SafetyOn Good practice guidelines

Post-incident decommissioning of onshore wind turbines

SafetyOn

In partnership with

energy institute

GOOD PRACTICE GUIDELINE: POST-INCIDENT DECOMMISSIONING OF ONSHORE WIND TURBINES

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This publication has been produced as a result of work carried out within the Technical Team of the EI, funded by the EI's Technical Partners. The EI's Technical Work Programme provides industry with cost-effective, value-adding knowledge on key current and future issues affecting those operating in the energy sector, both in the UK and internationally.

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FOREWORD

SafetyOn is the health and safety organisation for onshore wind sector. Providing a voice for the dynamic and innovative onshore wind industry, it ensures transparency about the industry's health and safety performance, as well as assisting industry stakeholders to see the key emerging risks are mitigated through cooperation and shared learning.

The final stage in the life cycle of a wind farm is decommissioning, which includes all dismantling, transport, disposal and recycling. Many of sites that have been decommissioned have been subject to repowering, a trend which is expected to rise as increased pressure on planning for new sites refocuses the industry on redeveloping sites where turbines have already been situated. It is also a reality of the industry that organisations occasionally have to conduct emergency decommissioning of wind turbines following major failure events, such as fires or structural failure. These events are rare but demand specific situational planning. Often companies faced by these situations do not have the experience of dealing with them and SafetyOn deems guidance based on experience beneficial.

The contents of these good practice 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.

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1 INTRODUCTION AND SCOPE

1.1 INTRODUCTION

Wind turbine generator (WTG) fires, structural failures or other emergency events which would require a tower to be decommissioned are thankfully rare. Many organisations operating in the onshore wind industry may never have encountered such an event. When these events do happen, the unpredictability of the type and extent of the failure means that risk management must be tailored to the situation.

This guide brings together the collective experience of the onshore wind industry and its purpose is to document a process which, if followed, will ensure the safe decommission of an irreparably damaged WTG. The document is set out to provide a course of action which should be adopted following the conclusion of the emergency response procedure (ERP) process. The process contained within this document should not override the ERP. The processes documented in this guidance should only come into effect when all relevant actions detailed within a project ERP have been completed.

This document is provided for all duty holders who have a responsibility for ensuring that safe working practices and procedures are considered and implemented in the process of decommissioning a WTG as a result of a catastrophic event.

1.2 SCOPE

This guidance covers activities required to keep the site safe after an emergency event, to ensure any investigation is carried out safely and to ensure the damaged asset is removed safely and with consideration of any potential environmental impacts. It does not include the initial emergency response or replace a company's crisis management process. It does not provide detail for dealing with local authority planning or notification of any parties with a financial interest in the asset(s), though these are noted for consideration. Likewise, it does not cover detail of installing a replacement WTG, as it is anticipated that organisations would already have these processes in place.

1.3 REGULATORY REQUIREMENTS

A list of United Kingdom (UK) legislation which needs to be considered in conjunction with this guidance is included in Annex A.

1.4 PROCESS FLOW CHART

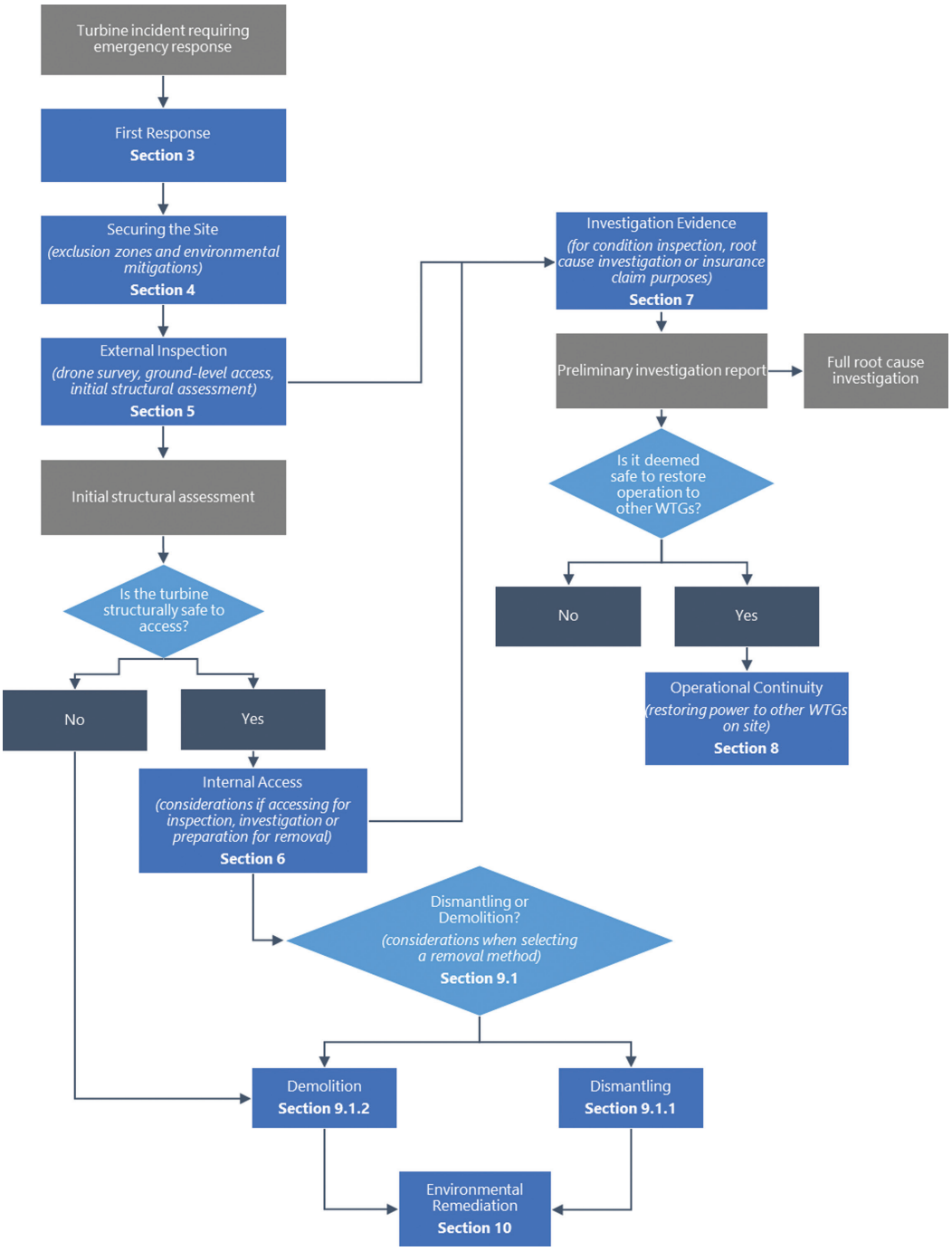

Figure 1: Process flow chart

2 BEST PRACTICE PREREQUISITES

With effective operation and maintenance processes in place, the risk of a fire or other major failure in a WTG can be mitigated. While such failures are uncommon, all wind farm operators should plan for the eventuality. This means being as prepared as possible to act quickly, efficiently, and safely.

An accurate, up-to-date, comprehensive, and accessible wind farm Health and Safety file can be of assistance when conducting an emergency decommissioning scope. Various contractors working on the damaged WTG may require detailed information (for example, on the composition of the structure, its internal workings, details of the foundation and/or the nature and quantities of hazardous substances held within), in order to assess the structure, identify hazards, mitigate risk, and plan any decommissioning actions.

Older wind farms and WTGs may have less complete sets of documentation, particularly if there have been changes of ownership over time. Nevertheless, reasonable efforts are recommended to close any such gaps with the support of all previous and current project stakeholders.

3 FIRST RESPONSE

Upon confirmation of an emergency event which has the potential to affect the structural stability of a WTG, the procedure(s) detailed within the project-specific ERP should be followed. Some stakeholders, such as the original equipment manufacturer (OEM), may also have their own major incident plans which should be put into action. In cases where emergency services have deployed, once the situation has been brought under control the process of assessing the situation and making safe can commence.

On site, the priority is to control any immediate risk of injury to personnel, environmental impact, or further damage to plant. The steps which should be taken to achieve this are:

- Set up an exclusion zone around the affected WTG to control access of personnel and ensure that, should any object fall from the top of the tower, or the tower collapse, there is no possibility for persons to be harmed. For further detail see 4.1.
- Remotely isolate the electrical supply to the WTG. This may require assistance from the network operator if access to the wind farm substation is deemed unsafe due to the proximity to the affected WTG.
  - Additional isolations in nearby WTGs may be required.
  - There may be an operational imperative to divert cabling around the affected WTG, allowing other WTGs on the site impacted by its isolation to be restored to operation as soon as safe and practicable. See section 8 for relevant safety considerations.
- An initial assessment of safety and environmental concerns should be made. The following list is not exhaustive:
  - continuing fires;
  - exposure to substances hazardous to health;
  - severe (i.e. obvious by visual inspection) structural damage which may lead to tower collapse;
  - failure of pressure systems;
  - falling objects (it should be assessed where objects may fall from and, based on the geometry, how far they could be carried), and
  - mitigation of the impact of an obvious environmental hazard outside of the exclusion zone:
    - potential for secondary fires caused by wind-blown debris;
    - impact on local watercourses, and
    - impact and risk to livestock.
  - The further impact weather may have on the damaged structure.
  - Establishing an aligned approach to press handling with stakeholders.
    - Preparation of a holding statement.
    - Agreement of a single point of contact and instructing all staff to channel to this contact.

In parallel with the immediate actions to make the site safe, other persons within the duty holder's response team should begin the information and evidence-gathering process, which is discussed further in section 7. While it is important to begin this work as soon as possible, it must not interfere with actions to both secure, and make the site safe.

4 SECURING THE SITE

During assessment of the damage to site, security should be assessed regularly for continued risk factors. Exclusion zones are imperative to control access to the impacted area.

4.1 CLOSURES AND EXCLUSION AREAS

When securing the site, consideration should be given to the following:

- As a minimum, the area should be at least 1.5 times the height of the remaining structure. If the WTG is thought to be at risk of collapse, a larger exclusion area should be established.
- Use of existing boundaries (fences, walls, roads, etc.) to reduce time for set up and maintenance.
- An assessment of measures necessary to prevent unauthorised access (e.g. sightseers, criminal activity) should be undertaken, e.g.:
  - Consider employing a security presence. This may require the provision of facilities and additional risk assessments and method statements (RAMS).
  - Additional measures to physically prevent access to the WTG, such as additional locks or removal of access steps, may be deemed appropriate.
- Methods of merely marking off an excluded area, such as tape, are often unsuitable for outdoor use beyond the very short term and pose an additional environmental hazard if blown away. It is recommended to install physical barriers (e.g. temporary construction fencing) as soon as practicable.
- The requirement for temporary arrangements and diversions to provide alternative routes of access. These should be placed at suitable distances from the exclusion zone to ensure compliance.
- If any public roads lie within the exclusion zone, contact the local police in the first instance to urgently arrange a road closure and diversion. It will still be necessary to subsequently follow local authority procedures for longer-term road closures.
- Contact project stakeholders to define the boundaries:
  - Where the country has a right-to-roam requirement (e.g. Scotland), the imperative is still to ensure safety – act to restrict access first and then notify stakeholders.
  - Where land is worked (livestock or agriculture), consult the local farmer.

4.2 ENVIRONMENTAL RESPONSE

Both the planning consent for the site and legislation will define the duty holder's obligations in relation to preventing environmental contamination. An immediate assessment must be made of hazards posed by the damaged turbine and appropriate control measures which can be implemented safely. Some chemical or debris releases may already have occurred and be obvious to the observer, requiring a rapid response. The basic principles are similar to those for a health and safety risk assessment:

– identify the hazards;
– assess the risks (how air, land or watercourses might be affected and what the consequences are, the probable pathway of release and likelihood of this occurring), and
– specify measures to control the risk.

To assist, an environmental response plan may be included in the site ERP; additionally, the Environmental Impact Assessment for the site may contain previous assessments of the environmental risks from a damaged turbine.

The guidance for pollution prevention (GPP) series of documents, published by the environmental authorities of Scotland, Wales and Northern Ireland, provide good practice guidance. The specific GPP documents **dealing with spills** and **pollution incident response planning** discuss practical techniques to mitigate releases and provide basic templates for risk assessment and response planning. The GPP documents make specific reference to legislation in Scotland, Wales and Northern Ireland only, although the guidance is generally applicable to the whole of the UK (the Environment Agency in England does not issue good practice guidance).

Some specific considerations follow.

4.2.1 Contamination risk

The environmental response must consider:

– the source (or potential source) of any substance releases;
– the pathway of release to groundwater or watercourses, and
– the destination of watercourses.

The requirement is to stop any release as close to the source as is reasonably practicable and safe. Having a detailed site plan readily available providing locations of watercourses, drainage ditches and ground make-up will help considerably in any rapid response required to manage environmental impacts. Where it exists, the Control of Substances Hazardous to Health (COSHH) register for the site containing Safety Data Sheets and volumes of each substance will be useful.

Debris from the WTG may be carried downstream of the location and should be checked for, and retrieved where found.

Measures such as downstream booms or use of cut-off ditches should be considered to contain contamination. Further guidance can be found through contact with the local environmental authorities. Specialist contractors may be required to contain/neutralise any unintentional release of substances.

4.2.2 Risk to livestock

A significant increase in traffic movement should be anticipated. To reduce the risk to livestock and drivers, livestock should be removed from site if possible. If it is not possible to remove livestock completely, access to the exclusion zone should be prevented using physical barriers appropriate to the situation.

Organise the removal of small and light loose materials on site which may have fallen outside of the controlled area and may pose risk to local livestock populations.

For a WTG fire situation, it should be taken into account that burned materials such as glass-reinforced polymer can be very light and may travel long distances.

Using historical wind data, either from site or local weather station, assess the expected direction of falling materials, plan and implement collection of debris outside of the exclusion zone. The assessment should also include the use of short-to-medium term weather forecasts for the local area to consider the risk of further debris.

Where livestock are unable to be removed from the exclusion zone, the owner should be informed of any risks posed by ground contamination before the clean-up has taken place.

5 EXTERNAL INSPECTION AND INVESTIGATION

5.1 INTRODUCTION

Once exclusion zones, environmental controls and site isolations are implemented, an assessment, beginning externally, must be made on the WTG's condition to inform further actions.

An immediate external visual inspection (from outside the exclusion zone) will give an indication of potential damage (e.g. visible signs of fire damage on the tower). If the structure is suspected to be compromised, a competent person should prepare an early engineering opinion report on its safety and integrity. No persons should attempt to enter the exclusion zone until this is complete.

If the WTG structure is deemed to be at high risk of total or partial collapse, immediate demolition should be the first consideration. Health and Safety considerations of this are highlighted in 9.1.2.

If satisfied that the structure is (or can be made) safe to access, a robust process is needed to manage access so that competent personnel can:

– Identify the actions needed to make the WTG safe in the immediate term, to prepare for its partial or total removal.
– Gather the information required to determine the most probable root cause of the failure and support any insurance claims.
– Identify lessons learned and corrective actions to be considered to reduce the risk of similar incidents occurring in future, whether restricted to the other WTGs on the same wind farm, across an OEM's WTG fleet or in the industry generally.

The preliminary investigation results should inform plans to restore other WTGs on the site to operation. Section 7 discusses the evidence-gathering process and section 8 includes considerations for restoration of the site.

Physical inspection of the WTG poses significant hazards. Considerations for various ways of inspection and information gathering are shown in Figure 2.

Inspection/access type	Risk profile	Objective	Considerations
Component inspection after partial/total WTG dismantling	Low	Gather evidence for full root cause investigation	Eliminates work at height – specialist inspectors may not possess height/rope-access training Removes work from critical path of WTG removal May be limited if WTG is demolished
With remote means (data, unmanned aerial vehicle (drone) survey)	Low	Initial inspection before allowing personnel access	No access to exclusion zone required
At ground-level, outside WTG	Medium	Visual inspections, chemical sampling, photography, fallen debris collection	Work inside exclusion zone if deemed safe to approach Can be controlled with simple RAMS
Inside WTG and/or at height on nacelle	High	Internal inspections to support detailed structural analysis, gather investigation data	Requires extensive, continuously reviewed RAMS and active monitoring Requires specialist personnel (e.g. rope access), plant and personal protection equipment (PPE)

Figure 2: Risk hierarchy for inspections

5.2 ROLES AND COMPETENCIES

Wind farm duty holders may not possess the full range of competencies needed to perform an assessment and inspection of a critically damaged WTG. Specialist contractors may be needed to perform many roles in the process. Several parties will have a role in either the investigation or decommissioning process.

The roles of principal designer (PD) and principal contractor (PC) will in most cases need to be designated with respect to the Construction (Design and Management) (CDM) legislation. A single company may be able to fulfil both roles.

In addition to fulfilling the role and duties of the client with respect to CDM, the site owner or operator must coordinate the root cause analysis and the various parties required to contribute to the investigation (such as the OEM, engineering, insurers, O&M service provider and specialist inspectors).

The OEM may be able to support the investigation process by collating and securely storing any data available to it. It may also be required to provide additional information necessary for contractors to be able to conduct their work scopes safely and effectively, should this not

already exist in the wind farm Health and Safety File. Information required may include, for example, construction detail on specific WTG components, or the locations and quantities of chemicals used within the WTG.

The operation and maintenance (O&M) service provider's personnel may also support the data-gathering process, as well as any actions within their competencies to make infrastructure safe.

Specialist contractors – from inside or outside the PC's organisation – may provide services such as:

- Rope access technicians (where conventional means of access are not practicable).
- Survey technicians (to perform drone or other external surveys of the WTG).
- Structural engineers (to assess the immediate condition of the WTG; this may involve information-gathering inside the structure).
- Specialist inspectors (to gather information relevant to the investigation, which may require WTG access).
- Crane or other plant operators working under the instruction of the PC or performing a contract lift (to support rope access and/or actions to prepare for dismantling).
- Environmental engineers (to assess and report on the state of the site, including any required remediation works).
- On-site welfare facilities (as required, dependent on the remoteness of the site and the number of personnel working there).

In all cases the parties must be competent to carry out their roles. Given the state of the WTG, however, where access is needed, special training or accreditation (e.g. rope access, use of breathing apparatus) may often be required over and above a contractor's core discipline.

5.3 EXTERNAL INSPECTION

5.3.1 Drone survey

It is strongly recommended to perform a drone survey of the WTG before attempting any form of personnel access, especially where the nacelle and/or top of the tower have sustained damage.

A drone survey can provide information on:

- the condition of the damaged WTG and safe points of access;
- equipment condition where access is not currently possible;
- loose components which are potential drop hazards, and
- any visible chemical/substance leaks or discharges.

Many service companies offer drone inspections. Operating companies and their personnel should be Civil Aviation Authority (CAA)-registered. It is also advisable to consider the insurance cover held by the chosen supplier.

5.3.2 Ground-level inspection

External inspections at ground level may also gather useful information. These should be conducted with the use of visual aids (e.g. binoculars) from outside the exclusion zone, unless a competent person has verified that the structure is safe to approach and there is no risk of collapse. Areas to be evaluated may include:

– examination and collection of any components or debris from the WTG which have already fallen to ground level;
– inspection of the tower exterior, if damage sustained at lower levels (e.g. fire at the bottom of the tower), and
– identification of any chemical discharges to the terrain.

Where larger components (e.g. all or part of a blade) have fallen to ground level, the inspection should also consider safe means of removing these from the area.

6 INTERNAL ACCESS

Once it has been verified that the WTG is structurally safe for personnel to access, the environment in which those working to secure the asset, carry out investigation works and prepare for dismantling/demolition must be taken into account.

When accessing the WTG, it will be difficult to predict the exact state of all areas within; therefore, extensive RAMS and dynamic reviews of these will be required that will take into account the potential conditions.

6.1 NACELLE ACCESS

A key consideration will be whether rope access technicians will be required to perform the works inside the WTG. The WTG's integral work at height safety systems may be damaged or destroyed, meaning that standard Global wind organisation (GWO) working at height training will not be sufficient. This will likely require the use of a specialist contractor.

Where failure has occurred in the tower, personnel access will typically require the deployment of cranes to the WTG and the use of man riding equipment. A preliminary risk analysis should determine the ability of plant to access the site and the position needed to allow safe transfer of personnel. Ground surveys should be conducted to confirm suitability for the plant. Any necessary permits and approvals must be arranged in advance of the work.

6.2 GROUND-LEVEL ACCESS

It may be deemed necessary and practicable to access the WTG though the main tower door (and/or access the exterior transformer station where this exists).

The main hazard external to the WTG is the possibility of falling objects. The risk to workers can be mitigated by installing:

– a container walk-through passage or similar within the exclusion zone, and
– a hard or inflatable barrier around the tower door and/or exterior transformer.

Direct uncovered access may be possible, subject to the condition of the tower, nacelle and blades, taking account of wind speed and direction. An external lookout/observer, located in a position of safety and in direct radio communication, should always be used in this situation.

Where measures, such as removal of access steps, have been taken to secure the site, alternative means (e.g. mobile elevating work platform (MEWP)) should be considered.

6.3 TYPICAL HAZARDS

This guidance document does not aim to provide an exhaustive list of hazards to consider when personnel are working inside a damaged WTG. Each situation must be planned and risk-assessed based on the available evidence. However, some specific common risk areas, lessons learned and points for consideration are considered here.

Chemicals

In the case of a fire-damaged WTG, chemical analysis of dusts should be considered. Cable sheathing produces hydrogen chloride when burned, which quickly dissipates in the open, but forms hydrochloric acid when it comes into contact with water.

Both sulfur hexafluoride (SF_6), commonly present in WTG switchgear, and hydrogen chloride are heavier than air and so can cause an asphyxiation risk if released into an inadequately ventilated space. Consider treating unventilated, fire-damaged areas of the WTG as confined spaces under the confined spaces regulations on first access.

Certain chemicals in a fire-damaged atmosphere may also cause the rapid corrosion of safety-critical equipment and PPE such as karabiners and restraint lines.

Therefore, any early intervention in a fire-damaged WTG should consider:

– atmospheric testing before any other actions are carried out;
– use of a general gas monitor and specific detectors for SF_6 and hydrogen chloride;
– suitable PPE, which may include breathing apparatus;
– additional supplies of, and an increased monitoring and change-out regime for, climbing/fall arrest PPE, and
– clear means of segregation and control of used PPE.

Aside from chemical residue or vapours released due to fire, hazards may also be presented by the need to remove materials such as lubricants, coolants, or hydraulic fluids from the WTG in preparation for dismantling or demolition. Components should be inspected for signs of damage and leaks which may affect the removal process.

Stability, loose and dropped objects

Where loose parts are found which are at risk of falling, these must be properly secured or removed. The parts should be photographed to support the investigation process before they are disturbed.

Additionally, some walking surfaces may be severely compromised; these must be inspected. Any at risk of collapse must be secured or removed, with barriers erected as necessary.

For a partially burnt-out nacelle, it may be advisable to construct temporary floors and barriers as necessary to define safe areas. This also creates a safer feel for persons who are not used to the exposure of a nacelle without walls and floors. The installation of temporary safety and fall restraint lines, deliberately over-engineered where practicable, provides a similar benefit and may make operations more efficient.

Where any climbing systems are still considered usable inside the WTG (e.g. ladders), it is advisable to clean these on first access – residues created in a fire-damaged environment may have made the surface slippery. Additionally, this may reveal otherwise undetected damage.

Lighting and visibility

Lighting will be unavailable in all or part of the WTG, presenting a further obstacle to safe working. The provision of a temporary lighting system will be necessary.

To increase awareness of hazards which have been identified (such as trip and bump hazards or loose parts of the structure), marking with high-visibility paint is recommended. Marking of

objects may occur for other reasons related to the investigation, in which case implementing a distinct colour scheme may avoid confusion.

Similarly, the use of brightly and distinctly coloured PPE, lifting and rigging accessories is advised to improve visibility.

Magnetism

Direct drive machines pose an additional hazard due to the possible presence of strong magnetic fields within the nacelle. It is essential to obtain the manufacturer's recommended exclusion zone when planning work in the WTG, as additional precautions are required if work needs to be conducted within this.

In particular, the risk posed to persons with active implanted medical devices such as pacemakers must be considered, and the use of non-magnetic tools and PPE may be necessary.

7 INVESTIGATION EVIDENCE

This section details the gathering of evidence for further investigation and should be read in conjunction with sections 5 and 6.

7.1 IMMEDIATE DATA GATHERING

The first priority in the investigation process must be to secure all available sources of data which relate to the failure; indeed, this should begin in parallel with the WTG recovery process. The longer the time taken to collate, the greater the risk of important information being lost to the investigation. Data sources will typically include:

- Data relating to the operation of the WTG and internal grid, such as:
  - event data from supervisory control and data acquisition (SCADA);
  - history of trips and interventions;
  - maintenance records, and
  - high voltage (HV) relay event logs.
- Meteorological data, taken from masts, remote sensing devices or nacelle anemometry, as well as past weather forecasts and lightning data, which will allow assessment of whether conditions contributed to the failure.
- Footage available from CCTV or taken by eyewitnesses on mobile phones.
- First-hand accounts from eyewitnesses: these may include employees at the site, members of the public, and reports from the fire service, if in attendance.

7.2 PHYSICAL EVIDENCE AND INSPECTION DATA

In addition to the various forms of data collected, small parts from the WTG may be required for investigation purposes. Of particular interest are items ejected from the structure and recovered at ground level and parts found to be damaged or loose inside the WTG which can safely be removed without creating an additional hazard.

A systematic approach to the collection is advised, where parts are photographed, tagged, registered, and stored securely e.g. in a specific container located at site. A person responsible for ensuring the security of the recovered evidence should be designated.

There is a lower risk of larger pieces of debris (e.g. blade sections) being mislaid; nevertheless, a robust system must be in place to ensure that these are handled correctly when being moved from the site. Aside from investigation purposes, these may need to be retained securely until insurance matters are settled.

8 OPERATIONAL CONTINUITY

After completion of the initial investigation, if the duty holder is satisfied that there is no risk of the failure event occurring on other WTGs, the remainder of the wind farm can be considered for return to normal operation. The specifics of restoring operation are beyond the scope of this document; however, some safety considerations stemming from the failure event are discussed here:

– Where the investigation has identified risk mitigation measures which can be applied to the other WTGs, these should be defined, specified and implemented as soon as practicable.

– Nearby WTGs should be inspected for possible debris impact or harm due to the damaged WTG prior to the reinstatement of operation.

– Any decision to reinstate operation to nearby WTGs should consider whether this activity will conflict with decommissioning works at the damaged WTG, should these still be ongoing.

– It may be required to cut and reconnect HV cables to bypass the affected WTG. Issuance of a Safety Rules Exclusion Certificate would be required in this instance. Any power diversions, even if temporary, must be recorded in the site Health and Safety File.

9 WHOLE OR PARTIAL WTG REMOVAL

9.1 DISMANTLING OR DEMOLITION?

The critical factor that distinguishes emergency from planned WTG removal is that, in most cases, it will not be possible to simply put the OEM's standard dismantling procedures into practice. It will be necessary to develop a procedure specific to the situation, which will lead to a decision to either dismantle or demolish. This section provides general guidance on safety concerns relating to each option.

A risk assessment of each of the possible outcomes, informed through thorough investigation by the contractors, must be prepared to allow a decision to be made on which course of action to follow. The comparative analysis should take into account the extended risks, costs and complexity of each approach.

Some benefits of each route from a safety and environmental perspective may be:

- Dismantling
  - Controlled lowering of materials for forensic analysis.
  - May allow better prevention of chemical discharges.
  - If structural analysis confirms possible, tower can be only partially removed to simplify reconstruction.
- Demolition
  - Substantially reduced working at height requirements, especially if dismantling requires rope access support.
  - Possible reduction in time for heavy plant on site.

Once a decision has been arrived at, a contractor with relevant experience in the chosen removal method should be engaged to manage the works. For dismantling, experience in assembling WTGs of the same or similar types is also desirable.

During both dismantling and demolition site works, general considerations to be taken are:

- Notification of event under CDM, if applicable.
- Access of plant:
  - Suitability of current road and hardstand infrastructure, including level of maintenance.
  - Suitability of the hard standing to support any plant used during works.
- Weather conditions during site works:
  - Daily update briefings looking at the weather forecast and assessing how to progress works. The ability to carry out certain tasks safely can be dependent on both wind speed and direction.
  - Obtain long-range forecast where available.

9.1.1 Dismantling

When planning to dismantle a WTG (wholly or partially), the safety of the remaining structure and impacts of decommissioning on this and the surrounding area should be considered.

Whilst dismantling a WTG, conditions inside the structure should be closely monitored to ensure a safe environment is maintained. This includes the assessment of:

- Safe routes of access and egress into the WTG.
- Working in confined spaces.
- Whether the assistance of a MEWP will be required for the duration of works.
- Isolations required and any damage caused which may prevent their application. Removal of the WTG from Wind Turbine Safety Rules (WTSR) (issue of a Safety Rules Exclusion Certificate) may need to be considered.
- Drainage of any contaminants, which may be subject to COSHH regulations, still existent in the WTG.
- Adaption of the exclusion zone to account for the lifting environment.
- Consideration of working under suspended loads and potential crush zones.

The OEM may be able to provide a standard practice documentation for planned dismantling of an intact WTG, which can be used as a basis for non-standard dismantling – although this may be old and require updating to reflect changes in legislation and the adoption of safer working practices.

Further detail on site clean-up after dismantling are provided in section 10.

9.1.2 Demolition

In instances where the demolition of a WTG (e.g. whether through controlled explosion or mechanical pull) is assessed and agreed as the lowest risk method, the PC is responsible for providing a detailed works risk management plan. This will be conducted in consultation with the contracted demolition specialist. The demolition contractor will provide a safe system of work, highlighting (if applicable) the transport, storage, and the use of explosives on site and how these will be controlled, e.g. dry storage environment.

Controlling the fall zone is imperative, with implications for continued site operation. Consideration should be given to the chosen direction of falling, physical impact from the fall, containment of environmental hazards such flying objects or hazardous substances held within the structure, and adaptation of the exclusion zone.

A critical consideration with regard to demolition is the built and natural environment in and around the wind farm permitted area. Both the demolition charges and the impact on landing of the WTG will generate some vibration, which may affect WTGs and other infrastructure on the site, as well as any sensitive industrial sites such as power stations which may be in the vicinity. Natural environment considerations may include rivers/sensitive waterways and any nearby sites of special scientific interest (SSSI). Any decision to demolish must therefore be supported by an engineering/environmental report which demonstrates that the surroundings will not be affected.

Mitigation of environmental hazards during demolition will reduce the scale of remediation needed upon dropping of the structure. The landing zone of the structure should be calculable to within a very precise area, allowing a controlled environment to contain any substances classed under COSHH (gearbox oils, coolants, etc.) and where materials will require clearing (fibreglass from the blades, small metal objects, etc.).

Where demolition is used to remove the WTG, the integrity of the foundation should be assessed if there is an ambition to reuse it for a replacement WTG.

9.2 OTHER CONSIDERATIONS

When assessing the risks implicated by the removal of the WTG, consideration should be given to the following:

- media management;
- planning consents set during site construction;
- pre-agreed settlements of output with an energy buyer;
- supply and purchase of equipment for works, and
- waste management control measures.

10 ENVIRONMENTAL REMEDIATION

Upon removal of all or part of the WTG through either dismantling or demolition, some further environmental remedial works may be required at ground level before proceeding to reassemble.

Consideration should be given to:

– Small components and debris: the dismantling or (particularly) demolition process may have resulted in more debris being scattered around the WTG at ground level, even if litter-picking operations have been conducted at an earlier stage. A decision should be made whether to collect and segregate or use an industrial lorry vacuum for full disposal; this would be dependent on the nature of the debris and the extent to which recovery or reuse of material is felt to be practicable.
– Spills: even with mitigation measures in place to reduce the risk of a spill during the WTG removal process, consideration to having resources immediately available to react to unplanned discharges is important. Even where there is no clear evidence of substance leaks, it is advisable to survey the area around the WTG for any signs of this. Testing may be required to identify unknown substances and inform the appropriate clean-up actions.
– Tower, nacelle, and internal components: it may not be possible to make immediate plans for final disposal of the major components, as they may need to be retained in a secure facility until insurance release. However, it is recommended that the duty holder considers any practicable options for recovery of materials before a decision to scrap is made.

An environmental assessment report should be prepared to verify that the ground conditions have been restored to the pre-failure state.

ANNEX A
REGULATORY REQUIREMENTS

Below is a list of United Kingdom (UK) legislation which needs to be considered when commencing the process to decommission, either partially or fully, a damaged WTG. The list is not exhaustive.

Even where the scope of works is limited to a partial decommission of a WTG, the **Construction (Design and Management) Regulations 2015**, or in Northern Ireland, the **Construction (Design and Management) Regulations (NI) 2016,** collectively referred to in this document as **CDM**, shall be applicable. All parts of the works must be planned and managed accordingly, with all applicable project stakeholders clearly identified, responsible and accountable for their duties. The works may be notifiable to the Health and Safety Executive (HSE), or in Northern Ireland, the Health and Safety Executive of Northern Ireland (HSENI), under CDM depending on their extent.

Depending on the failure mode, reporting to the HSE under the **Electricity Safety, Quality and Continuity Regulations 2002 (ESQCR)** may also be required. A requirement to file a report may be triggered by, for example, a partial collapse of the WTG, or where the extent of supply interruption meets the notification criteria specified under ESQCR.

For any inspection or decommissioning work which requires lifting operations the **Lifting Operations and Lifting Equipment Regulations 1998 (LOLER)** will have to be considered.

Where the emergency event has triggered, or has the potential to trigger, the exposure of chemicals to persons or contaminate the surrounding environment, the **Control of Substances Hazardous to Health Regulations 2002 (COSHH)** must be considered. A fire-damaged WTG may pose particular challenges in this regard.

The **Confined Spaces Regulations 1997** may apply if accessing areas of a fire-damaged turbine.

Environmental legislation varies between the four nations of the UK.

In all UK nations except for Northern Ireland, the **Environmental Protection Act 1990** establishes a duty of care on those who produce and dispose of waste. In Northern Ireland the **Waste and Contaminated Land Order 1997** imposes a similar obligation.

The table below summarises some other additional areas and selected regulations in each nation. Many of the regulations have been subject to amendments.

Area	England	Northern Ireland	Scotland	Wales
Pollution control	Pollution Prevention and Control (England and Wales) Regulations 2000	Pollution Control and Local Government (Northern Ireland) Order 1978	The Pollution Prevention and Control (Scotland) Regulations 2012	Pollution Prevention and Control (England and Wales) Regulations 2000
Waste	The Environmental Protection (Duty of Care) Regulations 1991 Waste (England and Wales) Regulations 2011 Waste Electrical and Electronic Equipment Regulations 2013 Hazardous Waste (England and Wales) Regulations 2005	Controlled Waste Duty of Care (Amendment) Regulations (Northern Ireland) Waste (Amendment) (Northern Ireland) Order Hazardous Waste Regulations (Northern Ireland) 2005 Waste Electrical and Electronic Equipment Regulations 2013	Waste (Scotland) Regulations 2012 Waste Management (Scotland) Regulations 2011 Special Waste Regulations 1996 Waste Electrical and Electronic Equipment Regulations 2013	The Environmental Protection (Duty of Care) Regulations 1991 Waste (England and Wales) Regulations 2011 Waste Electrical and Electronic Equipment Regulations 2006 Hazardous Waste (England and Wales) Regulations 2005
Liability	Environmental Damage (Prevention and Remediation) (England) Regulations 2015	Environmental Liability (Prevention and Remediation) Regulations (Northern Ireland) 2009	Environmental Liability (Scotland) Regulations 2009	Environmental Damage (Prevention and Remediation) (Wales) Regulations 2009
Contaminated land	Contaminated Land (England) Regulations 2006	Waste and Contaminated Land (Northern Ireland) Order 1997	The Contaminated Land (Scotland) Regulations 2000/2005	Contaminated Land (Wales) Regulations 2006
Water	The Water Resources Act 1991 Groundwater (England and Wales) Regulations 2009	Groundwater Regulations (Northern Ireland) 2009 Environment (Northern Ireland) Order 2002 Water (Northern Ireland) Order 1999	Control of Pollution Act 1974 Groundwater Regulations 1998 The Water Environment (Controlled Activities) (Scotland) Amendment Regulations 2013	The Water Resources Act 1991 Groundwater (England and Wales) Regulations 2009

ANNEX B
GLOSSARY

Abbreviation	Definition
CAA	Civil Aviation Authority
CDM	Construction (Design and Management)
COSHH	Control of Substances Hazardous to Health
EI	Energy Institute
ERP	emergency response procedure
ESQCR	Electricity Safety, Quality and Continuity Regulations
GPP	guidance for pollution prevention
GWO	Global wind organisation
HV	high voltage
LOLER	Lifting Operation and Lifting Equipment Regulations
MEWP	mobile elevating work platform
OEM	original equipment manufacturer
PC	principal contractor
PD	principal designer
PPE	personal protection equipment
RAMS	risk assessments and method statements
SCADA	supervisory control and data acquisition
SSSI	sites of special specific interest
TAC	technical advisory committee
UK	United Kingdom
WTG	wind turbine generator

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