fire, such as avoiding burning debris leading to secondary fires becoming established.

Depending on the demands on the fire and rescue service at the time of a call, the response may come from a number of different fire stations, so it cannot be assumed that firefighters attending a site would have been there before; early engagement with local fire and rescue services can ensure that robust arrangements are in place, with information available to all firefighters who might attend a site.

Any fire in a WTG is likely to be highly visible, and will attract attention; ERPs should include measures to manage such interest, including ensuring that onlookers are not putting themselves at risk or hindering emergency access, and being prepared to communicate effectively with local communities and the press. Lessons learned should also be shared across the industry, to minimise the risk of similar occurrences in future.

Once the fire has been extinguished, a range of follow-up actions may be necessary, such as:

• Establishing an exclusion zone, if the integrity of a WTG has been affected; and

• Clearing debris from the site;

Once the immediate risks have been addressed, planning for repair or removal of the WTG can progress.

C.10.3.2.5 Training

Employers should identify appropriate fire awareness training; the GWO Basic Safety Training standard includes a Fire Awareness module, which is intended to provide a common standard for the basic training of all personnel working on wind energy sites. This may need to be
supplemented by suitable training in site-specific arrangements; as a minimum, site inductions should provide a briefing on emergency arrangements, including action in the event of a fire.

C.10.3.3 MONITORING, REVIEW AND CHANGE MANAGEMENT

Fire protection systems are safety-critical, and must be maintained in an operable state.

Given the risks and expense involved in work at height, the maintenance requirements of a proposed fire protection system should be considered when it is being designed or selected, to ensure that they do not lead to an increase in the overall risk exposure; the use of self-monitoring systems or components with extended inspection intervals can minimise the maintenance burden.

C.10.4 CODES OF PRACTICE AND GUIDANCE

C.10.4.1 REGULATIONS AND STANDARDS

The Regulatory Reform (Fire Safety) Order 2005; the Fire (Scotland) Act 2005; and the Fire and Rescue Services (Northern Ireland) Order 2006 define, for their respective areas, fire safety duties and arrangements for enforcement.

BS ISO 23932:2009 - Fire safety engineering: General principles outlines the performance-based fire safety engineering design process.


C.10.4.2 OTHER RELEVANT GUIDANCE

HSE HSG 51 - The storage of flammable liquids in containers is mainly relevant to stores and maintenance facilities, where dedicated facilities for storage of flammable materials may be necessary.

HSE HSG 168 – Fire safety in construction provides guidance on fire risk assessment and precautions on construction sites.

HM Government – Department for Communities and Local Government - Fire Safety Risk Assessment: Factories and Warehouses provides detailed guidance and recommendations on the fire risk assessment process; while it has specific content for factories and warehouses, the underlying process could be used in a wide range of premises.

SSE Power Distribution – Safety Advice for the Fire Service outlines the hazards and precautions of fighting fires on electrical equipment.

RenewableUK Approved Training Standard – Fire Awareness (FA) has been fully aligned to the GWO Basic Safety Training – Fire Awareness module, and also includes specific reference to the particular requirements for delivery of training and the syllabus content within the UK.
C.11 HAZARDOUS SUBSTANCES

C.11.1 OVERVIEW

Hazardous substances can be in solid, liquid or gaseous form, and may:

- Always be present in a WTG, such as coolants or lubricants;
- Be introduced during specific operations, such as cleaning fluids; or
- Arise as a by-product of work activities, such as fumes from welding, paints and glass fibre repair compounds.

In some cases, hazardous substances may not be readily visible, such as dusts and vapours in the air.

The same substance may present different hazards in different stages of the lifecycle: for example, a coating may release solvents during application, but form a dust if mechanically abraded during removal.

Substances may present hazards to health as a result of their:

- Chemical or physical composition; or
- Explosive or flammable properties.

Different regulations apply in each of these cases; the same substance may present both types of hazard, and require management under both sets of regulations; fire and explosion hazards are considered in Section C.10, Fire.

When hazardous substances are used in confined spaces, the risk will be greatly increased, compared to use in less complex conditions; see Section C.5, Confined Spaces.

C.11.1.1 POTENTIAL HAZARDS AND RISKS

People may be harmed by any form of contact with hazardous substances, including skin contact or puncture, ingestion, absorption and inhalation. The severity and duration of the effects range from minor, temporary irritation, to chronic illness and death, and the onset of symptoms may range from an immediate reaction, to years after exposure. The potential combination of delayed onset and serious illness means that any use of hazardous substances requires careful management.

C.11.1.2 RELEVANCE TO KEY LIFECYCLE PHASES

Design decisions will determine the level of risk that substances will present in subsequent lifecycle phases. As a minimum, the design philosophy should seek to:

- Avoid the use of hazardous substances, by selecting non-hazardous or less hazardous alternatives. For example, traditional transformer oils have generally been superseded in WTGs by non-hazardous alternative fluids, or dry designs;
  - The Restriction of Hazardous Substances (RoHS) directive bans the placing on the market of new electrical and electronic equipment that exceeds specified levels of certain hazardous substances, including mercury, lead, hexavalent chromium, cadmium and various flame retardants;
  - Minimise the quantities present; and
  - Provide systems for containment / separation / handling and recovery of spills, to minimise the exposure of people to the substances.

The designer should also consider:

- Lifecycle requirements for maintaining systems that contain hazardous substances; for example, by ensuring that good access is available for changing gearbox oil, the risk of spillage and contact with people is minimised; and
- Hazards presented by materials in foreseeable damaged states; for example, certain materials used for cable insulation release hazardous vapours in the event of a fire.
In considering the lifecycle risk, the designer needs to balance the different risks that substances present; for example, when comparing alternative surface coating systems, the designer should consider both the hazards that the coatings present during application (such as the levels of solvent vapours), and their expected lifetimes and performance, which will determine how often people are exposed to the risks that maintaining the coating system may present, such as work at height.

During the construction phase, cement used in concrete and grouts can be hazardous to people, both as a dust and when wet; subsequent breaking or cutting of cured concrete can also release harmful dusts. Equipment used in the production and handling of concrete has to be washed, resulting in the generation of highly alkaline (pH 11-12) wash water, which can cause skin or eye injury.

During the O&M phase, periodic replacement of substances such as lubricating oils and greases may be required; additional care may be necessary as used fluids may be more hazardous than when equipment was first manufactured.

Hazards presented by non-routine repairs, which may involve hot work such as welding or grinding, should also be assessed, both in terms of the substances directly involved (such as fumes from welding) and any reaction products, such as fumes that may be released from surface coatings if exposed to excessive heat from these operations.

Exposure to hazardous substances can also occur as a result of disturbing contaminated ground on a site, without the substances having been introduced during construction; such situations are particularly challenging, as there may be initial uncertainty as to the exact substance involved.

C.11.2 Regulatory Requirements

The use of substances that are hazardous to health as a result of their chemical or physical composition is covered by the Control of Substances Hazardous to Health (COSHH) Regulations 2002; the employer has the principal duties under these regulations. Other relevant regulations include:

- The Chemicals (Hazard Information and Packaging for Supply) (CHIP) Regulations 2009 set common standards for classification, labelling and packaging of chemicals. These regulations are being superseded by the Classification, Labelling and Packaging (CLP) regulation, which is being phased in between 2010 and 2015, and under which, classification and labelling will transition to the Globally Harmonised System. The supplier of a substance is the duty holder under these regulations, but users will see changes in the content of Safety Data Sheets; and

- The Registration, Evaluation, Authorisation & restriction of Chemicals (REACH) regulations impose duties on suppliers relating to provision of safety information, and will also lead to some particularly hazardous substances being withdrawn.

C.11.3 Managing the Risks

Any use of hazardous substances must be managed in accordance with the COSHH Regulations 2002.

COSHH imposes a number of duties on employers, including a duty to ensure that a competent person carries out a suitable and sufficient assessment of the risk to health that is presented by the use of a substance; detailed guidance on factors to consider is given in the ACOP. Assessments made by the supplier, under REACH, are based on a hypothetical exposure scenario; these may be used to inform an assessment under COSHH, but do not replace it. Based on the outcome of the risk assessment, further duties may include:

- Prevention or control of exposure to the hazardous substance;

- Ensuring that control measures are used properly, are appropriate for the task, and, where more than one control measure is in place, that they are compatible with each other. For example, if both respiratory protective equipment (RPE) and eye protection are required, then they should be of compatible designs;

- Ensuring that control measures are maintained, so that they continue to provide the necessary level of protection;
- Provision of necessary information, instruction or training;
- Having suitable arrangements in place to deal with accidents, incidents and emergencies; and
- Monitoring workplace exposure and health surveillance, where the risk assessment identifies this requirement.

These duties apply in different ways for the protection of employees, others who share the workplace, and other people who may be affected by the activity. Employees have duties to cooperate with their employers in ensuring that the requirements of the regulations are fulfilled, ensuring that necessary PPE is used and suitably taken care of, and maintaining appropriate hygiene practices.

As the COSHH risk assessment primarily relates to the use of a substance, then if the intended use changes, the risk assessment must be reviewed.

While the CHIP regulations set the standards for labelling and packaging of substances from the supplier to the customer, the employer has a duty to ensure that suitable standards of labelling and packaging are maintained if substances are transferred to different containers for use in WTGs (such as decanting fluid into a more convenient size of container for lifting to the nacelle), or if used substances are collected in containers that differ from the original packaging. Likewise, users must read the labels, and use the substances in accordance with the precautions identified.

In addition to the risk to people, proper management of hazardous substances reduces the risk of release to the environment.

C.11.4 CODES OF PRACTICE AND GUIDANCE

C.11.4.1 REGULATIONS AND STANDARDS

HSE L5 - Control of Substances Hazardous to Health Regulations 2002 (as amended) Approved Code of Practice and guidance.

HSE EH40/2005 - Workplace Exposure Limits: contains the list of workplace exposure limits for use with the COSHH Regulations.

HSE L131 - Approved Classification and Labelling Guide (Sixth edition) - Chemicals (Hazard Information and Packaging for Supply) Regulations 2009 (CHIP 4) details the basis for the different risk and safety phrases used in the labelling of substances.

C.11.4.2 OTHER RELEVANT GUIDANCE

The HSE COSHH Essentials web pages provide concise summaries of the substance-related hazards of a wide range of operations, and their management; these include general guidance, skin and eye contact, Respiratory protective equipment, construction and Welding, Hot work and Allied Processes.

HSE INDG136 - Working with substances hazardous to health - What you need to know about COSHH.

HSE INDG233 – Preventing Contact Dermatitis at Work.

HSE CIS 26: Cement

HSE CIS 36: Construction Dust and HSE CIS 69 Controlling construction dust with on-tool extraction

The HSE has published further details of REACH, and an explanation of the relationship between COSHH, CLP and REACH on its website.

C.11.4.3 ELSEWHERE IN THIS GUIDANCE

Emergency Response & Preparedness
Confined Spaces
C.12 LIFTING

C.12.1 OVERVIEW

Wind farm construction, and some major maintenance activities, involve the lifting of large and heavy loads, such as tower sections, blades, nacelles, and substation transformers. The construction phase of a project typically involves many repetitive crane lifts of major components and sub-assemblies, together with numerous smaller lifts of construction materials, tools and consumables. Lifting during the construction phase will involve a very wide range of equipment, such as:

- High capacity cranes for lifting main WTG components during erection;
- Lorry-mounted loader cranes for delivering construction material to locations on the site;
- Rough-terrain telescopic forklifts (telehandlers); and
- Manual chain hoists in situations where heavy objects have to be raised, but powered lifting equipment is not available.

Maintenance activities over the life of a wind farm generally involve a wide range of lifting operations, ranging from the routine lifting of tools and equipment using the nacelle hoist, to complex lifts of major components. In some cases, further lifting within the WTG will be necessary in order to bring the load to the precise location where it is needed, which may also involve moving the load in very restricted spaces.

C.12.1.1 POTENTIAL HAZARDS AND RISKS

In any lifting operation, the most severe hazards to people arise from dropped objects, which may be caused by failure of lifting equipment or lifting points on the load itself, incorrect slinging or packaging of a load, or overturning of a crane. People can also be struck or crushed by a load, particularly if they are working in close proximity to it, such as when guiding it into the desired location.

Many major lifts in wind farm construction involve the use of two cranes, in order to lift a load from a horizontal orientation, and erect it in a vertical orientation, such as when erecting a tower; tandem lifting is significantly more complex than single lifts. Blades have the added complexity of having a large area and an aerodynamic profile, which combined with their relatively low weight, can impose far greater wind loads on cranes than other components of similar weight.

Other areas of complexity to address include:

- The workforce may be from a number of different countries, bringing the potential for difficulties arising from communication problems, or being accustomed to working under different regulatory systems;
- Limited space on crane pads, in relation to the size and number of components and cranes present, or the very restricted space in a WTG for landing a load, can give rise to proximity hazards, if people are under the path of a load, or at risk of being struck by it;
- Weather conditions can change rapidly and with little warning, resulting in a risk of operating limits being exceeded; and
- The safe operation of cranes depends on having suitable ground conditions for the loads imposed, so the loadbearing capacity of crane pads is of critical importance.

C.12.1.2 RELEVANCE TO KEY LIFECYCLE PHASES

Lifting operations will be required over the entire lifecycle of a wind farm; construction and major maintenance operations may involve significant heavy lifting activity, while even light maintenance is likely to involve lifting of components or tools to and from the nacelle.

During project design, the WTG selection will determine the lifting requirements, which will in turn determine the requirements for roads and crane pads. The civil design should be suitable for foreseeable crane types: on occasions, a crane supplier may provide a crane that has higher capacity than was specified, but this can cause problems if a greater area or bearing capacity is needed in order to accommodate the larger crane.
The WTG selection will also determine the nature of the lifts that will be required during erection; there will often be a trade-off between a larger number of smaller lifts, or a smaller number of large lifts – for example, the rotor may either be lifted as a hub and three separate blades, or as a single lift.

Design decisions regarding the capability of lifting equipment that is to be provided within nacelles, in terms of its lifting capacity and coverage of potential lifting locations in the nacelle, will determine the ease and safety of maintenance tasks, and how often an external mobile crane has to be brought to site.

C.12.2 REGULATORY REQUIREMENTS

Lifting equipment is subject to the Provision and Use of Work Equipment Regulations (PUWER), which require that it is suitable for the purpose for which it will be used, in terms of properties such as materials of construction, accessibility, protection of personnel, and withstanding the effects of high wind. Powered lifting equipment is also subject to the Supply of Machinery (Safety) Regulations, which implement the Machinery Directive; in addition to the Essential Health and Safety Requirements (EHSRs) that apply to all machinery, Annex 1, Part 4 of the Directive contains supplementary EHSRs that apply specifically to lifting equipment.

All lifting operations and lifting equipment are subject to the requirements of the Lifting Operations and Lifting Equipment Regulations (LOLER), which include:

- Lifting equipment, supporting structures, and the load, must all have adequate strength and stability;
- Equipment and accessories used for lifting persons is subject to additional design and operational safeguards;
- Positioning and installation of lifting equipment should minimise the risk to people, from suspended loads or crushing;
- Lifting equipment and accessories shall be subject to periodic inspection, thorough examination and record keeping;
  - The statutory minimum inspection frequencies may not be sufficient to monitor deterioration in lifting equipment that is subject to the intensive and repetitive use that can be expected in large scale wind farm construction; suitable systems for inspection and quarantine need to be established;
- Lifting operations must be properly organised; this includes planning, supervision and execution:
  - Lifting operations should be planned in accordance with BS 7121 by an Appointed Person, with the level of detail reflecting the complexity and hazards of a lift.
  - The LOLER ACOP states that the purpose of the plan is “to address the risks identified by the risk assessment and identify the resources required, the procedures and the responsibilities so that any lifting operation is carried out safely. The plan should ensure that the lifting equipment remains safe for the range of lifting operations for which the equipment might be used”.

The plan should also define the actions and necessary equipment in emergency situations, such as:

- The ability to abort a lift that has already started;
- Actions to take in the event of crane breakdown;
- Method of evacuation a casualty from a WTG tower, noting that the normal evacuation route of descending out of the nacelle will not be available until the nacelle and its rescue kit are in place.

All personnel involved in the lift need to have a full understanding of the plan before operations commence; this should be assured by carrying out a final briefing prior to the start of the lift.
C.12.3 MANAGING THE RISKS

While there are common risks across all types of lifting operation, proportionality demands that the effort devoted to planning and managing health and safety should reflect the risks and complexity of the intended operation; planning may therefore range from detailed calculations and hazard studies carried out in advance by a specialist team, to basic simple checks on the load and equipment, carried out by a competent person before executing the lift. However, all lifts must be planned; it is not acceptable just to set up and start lifting without an appropriate level of planning.

C.12.3.1 APPROACHES TO RISK ASSESSMENT

Once a requirement to carry out a lift has been established, a lifting plan should be prepared; as a minimum, the plan should cover:

- The load, its properties, and how it is to be lifted, taking account of effects such as how it reacts to wind loading;
- Selection of the crane(s) or other lifting equipment;
- Selection of lifting accessories such as slings, chains and connectors;
- Positioning of the crane(s) and load throughout the operation, including the required bearing capacity of the crane pad;
- Hazards arising from characteristics of the site, such as proximity to overhead lines;
- Arrangements for crane erection / dismantling, and attachment to / release of the load; and
- Weather conditions that may constrain the operation.

Based on the outline plan, a suitable and sufficient risk assessment of the proposed operation must be carried out, in accordance with the Management of Health and Safety at Work regulations. The risks identified by this assessment are then to be addressed by the method statement, prepared by an Appointed Person in accordance with LOLER requirements. This may either be:

- A generic method statement, for a series of routine lifts, such as the use of a telehandler for lifting pallets of construction materials off delivery lorries in the site compound; or
- A specific method for a non-routine lift, such as using the same telehandler to recover a shed load from an embankment – indeed, carrying out detailed planning can sometimes show that an entirely different approach should be taken, using different equipment.

The guidance on LOLER details many of the factors to consider when planning each stage of a lifting operation.

C.12.3.2 CLARITY ON RESPONSIBILITIES

There are two basic forms of contract for lifting, in which the client for the lifting operation (who, in this context might be the Principal Contractor or WTG supplier) takes on different responsibilities:

- Under a Crane Hire contract, the client is responsible for the planning, supervision and safe execution of the lift; the crane hire company provides a crane and operator, who will follow the lift plan prepared by the client; or
- Under a Contract Lift contract, the contractor provides the crane, operator, Appointed Person, documentation and insurance, and is responsible for planning, supervision and execution of the lift;

In both forms of contract, the responsibility for ensuring that the ground provides proper support for the crane, throughout the lift, and for providing information on site hazards, rests with the client. Contracts should also ensure that weather risk is clearly and appropriately allocated, and that the costs incurred do not encourage inappropriate behaviours.
C.12.3.3 RISK MITIGATION MEASURES

This risk of problems arising from lifting operations can be minimised by actions such as:

- Giving thorough consideration to lifting requirements in the design and selection of WTGs and major equipment items, considering details such as the location of lifting points with respect to the centre of gravity of the item, and the accessibility of lifting points;
  - Design details may enable the load to be lifted into its final position without needing people to guide it, thus avoiding placing people beneath the suspended load, or close to pinch-points between the load and the location that it is being lowered onto;
- Carrying out early initial planning of lifting operations, so that site infrastructure is suitable, and sufficient space is available at each WTG location for foreseeable types of crane;
- Selecting an appropriate crane and lifting configuration for the task; for example, lifting light equipment into a tower, using the main block of a heavy lift crane, may result in difficulty controlling the load, as its weight may be too small in comparison to the block and lifting cables; use of an auxiliary crane / block that is more suited to the light load will avoid this problem;
- Establishing reliable communications between the crane operator and the signaller / banksman; such communication is normally done by means of hand signals, although if the signaller has to be in a location in which they cannot be seen by the crane operator, radio communication will be necessary;
- Ensuring that the suspended load will not pass over locations where people will be present during the lifting operation, so that if, despite all the planning and preparation, the load (or part of it) drops, people will not be in immediate danger;
  - The use of long tag-lines to guide the load can assist in this, provided that there is sufficient space to enable people to stand back from the load;
  - During WTG tower erection, tower sections are generally lifted from a horizontal orientation, using two cranes, and rotated until vertical, at which point the lifting attachment on the lower flange has to be released. The use of suitable lifting accessories, or supports for the tower section, can allow the attachment to be released without the need for people to work under a suspended load;
- Obtaining site-specific weather forecasts, for wind speed, gust strength and lightning risk, taking account of site altitude, and the jib height of the cranes – both of these factors may give a significantly higher wind speed than at typical forecasting locations, which are usually based on 10m elevation in populated areas;
- Ensuring that items that are not designed to be lifted, such as tool bags and drums of oil, are lifted inside suitable lifting bags or nets;
- Ensuring that loads are properly prepared for lifting, so that there are no loose items that can fall out or become detached, even if the load swings against an obstruction during lifting – even a small object can cause serious injury if falling from sufficient height; and
- Providing safe access to attachment points on loads, for example, rigging a tower section for lifting from a lorry may involve handling heavy lifting accessories while working at height, so suitable access is essential.

Even where thorough planning is carried out, problems can still occur, such as interruptions in power and communications systems, failures of load-bearing components, and unexpected problems with the parts to be assembled, so advance contingency planning is essential.

C.12.3.4 MONITORING, REVIEW AND CHANGE MANAGEMENT

During lifting operations, monitoring should include:

- The crane’s Safe Load Indicator, which monitors crane load and configuration; and
- Weather conditions, especially wind and lightning, by observation and on-site measurement.
The information from this monitoring needs to be used within well-defined procedures to determine whether to proceed with or abort operations.

Lifting equipment within the WTG, such as the nacelle crane, is subject to periodic thorough examination under LOLER, in addition to pre-use checks by the user. Checks on nacelle hoists should pay particular care to components or locations that may be subject to wear while the hoist is in a parked position, as a result of nacelle movement.

In cases where a generic lift plan is to be used, the proposed lift should be reviewed against the constraints of the plan, to ensure that the intended equipment and methods are used, and that the load, the height and radius of the lift are within the intended operating envelope.

C.12.4 CODES OF PRACTICE AND GUIDANCE

C.12.4.1 REGULATIONS AND STANDARDS


C.12.4.2 OTHER RELEVANT GUIDANCE

HSE INDG422 - Thorough Examination of Lifting Equipment - A simple guide for employers.

HSE Website – Work Equipment and Machinery.

HSE Website: Hazards During Maintenance - Falls of Heavy Items.

Fédération Européenne de la Manutention - Guideline - Safety Issues in Wind Turbine Installation and Transportation addresses the transport and lifting of WTGs and components. (Freely available, but requires entry of name and email address to download).
C.13 NOISE

C.13.1 OVERVIEW

This section considers the risks that noise presents to people during work on wind farms; it does not address environmental noise, which should be assessed as part of the development process, and is covered in Section A.12.1.

Exposure to high levels of noise in the workplace may result in people suffering permanent or temporary hearing loss or damage.

The HSE notes that hearing loss is entirely preventable if:

“(a) employers take action to reduce exposure to noise and provide personal hearing protection and health surveillance to employees;
(b) manufacturers design tools and machinery to operate more quietly; and
(c) employees make use of the personal hearing protection or other control measures supplied.”¹⁶

C.13.1.1 POTENTIAL HAZARDS AND RISKS

Prolonged exposure to high levels of noise may result in people suffering gradual hearing loss, which may only be apparent later in life, and is permanent and irreversible.

Hearing damage may also result from sudden, extremely loud noises. Such incidents may cause temporary hearing loss, but could also cause longer-lasting or permanent hearing damage.

A noisy working environment also impairs communication, while the safety of people may be affected if safety alarms, such as vehicle reversing alarms, become part of the background noise.

Noise exposure may occur from a range of activities, including:

- Use of heavy construction plant, especially for tasks such as breaking out of rock or concrete, stone crushing, rolling of roads, or driving of foundation piles;
- Use of noisy power tools, such as impact tools or angle grinders; and
- Use of temporary power sources, such as generators or compressors.

The noise exposure is likely to be more severe when tools are used in restricted spaces within structures such as WTG towers, compared to undertaking the same task in the open air. As the main exposures to noise are likely to occur during construction and non-routine maintenance work, specialist teams who carry out such activities in campaigns on multiple sites, such as bolting tower sections together with impact tools, are likely to have a higher level of exposure than employees undertaking more varied tasks.

Hearing loss affects a person’s ability to communicate, adversely affecting their ability to work effectively, and potentially having a severe impact on their quality of life outside work, for the rest of their life.

C.13.2 REGULATORY REQUIREMENTS

The Control of Noise at Work Regulations 2005 impose duties on employers, including to:

- Assess the risks to employees from noise at work;
- Take action to reduce the noise exposure that produces those risks;
- Provide employees with hearing protection if noise exposure cannot be reduced sufficiently by using other methods;
- Make sure the legal limits on noise exposure are not exceeded;

¹⁶ HSE L108 – Controlling noise at work – The Control of Noise at Work Regulations 2005 – Guidance on Regulations
- Provide employees with information, instruction and training; and
- Conduct health surveillance where there is a risk to health.

Employees have a duty to make full and proper use of noise control measures, which include both personal hearing protectors and technical measures to reduce noise emission, and to report any defects in these.

C.13.3 MANAGING THE RISKS

C.13.3.1 APPROACHES TO RISK ASSESSMENT

An initial assessment should be carried out using the guidance provided by the HSE, in Table 10 below.

Table 10: Initial workplace noise assessment criteria (Source: HSE L108)

<table>
<thead>
<tr>
<th>Test</th>
<th>Probable noise level</th>
<th>A risk assessment will be needed if the noise is like this for more than:</th>
</tr>
</thead>
<tbody>
<tr>
<td>The noise is intrusive but normal conversation is possible</td>
<td>80 dB</td>
<td>6 hours</td>
</tr>
<tr>
<td>You have to shout to talk to someone 2 m away</td>
<td>85 dB</td>
<td>2 hours</td>
</tr>
<tr>
<td>You have to shout to talk to someone 1 m away</td>
<td>90 dB</td>
<td>45 minutes</td>
</tr>
</tbody>
</table>

If the initial assessment indicates that a noise risk assessment may be required, then it should be carried out by a competent person, in order to:

- “identify where there may be a risk from noise and who is likely to be affected;
- contain a reliable estimate of employees’ exposures, and compare the exposure with the exposure action values and limit values;
- identify what measures need to be taken to comply with the law, e.g. whether noise-control measures or hearing protection are needed, and, if so, where and what type; and
- identify any employees who need to be provided with health surveillance and whether any are at particular risk.”

The risk assessment needs to be based on reliable information, which may already be available from suppliers, or may have to be gathered by direct measurements.

Use of data sources such as BS 5228, or measurements from similar activities on other projects, can allow a screening assessment to be made before work starts on site, in order to identify activities that are likely to have a high risk from noise, and allow mitigation to be planned in advance. This approach can avoid the delays that can occur if a problem is first identified on a site, and mitigation has to be arranged, but is not a substitute for on-site assessment.

C.13.3.2 RISK MITIGATION MEASURES

Employers have a general duty under the Noise at Work regulations to reduce the noise exposure and risk to their employees so far as is reasonably practicable, even if a specific exposure limit is not exceeded. The risk should be mitigated according to a hierarchy of controls:

1. Eliminate the source of loud noise, for example by adopting a different process, such as using hydraulic bolt tightening in place of pneumatic impact tools, or using equipment that is designed and maintained to give lower noise emission;
2. Modify equipment to reduce noise and vibration emission, such as fitting silencers on air tool exhaust outlets;
3. Limit workers’ exposure to noise by reducing the time spent in noisy areas or operations, for example by rotating workers between different tasks.
If, after implementing technical and organisational control measures to reduce noise levels so far as is reasonably practicable, workers are still exposed to noise that exceeds specified levels, then the employer’s duties can be summarised as:

- No employee is permitted to be exposed to noise exceeding the Exposure Limit Value;
- If the upper Exposure Action Value is likely to be exceeded, hearing protection provision and use is mandatory; and
- If the lower Exposure Action Value is likely to be exceeded, hearing protection should be provided if requested, but its use is voluntary.

In all cases, employers should ensure that employees who are exposed to noise at work receive information on the risks, and instruction on the use of work equipment and PPE to reduce their noise exposure.

C.13.3.3 MONITORING, REVIEW AND CHANGE MANAGEMENT

Use of personal hearing protection should be carefully managed, to ensure that it is targeted at the areas and times when it is required, rather than as a blanket instruction if it is not always necessary.

Ongoing health surveillance, usually involving periodic audiometry, may be required as an outcome of the noise risk assessment.

The use of tools and equipment should be monitored, to ensure that:

- The actual working practices on site match those on which the risk assessment was based;
- Noise mitigation measures are in operation, for example, the acoustic housings on generators and compressors are kept closed when in use; and
- Powered tools and accessories are maintained or replaced as necessary, to ensure that their noise emissions do not exceed the specified levels.

C.13.4 CODES OF PRACTICE AND GUIDANCE

C.13.4.1 REGULATIONS AND STANDARDS


C.13.4.2 OTHER RELEVANT GUIDANCE


Update of Noise Database for Prediction of Noise on Construction and Open Sites provides some of the data used in the update of BS 5228.
C.14 REMOTE AND LONE WORKING

C.14.1 OVERVIEW

Many wind farm activities involve deploying small teams of workers to sites; often, and especially on small wind farms, there will only be one team on the site. Each team is therefore remote from immediate support and supervision, and the wind farm itself is remote from the further support that their employers could provide. In other situations, lone working may occur, either if only one person is on the site, or if more than one person is on the site, but one person is working in an area of the site that is remote from the other workers.

Remoteness should be considered in terms of:

- Site remoteness – the physical remoteness of the site activities from further support such as other teams of technicians and emergency services;
  - This will influence the emergency response arrangements for the wind farm as a whole;
  - Remoteness is not just about distance:
    - Severe weather can delay or prevent travel to or from a site – in extreme cases, this could lead to stranding;
    - Locations without good mobile phone coverage will present additional challenges in monitoring teams and responding to emergencies;
- Task remoteness – potential for remote working as part of routine construction and O&M tasks in locations where direct supervision and support of work teams can be difficult;
  - This will influence the safety management arrangements for the task;
  - In the most extreme case, whenever a team is working in a WTG, and the tower door is locked to prevent unauthorised access, the team is remote from any external support that does not have a key for the door.

C.14.1.1 POTENTIAL HAZARDS AND RISKS

In the event of an incident occurring on a WTG, any delay in stabilising and evacuating a casualty, and obtaining further medical support if necessary, could cause a situation that was initially fairly simple to escalate in severity.

The remote nature of work on wind farms also brings challenges in the provision of supervision and auditing, with each team being responsible for working in a safe manner, in accordance with approved procedures, achieving the required standard of work, and leaving the workplace in an appropriate condition, so that it will be safe for the next working party.

C.14.1.2 RELEVANCE TO KEY LIFECYCLE PHASES

Pre-construction activities on a site, such as surveys and wind resource measurement, may present some of the greatest remote working challenges, as these activities involve small teams of people working on a site that does not yet have any roads or other facilities.

During the construction phase, sites will generally have large numbers of people present, with a corresponding level of amenity facilities and first aid cover. Site management should be aware of the locations where teams and individuals are working.

During the O&M phase, the site will again have fewer people present; the exact arrangements will largely be determined by the size of the site, with only the largest sites having a regular presence on site. However, the operating site will have more comprehensive infrastructure and amenities than pre-construction.

C.14.2 REGULATORY REQUIREMENTS

There are no specific regulations or guidance on remote working, but it should be addressed as part of an employer’s general duties under HSWA and MHSWR, as an aspect of the work activity to be considered in the risk assessment.
The effects of remoteness should also be considered when planning work such as lifting, work in confined spaces, the use of hazardous substances, and work at height.

C.14.3 MANAGING THE RISKS

Any work to be carried out requires thorough planning, to ensure that the necessary resources are in place to support the task and foreseeable incidents that may occur while it is in progress. The planning of tasks at remote locations needs to ensure that all necessary work equipment, consumables, and means of waste disposal are provided, with appropriate spares as necessary. In the event of a shortfall in provision, there can be a temptation to improvise, using unsuitable equipment that may help to get the job done despite inadequate preparation, but expose the people involved to additional risks.

Work parties need to have the competence and equipment to manage foreseeable emergency situations up to the point where additional help will be available, making safe decisions in real time as situations develop, while maintaining communication with others, and staying within their competence.

The potential risks with remote and lone working also highlight the importance of suitable fitness to work assessments in order to identify any significant underlying health conditions.

C.14.3.1 APPROACHES TO RISK ASSESSMENT

It is important that all actual or potential remote or lone working situations are assessed and managed on a case by case basis. This is due to the variability of the risk profile for each project and lifecycle phase, and also the potential for rapid changes in operational and environmental conditions. This may require additional attention to be given to aspects such as:

- The competence of employees and contractors to assess and manage remote or lone working situations, such as their ability to identify hazards and mitigate risks, and undertake first aid, rescue and evacuation; and
- The effectiveness of procedures to monitor and supervise workers.

Risk assessments should include consideration of:

- The residual risks that the proposed tasks present, after mitigation actions have been implemented;
- Risks related to the site, rather than to specific tasks, such as risks of violence or intimidation in some locations;
- Site resources, in terms of people and equipment, to support remote or lone workers;
- Limitations on communications at the task location;
- Who else will be present, or nearby;
- The time that may elapse, from when an incident occurs, to when:
  - Additional support can be provided by other work parties on the windfarm;
  - Further support can be provided by the employer, or external emergency services; and then
  - Evacuation to medical care can be completed, taking account of any restrictions on access to the site.

These factors combine to determine the required level of provision of competent people and facilities at the remote location; the risk assessment may identify required competence standards, and any equipment that should be on site or at the task location prior to remote or lone working taking place.

The risk assessment would typically be provided to personnel as part of their work pack, to assist their preparations, and provide a starting point for their point of work risk assessment.

C.14.3.2 RISK MITIGATION MEASURES

It is important to maintain effective communication with all personnel working in diverse areas of a wind farm. Communication systems and protocols need to be capable of working across the
whole of a wind farm, and coping with the potentially large numbers of people who may be at work during peaks in activity, noting that not all personnel on site will have the same first language. As well as being vital for safety, a good communications system may also be used to provide technical support and a degree of remote supervision to personnel undertaking technical tasks. Direct communication should be possible between work parties and:

- The site manager and / or Operational Controller;
- Off-site supervision or technical support; and
- Others who will support them in the event of an incident, such as other work parties or off-site support such as in-company emergency management teams, or the emergency services.

Given that the ability to communicate is safety-critical, it may be necessary to provide access to at least two independent communications systems – these could be various combinations of landlines, mobile phones and satellite phones, depending on the nature and location of the site.

It is important to know the location of all personnel at all times, including when travelling off-site; suitable procedures should be put in place, such as a control centre being advised of the journey and contacted on completion, and having an escalation procedure if a person is overdue and cannot be contacted. In some cases, vehicle tracking systems can be used to support the operation of such procedures.

Each work party should have a sufficient number of people with appropriate levels of training in skills such as first aid and rescue, to ensure self-sufficiency and preservation of life in the event of an accident, until further support is in attendance. The size of the working party may determine the areas in which work is permitted, for example, a working party of two people might not be able to rescue a casualty from a hub, in which case, the hub should not be entered; clearly such constraints will depend on the WTG design and the rescue method.

Suitable arrangements should be in place for supervision and audit, to ensure that safe working practices are being used, and that approved procedures are being followed, and updated if improved methods are identified. Provision of a level of on-site supervision may help to achieve this, as well as providing technical support to technicians and assisting in quality assurance.

**C.14.3.3 MONITORING, REVIEW AND CHANGE MANAGEMENT**

The safety of remote working can be affected by changes that range from real-time changes in the operational situation, to major organisational changes.

Procedures should be in place to ensure that temporary changes and operational restrictions are communicated to all necessary parties so that planned operations can be modified accordingly; typical situations could include:

- Temporary restrictions affecting access routes; or
- Changes in the scope of work that alter its risk profile, requiring additional support or precautions to be in place before the work can go ahead.

More significant changes, such as the introduction of new procedures and service providers, could fundamentally alter the safety of remote working; thorough assessment of such changes, and effective communication, is essential in order to minimise the associated risks.

**C.14.3.4 LONE WORKING**

There are no absolute restrictions on working alone, and there are situations in which it may arise, such as:

- Site security: even if there is more than one person on duty, individual patrols of the site may be undertaken;
- A local site manager may visit a site to undertake basic checks without others being present; and
- A WTG technician may visit a site to undertake simple tasks such as local resetting of a stopped WTG that cannot be restarted remotely.
The risks presented by lone working should be assessed, and suitable safeguards put in place, such as:

- Defining clear limits to the tasks that a lone worker can undertake;
  - For example, access to a SCADA screen inside the ground level of a WTG might be acceptable, but opening a panel or ladder climbing would be prohibited;

- Ensuring that robust systems are in place to monitor the worker, such as:
  - Scheduled phone contact, including automatic systems that send an alert if the worker does not respond to a prompt on their phone;
  - Two-way radios with a “man down” function; and
  - GPS and satellite technology-based systems, for sites without reliable mobile phone reception or other personnel within range of a two-way radio;

When selecting and implementing lone-worker systems and procedures, consideration should be given to factors such as:

- Potential locations where the lone worker will be working and travelling, and how communication could be established;

- The hazards to which the worker may be exposed, and other foreseeable events;

- How the system is to be monitored, to ensure that alerts will receive a timely and appropriate response, whether this is managed by the employer or a third party; and

- Ensuring that follow-up procedures provide a means of having someone attend site within a reasonable timeframe to check for the presence and well-being of a lone worker; this might involve having an identified contact person in the local area, with an agreed protocol for site checks if a lone worker cannot be contacted.

C.14.4 CODES OF PRACTICE AND GUIDANCE

C.14.4.1 REGULATIONS AND STANDARDS

There are no specific regulations for remote or lone working; however, it must be conducted in accordance with the general duties of the HSWA, and managed in accordance with the MHSWR.

C.14.4.2 OTHER RELEVANT GUIDANCE

HSE INDG73 – Working alone – Health and safety guidance on the risks of lone working, although not specific to remote working, many of the points that are covered in this document are transferable to work in remote locations.

HSE HSG65 - Managing for Health and Safety.
C.15 TRANSPORT

This section considers the transport of large components, materials and construction plant from their origin (such as a manufacturing facility, port or quarry) over public roads to wind farms, and within the wind farm to unloading at their location of use. Hazards relating to mobile construction plant during construction activities are covered in Section C.6, personnel travel between sites is covered in Section C.7 and lifting is covered in Section C.12.

C.15.1 OVERVIEW

Transport operations can create some of the most significant off-site impacts of wind farm construction; a typical 2MW class WTG will involve about 6-8 abnormal loads being transported from ports or manufacturing sites to the wind farm, in addition to general construction traffic.

As wind farms are generally sited in rural areas, a large proportion of the transport takes place on minor roads that are not designed for heavy traffic, and which would normally see little use, so major transport operations can bring a significant temporary change in the character of these routes, and the experience of communities through which the roads pass.

C.15.1.1 POTENTIAL HAZARDS AND RISKS

The principal risks relating to the transport of large and heavy loads include:

- Driving off the edge of the loadbearing surface of a road, which can result in overturning (due to the road giving way) or becoming stuck in soft ground;
- Overtopping of the vehicle, which can have various causes such as excessive gradient / camber, inappropriate driving or loading;
- Loss of control of the vehicle, whether due to technical faults, road conditions or human error;
- Shedding of all or part of the load; and
- People being crushed or struck by the vehicle or the load when manoeuvring, loading or unloading.

In the event of an accident occurring, both the driver of the vehicle involved, and any persons nearby, would be at risk; site emergency plans could also be compromised if an access route was obstructed. The subsequent recovery of a vehicle or load could put further people at risk.

As transport operations take place on public roads, they have the potential to cause significant inconvenience to the communities on the transport route, or even put members of the public at risk if transport is not done safely.

C.15.1.2 RELEVANCE TO KEY LIFECYCLE PHASES

The most intensive transport operations will occur during construction, involving the delivery of WTGs and major BoP equipment such as transformers and large cable drums, in addition to cranes and general construction traffic. Construction traffic on public roads will be greatly increased if stone has to be imported to the site for road construction. The standards of transport planning, community liaison, driving and vehicle maintenance will all affect the level of impact on communities along transport routes.

In the event of major component replacement being necessary during the operating life of the wind farm, the replacement and removed components would need to be transported to and from the site.

When the wind farm is decommissioned, the WTGs and BoP equipment will be transported from site, either as complete components for re-use or scrapping off-site, or as smaller units in a partially scrapped state.

C.15.2 REGULATORY REQUIREMENTS

Transport on public roads is subject to the Road Traffic Act 1988, which sets legal minima for matters such as driving standards, driver training and licensing, and standards of construction and use of vehicles.
The transport of "abnormal" loads (i.e. those that are oversize or exceeding normal weight limits) is regulated under the Road Vehicles (Authorisation of Special Types) (General) Order 2003 (STGO) which defines three standard categories of load. Obtaining STGO permits involves several different bodies, depending on the STGO category, and the class of road (local or trunk) being used. These bodies include local authorities, bridge authorities, police, and national government agencies such as the Highways Agency. Abnormal loads exceeding certain dimensions specified in STGO require an "attendant" or escort, to attend to the STGO vehicle / load, and warn the driver and other road users of dangers arising from the presence of the vehicle / load. Attendants are most commonly provided by the haulier / developer (known as self-escort), but in some situations a police escort will be required, particularly as self-escorting attendants do not have the authority to stop or direct other road users or pedestrians.

The legal requirement for STGO drivers is to have normal LGV licences, backed up by mandatory initial and periodic Driver Certificate of Professional Competence (CPC) training; it is up to the employer to provide any additional training that is needed in order to be competent to manage the additional challenges of STGO driving. There are no standard qualifications for other safety-critical roles such as vehicle marshallers, escort vehicle drivers, or persons who control the rear-wheel steering of a vehicle.

Activities involving closure or restriction of public roads, or the placement of temporary road signage, will require permits made under the Road Traffic Regulation Act 1984; the permitting authority will either be the local council (for the local road network) or the national government for trunk roads.

The design, maintenance and safe management of site roads and access routes are subject to the Workplace regulations.

C.15.3 MANAGING THE RISKS

C.15.3.1 PROJECT DEFINITION

Initial feasibility studies should consider potential transport routes, as these may restrict the types of WTG that could be installed on a site. In many cases, a transport management plan may have to be submitted to the planning authority, as part of the consenting process.

The layout of site roads will often be a compromise between the ideal transport route, and minimising the environmental impact and cost of the roads, but must be capable of safe use for the loads that have to be moved over the life of the wind farm. In some cases, existing roads on a site may be upgraded for wind farm use; this can minimise the land area that is used for roads, and their visual impact, but will require thorough assessment of the properties of the existing roads in order to determine their suitability, and the scope of work that would be needed within the upgrade. The materials of construction of existing roads should also be checked; for example, if reclaimed material from demolition has been used in their construction, it could contain contaminants such as asbestos.

C.15.3.2 PROJECT DESIGN

Detailed design of roadways and planning of transport should be undertaken in advance of construction work.

C.15.3.2.1 Routes to Site

Planning the routes to site should consider factors such as:

- Permitting requirements;
- Condition and loadbearing capacity of roads and structures such as bridges;
  - This could affect the choice of route, or lead to a requirement to upgrade key locations on public roads;
- Any restrictions on the hours of use:
  - Night-time transport may reduce the potential for abnormal loads to create traffic congestion, compared to daytime transport; but
  - Transport in the dark on unlit rural roads is more hazardous than in daylight;
C.15.3.2.2 Site Roads

Planning and design of site roadways should consider factors such as:

- Protection of edges and drop-offs;
- Width of load-bearing surfaces, and means of identification of these areas in locations such as bends where construction techniques tend to spread the road wider;
- Effective drainage, balanced against minimising environmental impact;
- Provision of turning heads or one-way traffic systems;
- Signage to avoid unfamiliar drivers taking wrong routes;
- Limits on gradients, bend radii and road camber, which will be determined by the transport and crane requirements for the selected WTG types;
- Identification of areas where pedestrians may be present, and providing suitable segregation from vehicles;
- Provision of passing and parking places;
- Crossing of underground utilities, such as cables and pipelines;
- Hazards to be avoided, such as overhead electricity lines; and
- Any areas where lighting may be provided, ensuring that it improves safety and does not dazzle drivers.

C.15.3.2.3 Site Traffic Management

Residual hazards that cannot be fully mitigated by design should be controlled as part of the site rules and traffic management plan, which will typically cover:

- Designation of parking and loading / unloading areas, and any limitations on how and when they can be used;
- Traffic routes and limitations;
- Pedestrian areas;
- Speed limits, which may vary in different areas of the site;
- Planning for steep sections – calculations for push / pull movement of heavy loads; and
- Arrangements for collection and removal of waste.

It may be necessary to ensure that the format and language of communication of the traffic management plan is appropriate for use with drivers who are not native speakers of English. The site traffic management plan will have to interface with specific plans for management of locations such as borrow pits and batching plants.

C.15.3.2.4 Transport Contractor Selection

A suitable transport contractor should be appointed; the contract should consider factors such as:

- Competence standards for drivers, vehicle marshallers and supervisors in accordance with industry codes of practice;
• Arrangements to ensure that vehicles and trailers are maintained in a safe and legal state, taking account of the potential for arduous use on construction sites;
• Responsibility for obtaining all relevant permits and complying with their requirements;
• Contingency planning for any incidents that may occur;
• Escort arrangements, including the extent to which they may be provided by the police and / or the contractor; and
• Contingency arrangements in case delays cause drivers to reach their statutory limits on driving hours before the load movement has been completed.

Early appointment of the contractor can enable the design to take account of actual vehicle capabilities and requirements, rather than designing for a generic vehicle. Experienced contractors can make valuable contributions to effective detail design, planning and risk control, particularly if a workshop approach is used.

C.15.3.2.5 Planning of Transport Operations

In addition to the characteristics of vehicles and their loads, the planning of transport operations should also consider the duration of journeys, and ensure that there is adequate contingency in case of delays, noting that drivers cannot exceed legal limits on working hours, and that road closures and police escorts may only be available at certain times of the day or night. It is important to avoid creating situations where transport operations become subject to excessive time pressure.

The contractor should submit risk assessments and method statements (RAMS), which will generally be a combination of standard procedures and task or site-specific factors; these should be reviewed to confirm their quality, thoroughness and relevance to the project. Emergency response procedures should also be in place, to address challenging and potentially hazardous situations such as the recovery of a vehicle or load that has left the road. Sufficient time and resources should be allocated to planning any recovery operations, despite time pressure to re-open the road, in order to address factors such as:

• If the strength of the road, or parts of the road, may have contributed to the accident occurring, then the strength of adjacent areas should be checked before use in the recovery operation;
• Any lifting or towing / winching operations should be carefully planned (noting that the planning of lifts is a legal requirement under LOLER), ensuring that:
  o Cranes are set up on suitable ground, considering its gradient and bearing strength;
  o The direction of force is within the operating envelope of the crane and any lifting points being used;
  o Any situations where the sudden movement of a vehicle or load could give rise to a snatch load are identified and mitigated;
  o People remain in safe locations relative to tensioned ropes or chains, in case sudden parting of the rope or chain leads to it flailing dangerously; and
• Given that the accident may be blocking the access route, contingency planning should identify alternative routes for emergency site access, or consider halting work on site if emergency access is not available, and ensure that cranes will be able to reach the site of an accident if they are to be used for recovery.

Prior to load movements taking place, carrying out a trial run can assist the team in becoming familiar with the route and its challenges, and checking the adequacy of preparations, prior to the added complexity of manoeuvring laden vehicles. If a route has not been used for some time, then walking it over can help to identify any deterioration.

C.15.3.2.6 Security of Loads

Where WTG components are to be transported over long distances by road, particularly if crossing international borders, suitable arrangements should be in place to ensure that they are protected against theft, damage or unauthorised entry. This could involve a combination of
physical securing and the use of tamper-evident seals on potential points of entry, together with careful planning of journeys to ensure that loads are only parked in locations with an appropriate level of security, depending on local risks. Loads should be checked for signs of damage or forced entry, and any necessary remediation carried out, to ensure that equipment is in a safe and clean condition on delivery to site.

C.15.3.3 CONSTRUCTION AND COMMISSIONING

C.15.3.3.1 Key Personnel

The training and competence of the individuals deployed onto a particular job will have a major influence on the successful implementation of the agreed plan, for example:

- Drivers of abnormal loads require a level of competence that goes beyond the minimum required to hold a normal LGV licence; this will generally come from training and experience during their employment;
- Escort drivers need to understand the characteristics of the convoy that they are escorting, and communicate effectively with the drivers and other road users;
  - It is essential that there are enough radios, and clear protocols, to enable this to be done; and
- Vehicle marshalls have a key role in the safe movement of loads, and need to understand the limitations of the vehicles involved;

Pre-mobilisation competence assessments should be reinforced by on-site monitoring, to ensure that the required standards and behaviours are displayed.

The welfare of all personnel involved in transport operations is important, both to fulfil legal duties, and to ensure that people are in a fit state to maintain concentration during safety-critical activities. While LGVs may have sleeping accommodation integrated into the cab, escort drivers and vehicle marshalls may also need suitable overnight accommodation.

Abnormal loads will often have manually-controlled rear-wheel steering, which requires a second person to operate, in conjunction with the driver of the tractor unit. Anyone undertaking this work should have appropriate training and be provided with a safe working position, not riding on the trailer unless it is designed for this.

If vehicle marshalls are used on a site to guide loads over significant distances, or to manoeuvre multiple loads in one location, they will be exposed to the prevailing weather, such as wind, snow / rain and dust, for the duration of a safety-critical task that requires full concentration to be maintained. They should be provided with suitable PPE for the conditions of work, should always be visible to drivers, and have reliable communications with them.

C.15.3.3.2 Road Conditions

Vehicle movements may be affected by road conditions, including:

- Weather: snow and ice can lead to loss of control;
  - This is particularly hazardous on sites where slopes face in different directions: a south-facing section of a road may be clear of frost, while a north-facing section may have dangerous patches of ice;
- Contamination of running surfaces with mud, or severe rain can also reduce grip.

On sites where snow poles or edge protection of roads are to be installed, these should not obstruct the WTG deliveries; this may require the use of temporary snow poles until deliveries are complete, and consideration of the detail design and phasing of the installation of edge protection.

C.15.3.3.3 Loading and Unloading

The loading and unloading of vehicles presents direct risks to the people involved; any latent errors introduced during loading may lead to later incidents.

Hazards during loading and unloading include:

- Work at height, to reach securing straps and attachment points on loads;
The risk can be increased if surfaces on vehicles are slippery, due to weather conditions or oil contamination;

Safe access should be provided, both for loading and unloading;

- The method of securing the load should consider the access available at the location where the load is to be unloaded, to ensure that this can be done safely;

- People can be struck or crushed by moving vehicles or loads;
  - Exclusion zones should be set up to minimise the number of people in the vicinity of the operation;
  - Inadvertent movement of parked vehicles should be prevented by applying the parking brakes, switching the engine off and removing the ignition key;
  - All personnel involved in the task should wear high-visibility clothing, and maintain communication with the driver / crane operator as appropriate;
  - All lifting operations should be properly planned by an Appointed Person;
  - Care should be taken to ensure that the load is clear of all securing straps before attempting to lift, to avoid an uncontrolled release from the trailer;

- Care should be taken when uncoupling trailers from tractor units:
  - Trailers should only be uncoupled on firm and level ground;
  - Trailers can roll away unless their parking brakes are applied; brakes should be applied to trailers, with chocks being applied to wheels if necessary;
  - The landing legs of trailers will exert much higher ground pressure than the wheels, so require a strong road surface, or the use of spreader beams to ensure that they do not sink into the roadway;

- Tipping of loose materials can be hazardous:
  - The load can spread out as it is tipped, burying any personnel standing too close to the discharge point;
  - The trailer tailboard can swing open when unlocked, as a consequence of pressure from the load, even without the trailer being raised for tipping, and may swing further during tipping;
  - Wet or sticky loads, such as clay soils, may not flow freely from the trailer, potentially resulting in partial or uneven discharge, with the potential to put the trailer off balance, particularly if it is elevated to a high angle; and

- Where deliveries to site are made by drivers who are not regularly on the site, they may not be fully aware of site hazards, rules and layout;
  - Appropriate information should be provided in a useful format, such as a briefing on arrival and/or site information card.

C.15.3.4 OPERATIONS AND MAINTENANCE

The O&M phase may require occasional transport of large replacement components to and from the site. The transportation plans prepared for the construction phase can form a starting point for planning such movements, but should be reviewed and updated prior to use, taking account of changes such as:

- Different vehicle types, compared to the initial transportation;
- New obstructions along the transport route, such as changes to junction layouts, new street signs and furniture, or growth of overhanging trees;
- Deterioration of site roads, which may mean that remedial work is needed before transport can take place; or
• Deterioration of public roads and structures such as bridges, which may result in temporary restrictions on their use – although on rural roads, such temporary restrictions may last for several years if major repairs are necessary.

C.15.4 CODES OF PRACTICE AND GUIDANCE

C.15.4.1 REGULATIONS AND STANDARDS


C.15.4.2 OTHER RELEVANT GUIDANCE

Department for Transport - Code of Practice - Safety of Loads on Vehicles provides guidance on the principles of safe securing of loads, and on specific types of load such as reinforcing steel, containers and construction plant.

HSE HSG136 - A guide to workplace transport safety provides guidance on the themes of safe site, safe vehicle and safe driver, including specific requirements for site roads; HSE INDG199 - Workplace Transport Safety - a Brief Guide provides less detailed guidance, but with the same approach.

HSE HSG144 – The safe use of vehicles on construction sites

Irish Wind Energy Association – Transport of Abnormal Loads to Wind Farms (Draft) describes good practices and lessons learned in the transport of WTG components.

Highways Agency Code of Practice: Lighting and Marking for Abnormal Load Self escorting vehicles incorporating Operating guidance provides detailed specifications for escort vehicles, and guidance on escort personnel, their duties and operating practices.

Society of Operations Engineers - Safe Working Practice for Open Top Tipping Bodies

Society of Operations Engineers - Code of Practice – Coupling or uncoupling & Parking of Large Goods Vehicle Trailers

Fédération Européenne de la Manutention - Guideline - Safety Issues in Wind Turbine Installation and Transportation addresses the transport and lifting of WTGs and components. (Freely available, but requires entry of name and email address to download).

The RenewableUK Cymru Strategic Traffic Management Plan for Mid Wales Wind Farms sets out the general principles for the safe and efficient delivery of WTG components to strategic search areas in Wales, and provides a model approach that could be used elsewhere.

C.15.4.3 ELSEWHERE IN THIS GUIDANCE

Construction
Driving at Work
Lifting
C.16 VIBRATION

C.16.1 OVERVIEW

People may be exposed to different forms of vibration in the course of construction and maintenance work:

- Hand-arm vibration (HAV), most commonly arising from the use of certain tools; or
- Whole body vibration (WBV), which may arise from use of heavy construction plant and transit on rough surfaces.

Both of these can lead to painful conditions that impair or prevent people from carrying out their normal work and social activities.

C.16.1.1 POTENTIAL HAZARDS AND RISKS

HAV can cause damage to blood vessels, nerves and joints, resulting in permanent pain and disablement. The exact nature of the damage varies; resulting medical conditions include Hand Arm Vibration Syndrome (HAVS) and Carpal Tunnel Syndrome. The risk depends on the level of exposure to vibration, both in terms of magnitude and duration, so workers repeatedly carrying out tasks with vibrating tools are at highest risk. Depending on the level of vibration, exposure limits may be reached in timescales ranging from a few minutes to a large proportion of the working day.

Vibration-related health problems can permanently impair a worker’s capability, including becoming unable to carry out fine work with small components, sensitisation to cold / wet conditions, and reduced grip strength, which may affect activities such as ladder climbing.

WBV can lead to back pain, either due to unusually high levels of exposure, or more commonly in combination with other risk factors such as muscle strains caused by heavy physical activity, or maintaining an awkward posture for extended periods of time. Even if no injury occurs, WBV will contribute to physical and mental fatigue.

C.16.1.2 RELEVANCE TO KEY LIFECYCLE PHASES

C.16.1.2.1 Hand-Arm Vibration

As the risk from HAV increases with exposure, the people at greatest risk are workers who repeatedly undertake tasks with vibrating tools, such as:

- Assembly teams who move from one structure to another, and repeat tasks such as nut running with impact drivers; or
- Teams undertaking major maintenance / modification work, involving tasks such as grinding, cutting, and mechanical surface preparation on a large number of structures in turn.

Exposure is reduced where jobs are rotated between different members of a work team, or where a wide variety of tasks is undertaken during the working day.

C.16.1.2.2 Whole Body Vibration

WBV risks are mainly associated with the use of heavy construction plant, such as earth-moving machinery, and are therefore most relevant to the construction phase. While the duration of the construction phase on any given wind farm is limited, construction workers will move from site to site, so may be subject to WBV exposure throughout their working lives.

C.16.2 REGULATORY REQUIREMENTS

The Control of Vibration at Work Regulations 2005 regulate work activities that expose workers to either HAV or WBV.

C.16.3 MANAGING THE RISKS

The regulations place a duty on any employer, whose activities may expose workers to risk from vibration, to carry out a suitable and sufficient risk assessment of the risk to employees from a work activity, in order to decide on any measures necessary to protect employees from the
effects of vibration. The first step is to assess the level of exposure, averaged over an eight-hour period, which is then compared against the:

- Exposure Limit Value (ELV); this must not be exceeded, so if the assessment shows that this is being exceeded, then steps must be taken to bring exposure below this limit;
- Exposure Action Value (EAV); if this is likely to be exceeded, then:
  o Exposure must be reduced ALARP;
  o Health surveillance of exposed employees is required; and
  o The employer must provide employees with suitable and sufficient information, instruction and training.

The duty is always to reduce exposure ALARP, even if the assessment shows that it is below the EAV.

C.16.3.1 APPROACHES TO RISK ASSESSMENT

C.16.3.1.1 Hand-Arm Vibration

The risk assessment should consider:

- All the factors related to the risk, which include:
  o The estimated daily exposure;
  o Working conditions, including factors such as:
    ▪ Temperature: circulation is reduced in cold hands, increasing susceptibility to HAV;
    ▪ The nature of the exposure (intermittent or continuous);
    ▪ Working position and weight of tools; and
    ▪ Any pre-existing health problems;
  o Whether exposure can be prevented, for example by using a different process, or tools that are mounted or supported rather than being hand-held.

C.16.3.1.2 Whole Body Vibration

WBV can be assessed, in a similar manner to HAV, in terms of exposure averaged over an eight-hour reference period. However, this approach does not adequately assess the risks presented if the WBV arises from shocks and jolts, which are better measured in terms of a Vibration Dose Value (VDV).

C.16.3.2 RISK MITIGATION MEASURES

Where prevention of exposure is not reasonably practicable, then the duty is to limit the exposure.

C.16.3.2.1 Hand-Arm vibration

Exposure may be limited by measures such as:

- Use of improved tools, mounting arrangements and consumables;
- Ensuring that tools are properly maintained, and suitable for the task; and
- Limiting duration of exposure, by changing methods of work to reduce the need for processes which give rise to HAV, or by rotating the work amongst members of a team.

It should be noted that while PPE is available in the form of “anti-vibration” gloves, it is not judged by the HSE to be particularly effective, and may even increase vibration at certain frequencies. However, PPE that protects the worker against cold conditions, and thereby maintains circulation in the hands, reduces susceptibility to HAV.
C.16.3.2.2 Whole Body Vibration
Mitigation of the risk associated with whole body vibration on construction plant requires a combination of measures, including:

- Selection of appropriate plant for the task, taking account of:
  - Vibration levels;
  - Ergonomics of working positions and access to and from the driving position;
- Consideration of site layout, to minimise unnecessary driving distances where possible;
- Ensuring that engineered mitigation, such as suspension seating, is correctly set up and maintained to maximise its effectiveness, and in particular that it does not worsen the most severe impacts;
- Provision of information and training to employees;
- Planning work to ensure adequate rest periods, and in particular ensuring that a short break is taken between activities that give WBV exposure, and those involving manual handling operations;
- Appropriate driving and use of plant, including speed reduction where conditions dictate;
- Protecting employees from cold and wet weather, as these conditions can increase susceptibility to back pain; and
- Where the magnitude of exposure cannot be reduced sufficiently by the above means, limiting the duration of exposure.

C.16.3.3 Monitoring, Review and Change Management
Where manufacturers’ data is used in assessing the level of vibration, then it is important that the actual conditions of use match the reference conditions. Worn tools, or changes in consumables, can significantly increase hand-arm vibration levels; workers should report any such increases in vibration from a tool, especially if they experience symptoms such as numbness or tingling after working with tools.

The risk of developing vibration-related health problems varies between individuals; genetic factors, pre-existing health conditions affecting circulation, and muscle / back strains from other work can greatly increase susceptibility, so effective monitoring of workers who have been identified as being exposed to vibration is required.

C.16.4 Codes of Practice and Guidance
C.16.4.1 Regulations and Standards
HSE L141 – Whole-body vibration – The Control of Vibration at Work Regulations 2005, is mainly focused on WBV arising from activities such as the use of construction vehicles.

C.16.4.2 Other Relevant Guidance
HSE INDG175 - Control the risks from hand-arm vibration - Advice for employers on the Control of Vibration at Work Regulations 2005.
HSE INDG242 - Control back-pain risks from whole-body vibration - Advice for employers on the Control of Vibration at Work Regulations 2005.
HSE HSG170 - Vibration solutions - Practical ways to reduce the risk of hand-arm vibration injury is mainly focused on the manufacturing and construction industries, but provides some relevant examples of adjusting processes, and managing the provision of tools.
C.17 WASTE AND SPILLAGE MANAGEMENT

C.17.1 OVERVIEW

Wastes and spillages can arise from various activities over the lifetime of a wind farm, introducing a range of hazards, both directly, as well as during remedial actions such as the disposal and transport of waste. The nature and extent of the waste or spillage will determine the level of risk that is associated with it. This section addresses the health and safety risks to people in the course of dealing with wastes and spillages, rather than the environmental risks and disposal requirements.

A range of different waste streams may arise over the lifetime of a wind farm:

- Construction work involves intensive use of heavy plant, which typically uses diesel fuel, oil-based lubricants and hydraulic fluids;
- Plant used for concrete work has to be washed out, giving rise to alkaline wash water;
- Routine O&M work may give rise to small quantities of waste on a regular basis;
- Periodic maintenance, such as oil changes in gearboxes and transformers, will generate larger quantities on a less frequent basis; and
- Amenity facilities, whether temporary facilities for use during construction, or permanent site facilities, will require the treatment or removal of sewage.

The risks from waste streams should be considered, both in terms of the hazard presented by the wastes themselves, and from any disposal measures required.

C.17.1.1 POTENTIAL HAZARDS AND RISKS

Spillages and leakage, whether occurring during normal operation, maintenance activities, or waste disposal, present a range of hazards:

- Contamination of floors and ladders increases the risk of slips and falls;
- Contamination of equipment can degrade its performance, for example if oil leakage contaminates the surface of a brake; and
- Leakage of combustible materials, onto components that may become hot in normal or abnormal operation, introduces a fire risk.

Wastes and spillages of hazardous substances are considered in more detail in Section C.11.

C.17.1.2 RELEVANCE TO KEY LIFECYCLE PHASES

The design phase needs to consider:

- The inventory of materials, potential for leakage, and requirements for scheduled changeover (for example of oils or lubricants) over the lifetime of the wind farm:
  - It may be possible to incorporate systems that extend the life of fluids such as lubricants and transformer oils, through effective filtration and moisture removal;
  - This may also bring cost savings, and extended equipment life;
- How scheduled changeover of fluids will be carried out:
  - Where large volume changeovers may be required, such as on substation transformers, it may be beneficial to provide hose connections to enable fluids to be pumped, rather than handling in containers;
  - Where fluids are to be drained manually, suitable access will be needed, both at the point where the fluids are to be drained, and along the route through which containers will have to be moved.
- Where wastes should be collected on site:
  - A large site may need several skips or other containers for segregated collection of different waste streams, with:
• Hardstanding and sufficient space for manoeuvring, to enable regular collections by LGVs to be done safely;
• Security measures, such as a palisade fence around the area, to discourage unauthorised removal of materials such as scrap metal; and
• Suitable covers on containers to stop waste being spread by the action of wind or animals.

While the design phase will determine the risks, most of the challenges of managing waste and spillages will arise during the construction, commissioning and O&M phases.

Diesel fuel can present one of the most significant spillage risks on a wind farm, from the construction phase onwards, due to its toxic nature, and its tendency to penetrate deep into the ground; clean-up generally involves removing the contaminated soil, disposing of it at a licensed facility, and reinstating the site.

During the construction phase, the refuelling of mobile construction plant is generally undertaken in a designated area, with suitable surfacing / secondary containment of leakage and security measures. Personnel involved in refuelling should have appropriate training, including in the actions to take in the event of spillage.

Mobile plant and trailers often also contain hydraulic fluids; preparations should be in place for response in the event of leakage while in use on the site.

Concrete wash water is highly alkaline (typical pH 11-12), and has a high level of suspended solids, so has to be contained and treated before discharge, or transported to a suitable disposal facility; the site should have clear procedures and the necessary facilities in place prior to concrete works commencing.

If portable generators are to be used to provide temporary power supplies, this can involve significant volumes of diesel fuel being stored in temporary containers, distributed around the site, connected to the temporary generators. The design and operation of such arrangements should be subject to thorough risk assessment, to ensure that their temporary nature does not give rise to an increased risk of spillage or leakage; fuel tanks and many generators have integrated bunding, but particular care should be taken with connecting hoses, if these go outside the bunds.

C.17.2 REGULATORY REQUIREMENTS

An employer’s general duties under the HSWA include:
- Ensuring, “so far as is reasonably practicable, safety and absence of risks to health in connection with the use, handling, storage and transport of articles and substances”; and
- Maintaining places of work “in a condition that is safe and without risks to health”.

Employees are required to co-operate so far as is necessary to enable these duties to be performed.

More specifically, the Workplace (Health, Safety and Welfare) Regulations 1992 impose a duty on employers to ensure that:
• Every workplace is kept sufficiently clean; and
• So far as is reasonably practicable, waste materials shall not be allowed to accumulate in a workplace except in suitable receptacles.

When electrical or electronic components are replaced, their disposal is subject to the Waste Electrical and Electronic Equipment (WEEE) Regulations, under which the original supplier of such equipment (if supplied after August 2005) is responsible for taking it back, and disposal through an Authorised Treatment Facility; this responsibility may be discharged in a variety of ways, including contractual arrangements with the purchaser, or membership of collection schemes.
C.17.3 MANAGING THE RISKS

Maintaining a working environment that is free from wastes and spillages requires good attention to housekeeping; this may involve more effort in remote locations, due to the additional complications in waste transfer and disposal, and limited opportunities for auditing and inspection. The potential for wastes and spillages to arise in the course of planned work activities should be assessed, and suitable measures put in place for their management and safe disposal.

Employers should aim to establish a culture in which the importance of maintaining a clear workplace is emphasised:

- Encourage personnel to report any leakage or poor workplace conditions, and ensure that remedial action is taken:
  - Spillages and leakage should be cleared up as soon as possible, particularly if they are contaminating floors or ladders, which could affect personnel safety, or external areas, which could lead to ground contamination;
    - These actions can be supported by ensuring that suitable spill kits are always available in convenient locations, replenished as required, and that used absorbent materials are properly disposed of;
    - The planning of tasks should consider potential spillages and remedial actions;
    - All personnel on site should know what actions to take in the event of a spill or leak occurring:
      - Depending on a person’s role, training could range from basic induction to detailed training on how to manage spillages;
        - The cause of the leakage should also be identified and rectified;
  - The Transfer of Control, on completion of a work package under the Wind Turbine Safety Rules, should include confirmation that wastes have been removed, and the work location left in a clean and tidy state.

Practical steps should also be taken, including ensuring that containers to be used for transferring fluids are suitable for handling within the WTG, and lifting to/from the nacelle, probably involving a combination of manual and mechanical handling:

- A sufficient supply of suitable containers should be available to technicians, thereby reducing the temptation to improvise and use unsuitable containers for the transfer of fluids;
  - Containers used for potable water or foodstuffs should never be used for any other purpose;
- Wastes should be segregated according to storage and disposal requirements, and clearly labelled at all times;
- Unless containers are specifically designed for lifting, they should be lifted inside suitable lifting bags or other lifting equipment such as frames;
  - Lifting arrangements should minimise the risk of containers being damaged or dropped, as this could lead to leakage.

Containers should be stored appropriately, to minimise the risk of damage or corrosion leading to leakage, and with a suitably-sized bund to contain any leaks. Storage locations should protect bunds against water ingress, as this can lead to overflowing and loss of containment.

C.17.3.1 MONITORING, REVIEW AND CHANGE MANAGEMENT

Inspections and audits of wind farms should include checks for any leakage, or build-up of wastes; where these are found, they should be followed up promptly.

Planning conditions will often impose specific requirements relating to the control of pollution on a site, and arrangements for monitoring during construction and operation.
C.17.4 CODES OF PRACTICE AND GUIDANCE

C.17.4.1 REGULATIONS AND STANDARDS


C.17.4.2 OTHER RELEVANT GUIDANCE

HSE INDG225 – *Preventing Slips and Trips at Work* provides practical guidance.

HSE COSHH Essentials SR16: *Work involving motor vehicle fuel (diesel, petrol and LPG)* provides concise guidance on safe refuelling practices.

Oil storage is subject to the Oil Storage Regulations in **England and Wales**, **Scotland** and **Northern Ireland**.
C.18 WELFARE

C.18.1 OVERVIEW

Working conditions affect the health and safety of employees in relation to the risk of accidents, illnesses, and development of longer term health conditions. Wind farms are workplaces that, apart from the largest developments, are normally unoccupied, but will be subject to intensive periods of occupation and work during construction, commissioning and maintenance activities.

Key welfare issues to consider include:

- Maintaining appropriate conditions in the workplace, including ventilation, temperature, lighting, cleanliness and tidiness;
- Provision of suitable facilities for sanitary and eating requirements;
- Conditions for workers based on sites for extended periods; for example, workers may adopt very intensive working patterns during the construction phase;
- Working time, which will generally involve managing various forms of shift work; and
- Workplace stress.

Within this section, welfare issues relating to workplace conditions are considered first, with those relating to working time and stress being considered in C.18.3.

C.18.2 WORKPLACE CONDITIONS

C.18.2.1 POTENTIAL HAZARDS AND RISKS

The risk of accidents is increased in a workplace that has inadequate lighting, is dirty or untidy, or has inadequate access for the tasks to be undertaken. A lack of ventilation or control of temperature leads to discomfort, loss of concentration, and a tendency to rush tasks so that the worker can move to a more comfortable environment.

If workers are unable to maintain appropriate hygiene standards, then this introduces a risk of illness or infection.

C.18.2.2 RELEVANCE TO KEY LIFECYCLE PHASES

Welfare provision is necessary throughout the wind farm lifecycle, from the start of construction to the completion of decommissioning.

The required extent of facilities will be greatest during the construction phase, when large numbers of people are on site, or if major maintenance campaigns are undertaken over the lifetime of the wind farm; in such periods, temporary facilities may be needed to supplement the permanent provision on site.

Within WTGs, the working conditions will be determined by decisions made at the design stage, such as the layout of equipment and provision of lighting and ventilation, together with the effectiveness of arrangements to maintain acceptable standards over the operating life.

C.18.2.3 REGULATORY REQUIREMENTS

On construction sites, the CDM Regulations impose a duty on the Client to ensure that there are suitable arrangements in place for the provision of welfare facilities, and that construction (the definition of which includes decommissioning) does not start on a notifiable project until such facilities are provided. The Principal Contractor (PC) is responsible for providing and maintaining suitable facilities throughout the construction phase, although may subcontract the actual provision.

For workplaces other than construction sites, workplace conditions and welfare provisions are specified by the Workplace (Health, Safety and Welfare) Regulations 1992, which expand on an employer’s general duties under the HSWA. Amongst other issues, the regulations address:

- Conditions in the workplace, such as cleanliness, lighting, temperature and flooring, which affect both design and maintenance of workplaces;
- Provision of sanitary conveniences, washing facilities, drinking water, clothing accommodation, changing facilities and facilities for rest and eating meals;
  - At temporary work sites (i.e. those which are only used infrequently or for short periods), such facilities are to be provided so far as is reasonably practicable;
    - Note that the Workplace Directive (89/654/EEC), which underlies these regulations, does not apply to temporary or mobile work sites, so suppliers from other member states may not be familiar with the UK regulatory requirement.

A wind farm should provide all facilities required under the regulations, which also specify the level of provision in relation to the foreseeable needs of a workforce. Where WTGs are erected on the premises of existing businesses, it may be possible for existing accommodation for contractors or visitors to be made available to meet the welfare needs of visiting technicians.

The HSE provides guidance on provision of lighting; note that this states that “the lighting objectives for temporary installations should be the same as for permanent ones”. The guidance also covers the provision of suitable emergency lighting systems.

C.18.2.4 MANAGING THE RISKS

C.18.2.4.1 Risk Mitigation Measures

At the design stage, it should be recognised that a wind farm is a temporary workplace, so the relevant requirements should be considered, both in relation to working conditions within WTGs, and the provision of site amenity facilities. The duty under the Workplace regulations is therefore to provide sanitary, washing, rest and eating facilities so far as is reasonably practicable; the exact level of provision will depend on the size and location of the site.

C.18.2.4.2 Monitoring, Review and Change Management

Employers should set appropriate standards for maintaining workplace conditions, supported by suitable supervision or audit arrangements.

C.18.3 WORKING TIME AND STRESS

HSE guidance defines shift work as "all systems of work other than standard daytime hours", which are defined as "a work schedule involving an activity during the day, commonly for a period of eight hours between 7.00 am and 7.00 pm. There are usually two periods of work, one in the morning, the other in the afternoon, separated by a lunch-time break." Patterns of work, particularly during the construction phase, or major maintenance campaigns, will often involve long working days, sometimes over 12h, and fall within this definition of shift work.

Shift work may also be planned to enable 24h working, with one shift team handing the work over to another, to enable continuous working on the site. For these reasons, the management of working time on wind farms will often involve the management of shift work.

C.18.3.1 POTENTIAL HAZARDS AND RISKS

There is strong evidence that fatigued workers are more likely to make mistakes, increasing the risk of accidents occurring, or errors adversely affecting operations.

Working patterns may also lead to an increased susceptibility to, or worsening of symptoms of, chronic health problems such as cardiovascular disorders and diabetes.

While the risks related to stress and long hours may be particularly clear for site workers, work-related stress can occur in any workplace, especially if work is being undertaken against unrealistic schedules. In addition to the direct health impacts on the people affected, if tired people are making poor decisions, then this can adversely impact the implementation of a project, and the safety of those affected by the decisions.

If workers are living in temporary accommodation away from home, then this may not encourage a healthy lifestyle and sufficient rest between shifts; this could potentially affect short-term performance on specific tasks, as well as increasing the risk of longer term health problems.
C.18.3.2 REGULATORY REQUIREMENTS

The Working Time regulations define:

- A limit to the average working week of no more than 48h over a defined reference period, although individual employees can choose for this limit not to apply to them; and
- The entitlement of workers to minimum rest periods between shifts and breaks during the working day.

In addition to compliance with working time regulations, employers have duties under the MHSWR to carry out a suitable and sufficient assessment of the risk of stress-related ill health arising from work activities, and under the HSWA to take measures to control that risk.

C.18.3.3 MANAGING THE RISKS

C.18.3.3.1 Approaches to Risk Assessment

Individual workers have different degrees of susceptibility to adverse effects of shift work, due to each person’s unique combination of physiological and psychological factors; while such factors cannot be controlled by the employer, they should be aware that the effects of the same work pattern may differ between individuals.

The risk assessment should consider factors such as the shift pattern, the workload, and the nature of the work, in terms of the intensity, level of concentration required, the working environment, and the consequences of an error.

The HSE recommends that the Management Standards approach be used in assessing risk of workplace stress; this considers the demands on workers, the extent of their control of their working pattern, how they are supported in their work, relationships within the organisation, clarity of roles, and how organisational change is managed.

C.18.3.3.2 Risk Mitigation Measures

The HSE provide detailed recommendations of good practice, to minimise the effects of shift work on the safety and productivity of workers; these range from the overall design of shift patterns, to the detailed planning of tasks during a shift, so that safety-critical or hazardous tasks are avoided at times when workers are likely to be less alert.

C.18.3.3.3 Monitoring, Review and Change Management

If night time working is to take place, employers have a duty under the Working Time Regulations to ensure that employees are fit for this work, and to offer regular free health assessments to such workers. In addition, monitoring of actual working hours, effective supervision, and ensuring that employees can raise concerns relating to working time, can all help to identify issues at an early stage, before significant health and safety impacts occur.

Working hours need to be pro-actively managed; for example, there will be occasions where a task is incomplete at the end of a normal working day; in this situation, a risk assessment needs to consider the relative risks of leaving completion for another day, handing to another team (if available), or extending the working day. The progress of tasks should therefore be monitored, so that decisions can be made well before the end of the normal working day, and any necessary arrangements implemented in an orderly manner.

C.18.4 CODES OF PRACTICE AND GUIDANCE

C.18.4.1 REGULATIONS AND STANDARDS

HSE L24 - Workplace (Health, Safety and Welfare) Regulations 1992 Approved Code of Practice, describes workplace conditions and requirements for facilities.

HSE HSG218 – Managing the causes of work-related stress, and HSE INDG430 – How to tackle work-related stress provide detailed guidance on how to manage work-related stress through the adoption of the Management Standards approach.

HSE HSG256 - Managing Shift Work.

HSE HSG38 – Lighting at Work, gives details on the requirements for workplace lighting.

C.18.4.2 OTHER RELEVANT GUIDANCE

HSE RR446 – The development of a fatigue / risk index for shiftworkers, may assist risk assessment of shift work arrangements; an associated fatigue and risk calculation spreadsheet and guidance notes are also available, although note that the guidance cautions against its use in work patterns that only involve day working.
C.19 WORK AT HEIGHT

C.19.1 OVERVIEW
A place is considered to be “at height” if a person could be injured by falling from it; this means that work at height may occur in a wide range of situations, such as:

- Climbing ladders on WTG towers or met masts;
- Working in a nacelle, from which there might not normally be a risk of falling, unless hatches were open or a major component had been removed;
- Inspecting WTG blades, using a Mobile Elevating Work Platform (MEWP), suspended access or rope access techniques;
- Working from a scaffold to run cables within a site building; or
- Unloading components from a LGV trailer.

C.19.1.1 POTENTIAL HAZARDS AND RISKS
Work at height can expose people to a range of hazards, including:

- Falls from height can result in severe injury or death, and are the biggest single cause of workplace fatalities;
- If people are beneath work being carried out at height, then falling objects present a hazard;
- If a person is suspended in an upright position for a period of time, as may occur after a fall has been arrested, suspension intolerance or syncope may lead to loss of consciousness; and
- If a person is incapacitated, as a result of becoming ill or being injured in a workplace that is at height, then they may need to be rescued by others with suitable training, competence and work equipment, before medical help can be provided, potentially delaying treatment of their initial condition.

C.19.2 REGULATORY REQUIREMENTS
C.19.2.1 FALLS FROM HEIGHT
The Work at Height Regulations require employers to assess the risks of work at height, and, so far as is reasonably practicable, take steps to avoid those risks, according to a clear hierarchy of protective measures:

1. Avoid work at height;
2. Utilise an existing safe place of work;
3. Where work at height cannot be avoided, use work equipment or other methods to prevent falls from occurring;
4. Where the risk of falls cannot be eliminated, take suitable measures to minimise the distance and consequences of a fall;
5. Where it is not reasonably practicable to minimise the distance of a fall, the consequences of a fall should still be mitigated; and
6. Mitigate residual risk through procedural means such as training, instructions, inspection programmes, warnings to keep people away from locations where falls can occur, good housekeeping and provision of suitable footwear etc.

A decision to rely on protective measures from a lower level on the hierarchy is only justifiable if it is not reasonably practicable to adopt a higher (preferred) level of protection. At every level of the hierarchy, collective protection should take precedence over personal protection; for example, a guardrail is a more reliable means of fall prevention than relying on work restraint, which is only effective if consistently and correctly used by every individual.
Work at height should only take place in weather conditions that do not jeopardise the health and safety of workers, considering factors such as task-specific limits of wind speed, temperature and precipitation; if lightning is expected, then work in or on tall structures such as WTGs, met masts and cranes should not take place.

Specific mandatory requirements relating to workplaces and work equipment are given in the following schedules to the regulations:

1. Places of work, and access and egress at height;
2. Guard rails, barriers and other collective means of protection;
3. Working platforms;
4. Collective safeguards for arresting falls;
5. Personal fall protection systems;
6. Ladders; and
7. Inspection reports.

**C.19.2.2 FALLING OBJECTS**

The regulations impose duties to protect against danger from falling objects, with a simple hierarchy:

1. Take suitable and sufficient steps to prevent objects or materials from falling, so far as is reasonably practicable; then
2. Take suitable and sufficient steps to prevent people from being struck by any falling material or object that is liable to cause personal injury.

**C.19.3 MANAGING THE RISKS**

**C.19.3.1 APPLYING THE FALL PROTECTION HIERARCHY**

Reliance on measures at the lower levels of the hierarchy, or personal protection, such as fall-arrest systems (FAS), reduces but does not eliminate the risk of serious injury; for example:

- Even if the FAS works perfectly, the climber will still be subject to impact forces of up to 6kN, transmitted through their harness, and is also at risk of impact against adjacent structures during their fall, prior to the fall being arrested;
- If the FAS is not used correctly, then it may not be effective, for example if an error is made in scaffold-hook placement or connection, or if there is inadequate vertical clearance between the climber and solid objects below;
- Where FAS with detachable components such as “sliders” are used, then these must be compatible with the fixed rail or wire, otherwise they may fail to operate;
- The recently withdrawn EN standard for guided type FAS including a rigid line (or rail), EN 353-1:2002, had deficiencies that introduced dangerous shortcomings in performance, with the effect that if a person falls away from the ladder, rather than straight down, a fall arrester that complies with this standard may fail to arrest their fall. These shortcomings are addressed in EN 353-1:2014, and it is expected that FAS with CE marking to this standard will become available in the near future.
  - For FAS which pre-date the 2014 revision of the standard, the UK National Annex to EN 353-1:2002 standard makes additional recommendations for the testing and usage of these systems; the HSE advise duty holders who use / purchase equipment that meets the requirements of the 2002 revision to ensure that it has also passed suitable additional tests in order to address those deficiencies in the standard. Duty holders should check the scope of these tests with a relevant Notified Body, normally via the manufacturer.
C.19.3.2 APPLYING THE FALLING OBJECT HIERARCHY

Steps to prevent objects from falling include:

- Elimination of objects that could fall, for example:
  - Design details, such as:
    - The use of hinged hatches (so that they do not become loose objects when opened);
    - Provision of secondary retention on removable covers;
    - Ensuring that floors, platforms and hatches minimise openings through which objects could fall;
    - Considering the locations of equipment that will have to be maintained, to avoid placing it where objects could drop from height during maintenance;
  - Selection of work equipment, such as providing technicians with radio headsets in helmets, to eliminate the need for handheld radios;
  - Maintaining a high standard of housekeeping, including ensuring that tools and equipment are not stored in locations from which they could fall, and accounting for all tools and parts on completion of work;
  - Ensuring correct reassembly of plant, to avoid components coming loose after return to operation
- Use of work equipment to retain objects that could potentially fall:
  - Ensuring that tools are tethered, by means of a suitable lanyard, either to the user or to the structure, depending on the weight of the tool; and
  - Ensuring that tools and small parts are moved and stored in securely closed containers, which should also be of suitable rating if they are to be used for lifting tools and components between levels.

Should an object fall, the risk to people can be reduced by measures such as:

- Use of robust temporary covers over openings, to prevent the object falling to a lower level;
- Installation of debris netting below working areas, to arrest the fall of objects; and
- Establishing exclusion zones beneath areas where work is being carried out at height, with a radius that takes account of the potential for objects to bounce off structures and fall at a distance from the structure, in order to ensure that people are not in a hazardous location.

Safety helmets provide limited protection against small falling objects, but could not withstand an impact such as a typical tower flange bolt falling more than a few metres, and only protect the head.

C.19.3.3 LIFECYCLE RISK MANAGEMENT

C.19.3.3.1 Design

The project definition and design phases offer the greatest opportunity to reduce the risks from work at height over the rest of the project lifecycle. The specification and detailed design of WTGs, met masts and any other high structures should make suitable provision for safe access and work at height in order to undertake foreseeable tasks over the operating life of the asset. This involves addressing both the risks of falls from height, and of falling objects. While the Client or developer is not the designer of the WTG, so cannot change the design, they should ensure that decisions about WTG selection consider the safety of working on the WTG over its whole lifecycle.
The detailed design of WTGs should apply the hierarchy of protective measures, including:

- Determining whether foreseeable tasks over their operating lifetimes can be carried out without the need to work at height;
- Where an unavoidable need to work at height is identified, the design should ensure that the risks are minimised; this may involve measures such as:
  - Provision of suitable and sufficient anchor points for attachment of equipment for work positioning and fall-arrest; and
  - Provision of fixed FAS on ladders.

The detail design will also determine the risk posed by falling objects, in situations where it is foreseeable that work may be in progress at different levels of a structure.

**C.19.3.3.2 Construction and Commissioning**

Risk assessment of construction and maintenance activities should ensure that risks from work at height are identified and mitigated.

During construction and commissioning, there will be periods when lifts are not available, and fixed fall arrest systems are incomplete, or have not been inspected. The increased risk to people can be minimised by:

- Ensuring that lifts and fixed fall arrest systems are installed, commissioned and inspected at the earliest possible stage – ideally with as much of this work as possible being done at ground level, before tower erection;
- Providing appropriate temporary fall arrest systems, which should:
  - Have good ergonomics, to minimise the risks of errors in use, especially when attaching or detaching; and
  - Allow normal operation of ladder hatches, so that the risk of objects dropping through open hatches is not increased.

This approach minimises the duration during which fall arrest relies on the use of scaffold hooks and energy-absorbing lanyards when climbing tower ladders.

Some construction activities, such as fitting of tower flange bolts, involve the handling of large numbers of components that could potentially drop, and which cannot readily be attached to a means of retention. Other protective measures, such as catch nets or exclusion zones, should be put in place to ensure that people are not put at risk.

**C.19.3.3.3 Operations and Maintenance**

The O&M phase needs to consider the inspection and maintenance requirements of height safety systems, together with the long term integrity of structures that are used as anchorages. While it may be possible to conduct most routine O&M tasks without working at height, other than for initial access, additional care needs to be taken if tasks lead to the creation of temporary openings, such as open access hatches or gaps in floors where equipment has been removed, which may create a risk of falling from a location that would otherwise be safe.

Maintenance activities often involve disassembly of parts of a WTG; every loose component or tool has the potential to fall. This risk can be minimised by applying the hierarchy outlined in section C.19.3.2.

**C.19.3.3.4 Decommissioning**

The safety of work at height during decommissioning depends on:

- Ensuring that the design provides safe locations from which to undertake the intended sequence of decommissioning tasks;
- Permanently installed work equipment for safe work at height, such as anchor points and supporting structures, having been properly maintained and inspected, so that its integrity is assured when it is needed to be used during decommissioning;
- The sequence of decommissioning tasks allowing preferred means of access, such as lifts and permanently installed FAS, to be used for as much of the decommissioning work.
as possible, and suitable temporary systems being provided once the permanent systems can no longer be used; and

- Additional care being taken to manage the risk of falling objects, including both loose objects generated during dismantling (such as fasteners) and any other objects that may be present in inaccessible areas of the WTG, but which could move during dismantling or lifting operations.

C.19.3.4 Risk Mitigation Measures

The risks arising from work at height can be mitigated by ensuring that the hierarchy of protective measures required by the regulations is followed.

Where work at height is necessary, it must be:

- Properly planned, including ensuring that there are suitable arrangements for:
  - Planned access and egress;
  - Foreseeable emergencies and rescue situations;
  - Management of any changes in working methods that may be identified as the task proceeds;
- Carried out by a team with suitable competence, fitness, supervision and equipment for the task;
  - Fitness assessment includes both general health and fitness on the day; and
- Carried out in suitable weather conditions, particularly with respect to wind and lightning.

The GWO Basic Safety Training Work at Height module, adopted by RenewableUK, provides a common baseline level of training for work at height in WTGs; risk assessments may identify requirements for additional or alternative training for specialised work at height, such as access to some types of hub, or work on meteorological masts.

C.19.3.5 Monitoring, Review and Change Management

Safe work at height depends on the integrity of anchor points, and the strength and reliable operation of all equipment, including PPE. This is a complex area, so competent advice should be obtained in order to determine the nature and frequency of any inspection regime that is to be implemented.

The key legal duties under the regulations are that employers shall ensure that

“where the safety of work equipment depends on how it is installed or assembled, it is not used after installation or assembly in any position unless it has been inspected in that position”

and that:

“work equipment exposed to conditions causing deterioration which is liable to result in dangerous situations is inspected—

(a) at suitable intervals; and.

(b) each time that exceptional circumstances which are liable to jeopardise the safety of the work equipment have occurred.”

The regulations do not specify the interval between inspections. The scope of inspections is defined as “such visual or more rigorous inspection by a competent person as is appropriate for safety purposes” and “includes any testing appropriate for those purposes”.

Equipment and accessories used for lifting and lowering people (such as those used for rope access, or designed specifically for emergency evacuation) are subject to LOLER, under which the default interval between thorough examinations is six months, although, subject to a written scheme of examination drawn up by a competent person, this period might be longer, subject to risk assessment. The risk assessment should take account of the frequency of usage, loading, condition and the operating environment. The scheme of examination should define the scope of the examination, such as whether proof load testing at periodic intervals is required, in order to assess the integrity of the anchor. The manufacturer of the anchor device should be consulted for
advice. In other cases, such as anchors for fall-arrest, EN 365 includes a recommendation that the periodic examination frequency for PPE shall be at least every 12 months.

**C.19.4 TEMPORARY ACCESS FOR WORK AT HEIGHT**

Where it is not possible to avoid work at height, or to work from an existing safe place of work, scaffolding is commonly used in many industries, and is likely to be used during construction of site buildings. For higher structures, such as WTGs, several other methods are available; HSE guidance\(^{17}\) lists the order of preference for these alternative methods as:

1. Mobile access systems, such as MEWPs;
2. Suspended access systems, such as cradles; and
3. Rope access.

While this provides a general hierarchy, deciding which method should be used for undertaking a specific task should be based on thorough assessment of the risks that the different options present; this assessment should consider the risks involved in erection / dismantling / movement of a system, as well as the risks during use. Each form of temporary access is a specialised area of work, so the selection of approach, planning of work, and review of proposed methods, should be undertaken by people with the necessary competence.

In addition to the specific safety considerations for the different temporary access systems, their safety also depends on integration into a safe system of work, which should include:

- Establishing any necessary exclusion zones beneath the work; and
- Correct operation of the WTG, such as locking the rotor and yaw mechanism prior to setting up the temporary access system, and ensuring that the system is clear of the rotor before movement is allowed again.

**C.19.4.1 SCAFFOLDING**

Scaffolding can be used to provide access and collective protection for work at height. There are two basic categories of scaffold:

- General access scaffolds, which can be erected to a range of standard designs, or to a bespoke design for a particular task; and
- Tower scaffolds, which are less versatile, but offer simpler erection.

Key principles for both types of scaffold include:

- Selection of a suitable system for the task to be undertaken;
- Ensuring that the scaffold is built on firm supporting ground, tied to the structure as necessary, and protected from vehicle impact;
- Erection, alteration and dismantling by competent persons, either in accordance with the manufacturer’s instructions for a tower scaffold, or a standard or bespoke design for a general access scaffold;
  - Scaffold erectors should work safely, either by remaining within safe areas (such as completed platforms that provide collective protection against falling), or by using fall arrest PPE;
  - Working platforms should be fully boarded, with appropriate guard rails, toe boards and any debris mesh installed as specified by the design;
- Regular inspection by a competent person, including after installation, assembly, alteration or any event that may have affected its stability, and on a periodic basis; and
- Usage in accordance with the design intent, such as ensuring that the scaffold is not overloaded.

\(^{17}\) HSE HSG150 – *Health and safety in construction*
C.19.4.2 Mobile Elevating Work Platforms (MEWPs)

A wide range of MEWPs is available, from small scissor lifts providing vertical lift of a few metres, to truck-mounted machines with articulated and telescopic booms and working heights in excess of 100m.

Safe use of MEWPs depends on factors such as:

- Selection of a suitable MEWP, considering:
  - The work to be carried out, including the number of people involved, materials required, and the height and outreach needed to access the work area;
  - Restrictions in the working area;
  - Bearing capacity of the location where the MEWP is to be used;
  - Limitations due to wind speed;
  - Specific precautions for hazards such as operator entrapment between the MEWP and fixed structures;
- Planning the work, including planning for rescues;
- Ensuring that the MEWP is maintained and subject to periodic and pre-use inspections;
- Competent operation under appropriate supervision, including:
  - Experience with the specific type of MEWP to be used;
  - Correct positioning, to minimise risk of collision / crushing at height;
  - Correct use of PPE, to prevent falls from the basket; and
- Ensuring that the MEWP is safeguarded from other vehicle movements when in use.

C.19.4.3 Suspended Access Equipment

Suspended access equipment, such as cradles, is commonly used for tasks such as inspection and maintenance of the exterior of WTG blades and towers. The safety of this approach depends on:

- The design of the cradle, ensuring that it has sufficient strength, adequate guard rails, toe boards, floor and anchor points for people;
- The condition and correct installation of the cradle and its suspension system, including anchor points;
- Provision of safe access and egress to / from the cradle, ideally at ground level, and ensuring that personnel in the cradle can be rescued if necessary;
- Provision and use of a secondary safety rope, with fall arrest, to protect people in the event of cradle failure; and
- Ensuring that cradles are operated correctly, considering safe working practices, limits and distribution of loads, and wind speed.

C.19.4.4 Rope Access Work

Rope access techniques are used for gaining access to locations at height that would be difficult to access by other means, such as external access to rotor blades, or replacement of internal ladders. The key principle is that whenever a technician is suspended, they are always attached to at least two independently anchored ropes, one of which is taking their weight (the “working rope”), and the other of which is a back-up “safety rope” that will prevent a hazardous fall if the working rope fails.

Within this system, users can use the ropes to ascend, descend and work position where required.

Competence standards for rope access technicians and supervisors are set by trade associations, which include Industrial Rope Access Trade Association (IRATA International), Society of Professional Rope Access Technicians (SPRAT, USA); and Samarbeidsorganet For
Tilkomstteknikk (SOFT, Norway). The fundamental principles of safe rope access are described in ISO 22846-1 and the IRATA International Code of Practice (ICOP). Key considerations include ensuring that:

- Rope access work is planned and managed by a suitably qualified person, on the basis of a risk assessment, and including suitable measures to avoid injury to technicians, or damage to ropes – in particular, ensuring that ropes are not routed over edges;
- Work is undertaken by teams with the necessary competence, sufficient numbers of technicians, appropriate supervision and provision for rescue;
- Work equipment is of suitable design, procured with full traceability to the manufacturer, and correctly inspected, maintained and used;
- Methods of work enable technicians to connect to the rope access system in a safe location, and maintain continuous attachment to both ropes while working;
- The set-up of the system prevents inadvertent descent off the bottom of the ropes; and
- Technicians are able to communicate as necessary, with each other and with personnel on the ground.

**C.19.5 Work at Height on Small and Medium WTGs**

The hierarchy of protective measures as outlined in Section C.19.2 should be applied to the design and methods of work on small and medium WTGs, in order to ensure that these do not present an increased health and safety risk to people undertaking such work, compared to work on large WTGs. Key considerations include:

- Eliminating work at height on WTGs that can be lowered to the ground for maintenance, although this is only practical on the smallest WTGs;
- Providing safe access, such as ladders with fixed fall arrest systems;
- Ensuring that technicians can make a safe transition between ladders and working platforms;
- Ensuring that technicians can be rescued from any foreseeable working location, without undue delay; and
- Ensuring that working platforms provide a safe working location, considering both the person(s) on the platform, and the risk to people below from falling objects.

Where external access ladders are used, suitable security measures should be in place to minimise the risk of unauthorised climbing, theft or vandalism.

**C.19.6 Provision of Lifts**

Lifts should be provided, where reasonably practicable, for personnel access within WTG towers, as this eliminates the risks associated with repeated climbing of long ladders. In practice, the expectation is that all new WTGs with a hub height exceeding 60m will be equipped with a lift; shorter towers should also have lifts where reasonably practicable. Retrofitting should be considered in existing WTGs that do not have lifts, however unless the design of the WTG could readily accommodate a lift (such as already having suitable mounting points and platform designs), the risks involved in undertaking a retrofit could well outweigh the benefits that the lift could bring.

Where it is not reasonably practicable to install a lift, either from new or as a retrofit, then a climbing aid that provides weight relief to the climber should be installed if reasonably practicable. If a climbing aid is used in conjunction with a separate fall arrest system, their compatibility should be confirmed, to ensure that the fall arrest system can still function effectively.

The use of lifts brings other risks that need to be managed, including the potential for:

- Falls from landings that are used to access the lift;
- Crushing or entrapment between moving parts of the lift and adjacent structures; and
- Malfunction or failure of the lift.
Lifts installed in WTGs are subject to the Machinery Directive, rather than the Lifts Directive, and should therefore conform to the Essential Health and Safety Requirements (EHSRs) of the Machinery Directive, in accordance with the General Principles; these recognise that machinery may represent the state of the art, even where this may not fulfil every aspect of the EHSRs. (See Section A.1.7.1) The combined system of the lift and its interfaces with the WTG, such as landings and working areas, requires a Declaration of Conformity to be issued by a Notified Body.

The design of the lift should minimise risks both during normal operation and foreseeable maintenance activities, such as by ensuring that the suspension ropes of the lift can be inspected from a place of safety that provides a clear view of the ropes.

Operating procedures should take account of reasonably foreseeable malfunctions, such as the lift stopping at a level other than a designated landing, and ensure that a safe means of escaping from the lift is available, and that personnel using the lift are trained and competent in this procedure. Inspection and maintenance programmes should ensure that the lift operation is safe and reliable throughout the lifetime of the WTG.

C.19.7 CODES OF PRACTICE AND GUIDANCE

C.19.7.1 REGULATIONS AND STANDARDS

**Work at Height Regulations 2005**, define the legal requirements, together with specifying design requirements in the Schedules. Brief explanation is given in **HSE INDG401 – The Work at Height Regulations**. For the avoidance of doubt, note that the Work at Height Regulations revoke Regulation 13(1-4) of the Workplace Regulations, which relate to work at height.


C.19.7.2 TECHNICAL STANDARDS

The revised standard BS EN 353-1:2014 - Personal protective equipment against falls from a height. Guided type fall arresters including a rigid anchor line contains significant technical changes, compared to the previous revision; once this is published in the Official Journal of the European Union, fall arresters with CE marking to this standard will start to become available. The changes include more stringent performance and testing requirements, in order to address the shortcomings in the previous revision of the standard.

Most fall arrest systems currently on the market, and already installed, refer to BS EN 353-1+A1:2002; the amendment in 2005 added a National Annex to address dangerous shortcomings in the EN standard. Due to the shortcomings, this standard is subject to **Commission Decision of 19 March 2010 withdrawing the reference of standard EN 353-1:2002 in accordance with Council Directive 89/686/EEC (published in the Official Journal of the European Union)**; this has the effect of requiring additional testing, beyond the standard, to demonstrate conformity with the requirements of the PPE directive. These additional tests are not required on fall arresters tested to the 2014 revision of the standard.

BS EN 795:2012 - Personal fall protection equipment. Anchor devices covers anchor devices for use by a single user.


C.19.7.3 CODES OF PRACTICE

**RenewableUK Approved Training Standard – Work at Height and Rescue** has been fully aligned to the GWO Basic Safety Training – Work at Height module, and also includes specific reference to the particular requirements for delivery of training and the syllabus content within the UK

BS 5974:2010 Code of practice for the planning, design, setting up and use of temporary suspended access equipment.

BS 7883:2005 - Code of practice for the design, selection, installation, use and maintenance of anchor devices conforming to BS EN 795.

BS ISO 22846-1:2003 - Personal equipment for protection against falls. Rope access systems. Fundamental principles for a system of work.

C.19.7.4 OTHER RELEVANT GUIDANCE

HSE HSG150 – Health and safety in construction provides practical guidance on work at height; specific relevant content includes selection of means of access and work equipment (para 121-130), MEWPs (169-178) and suspended access (184-193).

HSE INDG367: Inspecting fall arrest equipment made from webbing or rope

RenewableUK PPE (Work at height) procurement guidance sheets provide detailed guidance on PPE for work at height, including references to appropriate standards. (Note: Some of the content is now out of date. However copies are available on request from RenewableUK.)

Renewable UK - Lifts in Wind Turbines.

HSE RR258 Preliminary investigation into the fall-arresting effectiveness of ladder safety hoops has now been followed up by RR657 Investigation into the fall-arresting effectiveness of ladder safety hoops, when used in conjunction with various fall-arrest systems; the HSE policy arising from this research is summarised in Safety Bulletin CCID 1-2012.

HSE CIS58 - The selection and management of mobile elevating work platforms

HSE Information Sheet MISC611 Safety in window cleaning using suspended and powered access equipment; while this information sheet is not targeted at wind energy, it provides very clear and practical checklists that are relevant to the use of these types of equipment on wind farms.

C.19.7.5 TRADE ASSOCIATIONS

IRATA – information about roped access; key publications are the International Code of Practice (ICOP) and Application of IRATA International rope access methods for work on wind turbines.

PASMA (Prefabricated Access Suppliers' & Manufacturers' Association) defines training standards for personnel working with different types of scaffolding.

IPAF – International Powered Access Federation publishes detailed guidance and training standards for inspection and use of MEWPs.

Strategic Forum for Construction - Best Practice Guidance for MEWPs – Avoiding Trapping / Crushing Injuries to People in the Platform

C.19.7.6 ELSEWHERE IN THIS GUIDANCE

Supply of Machinery (Safety) Regulations and Harmonised Standards Medical Fitness to Work.
## Appendix: EU Directives and Associated UK Regulations

Table 11: EU Directives and the associated principal regulations made under the HSWA (Great Britain) and the Health and Safety at Work (Northern Ireland) Order 1978.

Note that most directives will affect multiple regulations, in addition to the principal regulations listed here.

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<tr>
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<th>Principal GB Regulation</th>
<th>Principal NI Regulation</th>
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<td>Personal Protective Equipment at Work Regulations 1992</td>
<td>Personal Protective Equipment at Work Regulations (Northern Ireland) 1993</td>
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<td>Noise (2003/10/EC)</td>
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<td>The Control of Noise at Work Regulations (Northern Ireland) 2006</td>
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<td>Vibration (2002/44/EC)</td>
<td>Control of Vibration at Work Regulations 2005</td>
<td>The Control of Vibration at Work Regulations (Northern Ireland) 2005</td>
</tr>
<tr>
<td>Safety and / or health signs (92/58/EEC)</td>
<td>Health and Safety (Safety signs and signals) Regulations 1996</td>
<td>Health and Safety (Safety Signs and Signals) Regulations (Northern Ireland) 1996</td>
</tr>
<tr>
<td>2001/45/EC - provisions concerning the use of work equipment provided for temporary work at a height</td>
<td>The Work at Height Regulations 2005</td>
<td>The Work at Height Regulations (Northern Ireland) 2005</td>
</tr>
</tbody>
</table>
Part D Further References and Glossary

D.1 FURTHER REFERENCES

EN 349:1993+A1, Safety of machinery – Minimum gaps to avoid crushing of parts of the human body
EN 362:2004, Personal protective equipment against falls from a height – Connectors
EN 795:2012, Protection against falls from a height - Anchor devices - Requirements and testing
PD CEN/TS 16415:2013: Personal fall protection equipment. Anchor devices. Recommendations for anchor devices for use by more than one person simultaneously
EN 953+A1:2009, Safety of machinery - Guards - General requirements for the design and construction of fixed and movable guards
EN 1088:1995+A2, Safety of machinery - Interlocking devices associated with guards - Principles for design and selection
EN 1838:1999, Lighting applications – Emergency lighting
EN ISO 12100:2010, Safety of machinery - General principles for design - Risk assessment and risk reduction
EN ISO 13849-1:2008, Safety of machinery - Safety-related parts of control systems- Part 1: General principles for design
EN ISO 13850:2008, Safety of machinery - Emergency stop - Principles for design
EN ISO 13857:2008; Safety of machinery - Safety distances to prevent hazard zones being reached by the upper and lower limbs
EN 50172:2004, Emergency escape lighting systems
EN 60204-1:2006, Safety of machinery - Electrical equipment of machines. Part 1: General requirements
EN 60204-11:2000, Safety of machinery - Electrical equipment of machines. Part 11: Requirements for HV equipment for voltages above 1000 V a.c. or 1500 V d.c. and not exceeding 36 kV.
EN-61310-1:2008, Safety of machinery - Indication, marking and actuation - Part 1: Requirements for visual, acoustic and tactile signals

EN 61310-2:2008, Safety of machinery - Indication, marking and actuation - Part 2: Requirements for marking

EN 61310-3:2008, Safety of machinery - Indication, marking and actuation - Part 3: Requirements for the location and operation of actuators

EN 61400-1:2005, Wind turbines – Part 1: Design requirements


EN 62305-3 A11:2009, Protection against lightning - Part 3: Physical damage to structures and life hazard
## D.2 Abbreviations

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<th>Definition</th>
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<td>4WD</td>
<td>Four Wheel Drive</td>
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<tr>
<td>ACOP</td>
<td>Approved Code Of Practice</td>
</tr>
<tr>
<td>ALARP</td>
<td>As Low As Reasonably Practicable</td>
</tr>
<tr>
<td>ATC</td>
<td>Air Traffic Control</td>
</tr>
<tr>
<td>AWP</td>
<td>Approved Written Procedure</td>
</tr>
<tr>
<td>BIS</td>
<td>Department for Business, Innovation &amp; Skills</td>
</tr>
<tr>
<td>BoP</td>
<td>Balance of Plant</td>
</tr>
<tr>
<td>BS</td>
<td>British Standard</td>
</tr>
<tr>
<td>CAA</td>
<td>Civil Aviation Authority</td>
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<tr>
<td>CCTV</td>
<td>Closed Circuit Television</td>
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<tr>
<td>CDM</td>
<td>Construction (Design and Management)</td>
</tr>
<tr>
<td>CDMC</td>
<td>CDM Co-ordinator</td>
</tr>
<tr>
<td>CHIP</td>
<td>Chemicals (Hazard Information and Packaging for Supply)</td>
</tr>
<tr>
<td>CIC</td>
<td>Construction Industry Council</td>
</tr>
<tr>
<td>CITB</td>
<td>Construction Industry Training Board</td>
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<tr>
<td>CLP</td>
<td>Classification, Labelling and Packaging</td>
</tr>
<tr>
<td>COSHH</td>
<td>Control Of Substances Hazardous to Health</td>
</tr>
<tr>
<td>CPCS</td>
<td>Construction Plant Competence Scheme</td>
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<tr>
<td>CPP</td>
<td>Construction Phase Plan</td>
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<tr>
<td>CUSC</td>
<td>Connection and Use of System Code</td>
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<tr>
<td>DNO</td>
<td>Distribution Network Operator</td>
</tr>
<tr>
<td>DTI</td>
<td>Department of Trade And Industry</td>
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<tr>
<td>EAV</td>
<td>Exposure Action Value</td>
</tr>
<tr>
<td>ECITB</td>
<td>Engineering Construction Industry Training Board</td>
</tr>
<tr>
<td>ECS</td>
<td>Electrotechnical Certification Scheme</td>
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<tr>
<td>EHSR</td>
<td>Essential Health and Safety Requirement</td>
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<tr>
<td>EIA</td>
<td>Environmental Impact Assessment</td>
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<tr>
<td>ELV</td>
<td>Exposure Limit Value</td>
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<tr>
<td>EOD</td>
<td>Explosive Ordnance Disposal</td>
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<tr>
<td>ERP</td>
<td>Emergency Response Plan</td>
</tr>
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<td>ESQCR</td>
<td>Electricity Safety, Quality and Continuity Regulations</td>
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<tr>
<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>EUSR</td>
<td>Energy and Utility Skills Register</td>
</tr>
<tr>
<td>FAS</td>
<td>Fall Arrest System</td>
</tr>
<tr>
<td>FIT</td>
<td>Feed In Tariff</td>
</tr>
<tr>
<td>FMEA</td>
<td>Failure Mode and Effects Analysis</td>
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<tr>
<td>GB</td>
<td>Great Britain</td>
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<tr>
<td>GPS</td>
<td>Global Positioning System</td>
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<tr>
<td>Abbreviation</td>
<td>Definition</td>
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<tr>
<td>GWO</td>
<td>Global Wind Organisation</td>
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<tr>
<td>HART</td>
<td>Hazardous Area Response Team</td>
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<tr>
<td>HAV</td>
<td>Hand-Arm Vibration</td>
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<tr>
<td>HAVS</td>
<td>Hand-Arm Vibration Syndrome</td>
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<tr>
<td>HazOp</td>
<td>Hazard and Operability</td>
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<tr>
<td>HSE</td>
<td>The Health &amp; Safety Executive</td>
</tr>
<tr>
<td>HSG</td>
<td>Health and Safety Guidance</td>
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<tr>
<td>HSWA</td>
<td>Health and Safety at Work etc. Act 1974</td>
</tr>
<tr>
<td>HV</td>
<td>High Voltage (&gt;1000 V AC or &gt;1500 V DC)</td>
</tr>
<tr>
<td>IEC</td>
<td>International Electro-Technical Commission</td>
</tr>
<tr>
<td>IEE / IET</td>
<td>Institution of Electrical Engineers (now Institution of Engineering and Technology)</td>
</tr>
<tr>
<td>INDG</td>
<td>Industry Guidance</td>
</tr>
<tr>
<td>IOSH</td>
<td>Institute of Occupational Safety and Health</td>
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<tr>
<td>IRATA</td>
<td>Industrial Rope Access Trade Association</td>
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<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
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<tr>
<td>LGV</td>
<td>Large Goods Vehicle</td>
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<tr>
<td>LOLER</td>
<td>Lifting Operations and Lifting Equipment Regulations</td>
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<tr>
<td>LPG</td>
<td>Liquefied Petroleum Gas</td>
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<tr>
<td>LV</td>
<td>Low Voltage</td>
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<tr>
<td>MAM</td>
<td>Maximum Authorised Mass</td>
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<td>MCA</td>
<td>Maritime and Coastguard Agency</td>
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<tr>
<td>MCS</td>
<td>Microgeneration Certification Scheme</td>
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<td>MEWP</td>
<td>Mobile Elevating Work Platform</td>
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<td>MGN</td>
<td>Marine Guidance Notice</td>
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<tr>
<td>MHSWR</td>
<td>Management of Health and Safety at Work Regulations</td>
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<tr>
<td>MIS</td>
<td>Microgeneration Installer Scheme</td>
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<td>MOD</td>
<td>Ministry of Defence</td>
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<tr>
<td>MPQC</td>
<td>Mineral Products Qualifications Council</td>
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<td>NATS-AIS</td>
<td>National Air Traffic Services - Aeronautical Information Service</td>
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<tr>
<td>NI</td>
<td>Northern Ireland</td>
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<td>NOS</td>
<td>National Occupational Standard</td>
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<td>NOTAM</td>
<td>Notice To Airmen</td>
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<td>O&amp;M</td>
<td>Operations and Maintenance</td>
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<td>PC</td>
<td>Principal Contractor</td>
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<td>PCI</td>
<td>Pre-Construction Information</td>
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<td>PELV</td>
<td>Protective Extra Low Voltage</td>
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<td>PPE</td>
<td>Personal Protective Equipment</td>
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<tr>
<td>PTW</td>
<td>Permit to Work</td>
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<tr>
<td>PUWER</td>
<td>Provision and Use of Work Equipment Regulations</td>
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<td>Abbreviation</td>
<td>Definition</td>
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<tr>
<td>RAMS</td>
<td>Risk Assessment / Method Statement</td>
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<tr>
<td>RCS</td>
<td>Risk Control System</td>
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<tr>
<td>REACH</td>
<td>Registration, Evaluation, Authorisation &amp; Restriction of Chemicals</td>
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<tr>
<td>RLV</td>
<td>Reduced Low Voltage</td>
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<td>ROP</td>
<td>Routine Operating Procedure</td>
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<td>RPE</td>
<td>Respiratory Protective Equipment</td>
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<tr>
<td>RR</td>
<td>Research Report</td>
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<td>Road Traffic Act</td>
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<td>SAR</td>
<td>Search And Rescue</td>
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<tr>
<td>SCADA</td>
<td>Supervisory Control And Data Acquisition</td>
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<tr>
<td>SELV</td>
<td>Separated Extra Low Voltage</td>
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<tr>
<td>SHEA</td>
<td>Safety Health and Environmental Awareness (EUSR scheme)</td>
</tr>
<tr>
<td>SONI</td>
<td>System Operator Northern Ireland</td>
</tr>
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<td>SORT</td>
<td>Special Operations Response Team</td>
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<td>STC</td>
<td>System Operator – Transmission Owner Code</td>
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<td>STGO</td>
<td>Road Vehicles (Authorisation of Special Types) (General) Order 2003</td>
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<td>TWC</td>
<td>Temporary Works Co-ordinator</td>
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<td>UK</td>
<td>United Kingdom</td>
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<tr>
<td>UPS</td>
<td>Uninterruptable Power Supply</td>
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<tr>
<td>UXO</td>
<td>Unexploded Ordnance</td>
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<tr>
<td>VDV</td>
<td>Vibration Dose Value</td>
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<td>WBV</td>
<td>Whole Body Vibration</td>
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<td>WTG</td>
<td>Wind Turbine Generator</td>
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<td>WTSR</td>
<td>Wind Turbine Safety Rules</td>
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</table>
Our vision is for renewable energy to play a leading role in powering the UK.

RenewableUK is the UK’s leading renewable energy trade association, specialising in onshore wind, offshore wind, and wave & tidal energy. Formed in 1978, we have a large established corporate membership, ranging from small independent companies to large international corporations and manufacturers.

Acting as a central point of information and a united, representative voice for our membership, we conduct research, find solutions, organise events, facilitate business development, advocate and promote wind and marine renewables to government, industry, the media and the public.