G+ Good practice guidelines for unmanned aircraft systems in the offshore wind industry

G+ Global Offshore Wind
Health & Safety
Organisation

In partnership with
energy institute

G+ GOOD PRACTICE GUIDELINES FOR UNMANNED AIRCRAFT SYSTEMS IN THE OFFSHORE WIND INDUSTRY

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FOREWORD

Unmanned aircraft systems (UASs) are increasingly being used in the wind energy industry. They can offer time and financial benefits whilst reducing personal exposure to hazards for some tasks. However, they also present hazards, with possible catastrophic effects. For example:

– Aerial collisions between unmanned aerial vehicles (UAVs) ('drones') and crewed aircraft have occurred in other sectors. A collision with a helicopter offshore could lead to a devastating loss of personnel.
– As the mass of UAVs continues to grow, an uncontrolled gravitational descent could be fatal to persons below.
– A UAV striking a wind turbine generator (WTG) blade can cause damage, potentially leading to structural failure.

Even though regulators, UAS providers and the industries that use them continue to work towards a robust, structured framework for controlling the risks, the rapidly evolving nature of the field results in a degree of lag, as regulation and guidance catch up with new technology and applications. In offshore wind operations, many of the controls present for crewed aviation are absent: the market is open to new and inexperienced operators, unfamiliar with integrated, structured ways of controlling risk, contract expectations and controls on sub-contracting are more relaxed, and some light UAVs are unregulated. Accordingly, the onus is on offshore wind companies to ensure that UASs are effectively incorporated into the wider safety management system applicable to the whole operation. This G+ good practice guideline (GPG) explains the steps needed to achieve this.

G+ welcomes any feedback. This should be sent to gplus@energyinst.org.

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G+ would like to express sincere gratitude to Lee Harris for his insights and expertise in contributing to this GPG.

DISCLAIMER

The contents of these guidelines are intended for information and general guidance only, they 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.

PRESENTATION

Information in normal text introduces the background to or rationale for the requirements, providing understanding and discussion of the issues involved.

Requirements are concise statements of G+ recommendations for what offshore wind companies (OWCs) should do. They are numbered and shown in **bold, blue** text.

Guidance gives additional detail of the requirements, and potential means of complying with them. They are shown in light blue text.

TERMINOLOGY

In this GPG the following terms have special meanings.

Consents is used as a general term for consents, licences, authorisations, approvals, permissions etc, issued by a regulator or other authority to allow an OWC or other organisation to proceed with a particular activity.

Legislation is used to mean any law that places an obligation on an OWC (cf 'Regulation').

May indicates a requirement whose suitability depends on circumstances, as in '…it may be helpful to… in cases where … '). 'May' is also used to describe different possible situations that need to be considered, as for example in '…there may be more than one UAS provider on a site'.

Offshore wind companies (OWCs) is used as a general term for offshore wind farm developers, owners, operators, and prime contractors. OWCs, especially those who are new entrants to the offshore wind sector, are the main intended audiences for this GPG.

Regulation means the systems and organisations (regulators) that (to varying degrees) provide guidance on legislation, check OWC compliance and, where they see it as necessary, take enforcement action. OWCs may have legal duties even where there is no requirement to obtain prior consent from a regulator, nor any proactive regulatory audit/inspection regime.

Safety is used as shorthand for 'health and safety' (except where health is being specifically referred to) and should be taken to include health (both mental and physical) as well safety. This is in no way intended to imply that health concerns are less important, but simply because always writing 'health and safety' in full can lead to clumsy wording.

Shall/must. G+ does not have legal authority to mandate safety requirements for its members or others, so these terms are not used, except when citing legal requirements.

Should. Consistent with other GPGs, we use 'should' as the standard term for presenting good practices. This allows for flexibility in the means of achieving the safety aims but does not mean that the practice is merely optional. Rather, G+ recommends that OWCs should either:

- follow the requirements, going beyond them where reasonably practicable,
- do something else at least equally safe, or
- risk assess, justify and document the acceptance of any exemption.

System, as in 'UAS' includes all elements: people, policies and procedures in their operational and environmental contexts.

Unmanned aerial vehicle (UAV) – the aircraft (or 'drone'). Other terms are in use, such as uncrewed[1] aerial vehicle, small unmanned aircraft (SUA) or small unmanned surveillance aircraft (SUSA). There are no major differences of meaning between these terms for most practical purposes.

1 Terms such as 'uncrewed' are more inclusive and hence preferable in principle, but we have retained the term 'unmanned' (as used by ICAO and EASA for example) for now because (a) the sector has not yet converged on a gender-neutral alternative and (b) interested parties will find it easier to look up related references using 'unmanned', because it has been in use for longer.

Unmanned aircraft system (UAS) refers to the whole system, including the UAV itself and, for example, the remote pilot, the communication system, and ground-based supporting systems. Other terms are in use, such as unmanned aerial system, unmanned/uncrewed aircraft system, and remotely piloted aircraft (or aerial) system (RPAS). Again, there are no major differences of meaning for most practical purposes.

UAS providers refers to organisations or functions that provide a UAS service. They may be external contractors to the OWC, or a function or department within the OWC itself.

(UAS) contractors are external contractors providing UAS services to OWCs. This term is used when specifically referring to external contractor and the associated contracting arrangements and considerations. The more general term ‘UAS provider’ (as above) covers both external contractors and internal OWC functions.

UAV operators are organisations or individuals who fly UAVs on site.

SUMMARY

G+, the Global Offshore Wind Health and Safety Organisation, has developed this GPG to share, advance and encourage good health and safety[2] practice when using UASs in support of offshore wind energy projects.

This summary outlines the key safety considerations that OWC management need to be aware of in deciding whether and how to use UASs.

The need for this guidance

The following characteristics of the UAS industry, as it is at present, contribute to a context in which safety needs particularly careful management.

- The scope of UAS applications is expanding rapidly.
- The industry ecosystem is immature, relative to that for crewed aircraft. UAS providers are often new and inexperienced, typically coming from innovation or software backgrounds rather than aviation. They can also be very small companies, without an established organisational structure or roles and responsibilities to deliver safety.
- There is extensive subcontracting. On site, UAVs may be operated by a second or even lower-level subcontractor, especially where the prime UAS contractor does not have a local presence in the region.
- Air traffic management services, and communication, navigation and surveillance capabilities offshore are limited due to, for example, poor radio and radar coverage, different radio systems being used by the various aircraft and vessel operators and untrained users, unfamiliar with radio protocols and phraseology.
- Regulation is having to catch up with a fast-developing industry, and so may not always be fully appropriate or proportionate to the risks. There is, for example, no equivalent for UAVs of the comprehensive certification requirements that are in place for crewed aircraft.
- There is limited experience and information. A UAS contractor may be engaged on one wind project or for a specific activity, then not again for a long time. Systems for sharing and analysing incident data have not long been in place. As a result, the understanding of safety is less well-developed than that for crewed aircraft.

Renewable UK, the UK trade association for wind, wave and tidal energy, published the document *Renewables & Unmanned Aircraft Systems – Requirements for Operations* (the 'RUGO') in 2020. It was UK-specific, and there have been advances in UAS technologies and applications as well as changes in regulation since then. Other guidance on UAS safety exists, but is not tailored to the wind industry. G+ therefore decided to update and internationalise the RUGO content, focussing on offshore wind in accordance with the G+ remit.

Objectives

This GPG sets out the G+ view of good practice in managing the safety risks associated with the use of UASs in the offshore wind energy industry.

Audience

This GPG is mainly intended for OWCs: developers, owners, operators or prime contractors who are considering, or are already, using UASs.

OWCs may operate UASs themselves, or engage external UAS contractors. An OWC that operates UASs will need the same competencies, roles, responsibilities, procedures, documentation, etc. as would be expected of an external contractor.

Using the requirements

This GPG is a resource for OWCs to adopt and implement within their own business and safety management systems (SMSs), for example by:

- using them to set a baseline of common expectations between contract parties,
- incorporation into company standards, procedures and practices,
- incorporation into contract specifications, Employer's Requirements, etc. and
- use as prompts in audits and reviews.

OWCs should reference the requirements as mandatory minimum requirements where they can, for example when placing a contract. Alternative solutions should be justified as being at least equally safe.

The requirements should be used in conjunction with the most up to date, relevant legislation, regulatory guidance, standards and other sources of good practice.

Scope

This scope of the GPG has been defined to reflect the remit and focus of G+ and its members. It considers offshore wind energy, but is also applicable to onshore elements of offshore projects.

The focus is on UAS-specific matters rather than generic SMSs – we assume that OWCs will already have an appropriate overarching SMS in place. However, to help OWCs manage less experienced UAS providers, there are requirements on what aspects of an SMS to expect from a provider, and how to help them deliver this.

The GPG considers all elements of the UAS: UAVs, control and communication systems, launch and landing sites, pilots, maintenance, operational support, etc. It covers UAVs of all sizes and levels of complexity, in current and foreseeable applications.

The GPG is intended to be applicable anywhere in the world and to all stages of a wind farm's lifecycle, from initial planning, through operation and maintenance, to eventual decommissioning. Requirements are also given on abnormal and emergency situations.

Key exclusions – i.e. topics on which this document does *not* offer guidance — are:

- passenger-carrying UAVs,

- internal applications of UAVs, i.e. within WTGs and other spaces and structures,
- design and manufacture of UAS elements,
- risks to the natural environment, and
- risks related to the purpose of the UAS mission, e.g. whether image quality is sufficient for blade inspection.

UAS applications and UAV types

Applications include, but are not limited to:

- site surveys,
- monitoring operations,
- inspection, maintenance or repair,
- logistics, e.g. delivery of items,
- surveillance e.g. for site security, record-keeping or accident investigation,
- emergency support – e.g. to assist in search and rescue (for additional information on OWCs' duty of care and responsibility to contribute to emergencies at sea, see the G+ GPG on Integrated Offshore Emergency Response (G+ IOER) – https://www.gplusoffshorewind.com/__data/assets/pdf_file/0008/671399/G-integrated-offshore-emergency-response-G-IOER.pdf), and
- photography and video.

UAVs vary from below one kg in weight to the size of commercial crewed aircraft. They can be manually controlled, or have varying degrees of flight automation. They may be powered by fossil fuel or by batteries.

Hazards and benefits

The hazards associated with UASs include:

- Collisions with people, other aircraft, vessels, structures, assets or equipment.
- Disruption to other activities, e.g. by creating airspace conflict, distraction or electromagnetic interference.
- Dropped loads: either the UAV itself falling or a load carried by a UAV being dropped.
- Moving blades.
- Fire, electrocution and hazardous substances associated with UAV power sources.

UASs also have potential safety benefits, as UAVs can be used in conditions and environments that are hazardous to people. For example:

- Using a UAV for blade inspection reduces the need for technicians to work at height, by rope access or other means.
- Using a UAV rather than a manned aircraft for site surveys eliminates the risks of flight to aircraft crew.

Key messages – overview of the requirements

Sections 3 to 9 present requirements for each lifecycle stage of a UAS.

Section 3 requirements apply across all lifecycle stages. They include the need to comply with any local legislation and requirements as well as following this GPG, legal duties and the as low as reasonably practicable (ALARP) principle, taking a whole-system view, engaging with UAS providers and other interested parties, and risk assessment.

Section 4 covers what an OWC should do in preparing to deliver or contract out UAS services: developing a policy for when and how UASs will be used, and developing their own intelligent customer capability.

Section 5 covers the planning and design phases. The aim is to achieve safety by design, i.e. to eliminate hazards wherever reasonably practicable, and minimise them if not. Decisions about how UASs will be used on a specific project lead to a wide range of planning, design and operational considerations, such as wind farm layout, the design of launch and landing platforms and how UAS operations can be safely integrated with crewed aircraft operations and other activities.

Section 6 covers the process for providing UAS services, either by the OWC itself or by an external contractor. Some of the subsections are specific to the considerations involved in contracting out, with particular attention to managing the risks inherent in dealing with a relatively immature industry.

Sections 7 to 10 respectively cover: trials, normal operations, monitoring and supervision, abnormal conditions and emergencies, and continual improvement.

The Annexes provide supporting information and illustrative examples of templates and materials. It is essential to note, though, that the examples are purely illustrative: OWCs should not simply copy and paste such material, but need to review and adapt them for their own UAS applications, operations and contexts.

Presentation of the requirements

Information in normal text introduces the background to or rationale for the requirements, providing understanding and discussion of the issues involved.

The requirements themselves, i.e. concise statements of G+ recommendations for what OWCs should do, are numbered and shown in **bold, blue** text.

Where additional guidance is given on how to follow a requirement, this is in light blue.

1 INTRODUCTION

1.1 BACKGROUND

UASs are increasingly being used to support offshore wind projects. UASs are already being used extensively for inspection flights and the wind industry is exploring ways to use UASs in new roles, such as cargo delivery. The use of UASs in wind is an area of significant interest and opportunity for operators of UASs and wind farms alike.

These changes lead to new health and safety[3] risks, for example in relation to the interaction between UAVs, and other aircraft, people and assets. But they also present new opportunities to improve safety (as well as operational efficiency), for example by reducing the need for people to go offshore or to work at height or in confined spaces.

For UAS operators to serve the growing wind industry demand, they must meet the requirements of the large multinational entities that typically manage wind farms, and of the safety regulators, and demonstrate the ability to manage not only current but new and emerging hazards, and to maximise the safety benefits.

With the increasing use of UASs, legislation, regulatory arrangements, standards and practices are evolving. The International Organization for Standardization (ISO) and other standards bodies are developing standards. Industry bodies in other sectors, such as the maritime and oil and gas sectors have also produced relevant material.

Overall, the status, characteristics and regulation of UASs in wind energy contribute to a context in which safety needs particularly careful management (see 2.10 for further detail of the risk-shaping factors).

In 2020, RenewableUK, the UK trade association for wind, wave and tidal energy, reviewed and drew together understanding of health and safety (H&S) for UASs at the time and published the document *Renewables & Unmanned Aircraft Systems – Requirements for Operations* (the 'RUGO'). The RUGO was specific to the UK context, and there have been advances in UAS applications and technologies, and changes in regulation and guidance, since 2020. Other guidance on UAS safety exists, but is not tailored to the wind industry. G+ has therefore produced the present document to provide updated, international requirements. In accordance with the G+ remit as the health and safety organisation for offshore wind, the focus is on offshore wind applications,

This document has been prepared by a working group of industry representatives, drawn from G+ member companies, with the Energy Institute providing the steering function and secretariat. Orano Ltd was contracted to carry out the technical work.

1.2 OBJECTIVES

The purpose of this GPG is to share, advance and encourage good practice when using UASs in support of offshore wind energy projects.

1.3 AUDIENCE

The main intended audience for this GPG is OWCs – developers, owners, operators or prime contractors – who are considering, or are already, using UASs. This may be either by operating UASs themselves or by engaging an external contractor.

The GPG may be particularly helpful to OWCs who are new entrants to the offshore wind sector.

During the planning, design and construction phases, and during upgrade, repowering or decommissioning, the organisations with primary responsibility for H&S are likely to be clients, developers or prime contractors. During routine operations and maintenance (O&M), they are most likely to be the owner or operator. The requirements are intended for OWCs who are managing UAS operations, either for themselves or via an external contractor. An OWC that operates UASs will need the same competences, roles, responsibilities, procedures, documentation etc as an external UAS provider would.

The requirements may also be of use to other interested parties, such as UAS suppliers and contractors, maintenance contractors, interfacing disciplines within the offshore wind sector (e.g. operators of crewed aircraft) and regulators.

The requirements are not intended as a primary resource for organisations whose main business is the design, manufacture, supply or operation of UASs.

The GPG sets out the G+ view of good practice, in terms of what OWCs should do, and what they should expect from contractors, especially those who provide UAS services.

1.4 USES OF THE REQUIREMENTS

The requirements provide a resource for OWCs to adopt and implement within their own businesses and SMSs, for example by:

- using them as a baseline of common expectations between contract parties,
- incorporation into company standards, procedures and practices,
- incorporation into contract specifications, Employer's Requirements, etc. and
- use as prompts in audits and reviews.

OWCs should reference the requirements as mandatory minimum requirements where they can, for example, when placing a contract. Alternative solutions should be justified as being at least equally safe, be agreed between contracting parties and be documented, explaining the rationale for adopting them rather than following this GPG.

The GPG should be used in conjunction with the most up to date, relevant legislation, regulatory material, standards and other sources of good practice (see 1.6). Due to rapid industry and technological change, it is not possible for a document such as this to be fully comprehensive or future-proof.

1.5 SCOPE

Table 1 summarises what is and is not covered in this GPG. This scope has been defined to reflect the remit and focus of G+ and its members.

Table 1: Scope of the GPG – inclusions and exclusions

Topic	Included aspects	Key exclusions
Safety management focus	UAS-specific matters. However, to help OWCs manage UAS providers who are less experienced in safety, we include requirements on what elements of an SMS to expect from a provider, and how to help them deliver this	H&S management in general. It is assumed that OWCs using this GPG already have an appropriate SMS in place Product safety legislation and management (e.g. CE marking in the EU)
UAS elements	All: including but not limited to UAVs, control and communication systems, launch and landing sites, pilots, maintenance, operational and 'back-office' support	-
UAV types	All UAV sizes, levels of complexity and regulatory classifications Free-flying and tethered	Power-generating systems using tethered UAVs or kites
UAS operations	Current and foreseeable uses of UASs (see Section 2)	Passenger-carrying UAVs Concepts, technologies, applications and regulations are not mature enough to be able to give specific requirements, other than a general caveat (see Requirement 2) that passenger operations will require additional safety measures, OWCs should therefore consider any plans for passenger operation very carefully, engaging with regulators and other interested parties

Table 1: Scope of the GPG – inclusions and exclusions (continued)

Topic	Included aspects	Key exclusions
Operational locations	External airspace around and en route to and from wind farms	Internal spaces, e.g. using a UAV for inspection inside a WTG The use of UAVs within buildings and other assets is not regulated by National Aviation Authority (NAA), but under general industrial safety regulation. Nevertheless, some of the guidance in this GPG may still apply
Industry sectors of application	Offshore wind energy, including onshore elements of offshore wind projects	Onshore wind energy projects (although, in practice, some aspects may be relevant to onshore wind as well as offshore. Note that the RUGO covered both)
Geographical range	World-wide. The content mainly reflects, however, material from those areas where there is most experience of offshore wind, i.e. Europe, North America and Asia Pacific, as well as from international organisations such as ICAO. It would not be practical to identify and compare legislation, regulation and practices in each state	Details of legislation and guidance in individual regions or states
Lifecycle stages of the wind farm asset infrastructure or equipment	All, including project planning, survey, design, construction, installation and commissioning, operation and maintenance, repowering/upgrade/modification, decommissioning and abnormal or emergency situations	-
Lifecycle stages of the UAS	Selection and use by an OWC	This GPG does not give guidance on the design and manufacture of UAVs and other system elements. However, in selecting a UAS, the OWC **should** consider how it assures itself that the design, quality control, etc. are appropriate to the use

Table 1: Scope of the GPG – inclusions and exclusions (continued)

Topic	Included aspects	Key exclusions
Risk types (who or what may be harmed)	Safety risks related to UAS operations (collisions, dropped loads etc)	Risks to the natural environment, e.g. from a UAV carrying fuel, batteries or dangerous goods ditching in the sea[4] Risks from deliberate, malicious acts, such as interference with UAS operations by cyber-attack (UAVs sometimes use non-secured local communications networks such as 4G/5G) or by using UASs for activities such as sabotage, terrorism or espionage Security, privacy, disturbance or nuisance issues in flying near certain sites Contractual, commercial and financial risks Risks related to the *purpose* of the UAS mission, e.g. whether image quality is sufficient for blade inspection

1.6 RELATIONSHIP TO OTHER REQUIREMENTS AND GUIDANCE

Documents that complement the present requirements are referenced at various points throughout this document. A full list of references is in Annex L. Documents of which OWCs should be aware, as key sources of additional requirements or guidance, are summarised in Table 2.

2 The environmental risks and impacts are not considered in this GPG, but note that a ditched drone can also present safety risks: from the hazardous substances, and in the operations necessary to retrieve it from on or below the sea surface.

Table 2: Key references complementary to this GPG

Organisation	Document	Primary audience(s)	Purpose and scope (UAS applications, geographic limits)	Comment
G+/EI	**This GPG**	**OWCs using UASs**	**Industry requirements for safe use of UASs** **Specific to offshore wind applications** **International**	
European Union Aviation Safety Agency (EASA)	Various. The Easy Access Rules https://www.easa.europa.eu/en/document-library/easy-access-rules/easy-access-rules-unmanned-aircraft-systems-regulations-eu are a good way in to the more formal regulatory documentation	UAS providers	Regulatory requirements (framed in terms of Implementing Rules, Acceptable Means of Compliance and Guidance) for UASs in most applications EU Member States and others that have agreements with EASA	As per Requirement 1, OWCs should identify, and as a minimum comply with all applicable local legislation, regulatory requirements, guidance and expectations
Federal Aviation Administration (FAA)	Various – see https://www.faa.gov/uas	UAS providers	Regulatory requirements and guidance for UASs in most applications USA	
National aviation authorities (NAAs)	Various – see for example https://www.caa.co.uk/drones/rules-and-categories-of-drone-flying/introduction-to-drone-flying-and-the-uk-rules/for the UK	UAS providers	Regulatory requirements and guidance for UASs in most applications National	

Table 2: Key references complementary to this GPG (continued)

Organisation	Document	Primary audience(s)	Purpose and scope (UAS applications, geographic limits)	Comment
Flight Safety Foundation (FSF)	FSF Basic Aviation Risk Standard (BARS) – Remotely Piloted Aircraft Systems. Version 4, Oct 2022	UAS providers and (BARS) Auditors	Industry standards International	The FSF Standard and Implementation Requirements are structured in terms of threats to safe operations, controls and recovery or mitigation measures
	FSF-BARS Remotely Piloted Aircraft Systems. Implementation Requirements. Version 4, Oct 2022		An extended version of the FSF Standard (as above), with the addition of guidance on how each standard could be met, and on what evidence an auditor could look for International	
International Association of Oil & Gas Producers (IOGP)	IOGP Report 696 – Remotely Piloted Aircraft Systems	IOGP members (oil and gas industry) UAS providers (operated directly or subcontracted by IOGP members International	Industry association recommended practices International	This document has a rigorous structure and is quite detailed, setting out the purpose and expectation of each recommended practice, the processes and practices to be followed to comply, and giving references to other documents providing additional guidance

1.7 STRUCTURE AND PRESENTATION OF THIS DOCUMENT

After this introductory Section 1, Section 2 presents a framework for defining and describing a UAS in terms of, for example: the physical and operational elements of the UAS itself, its operational context and the interested parties.

Sections 3 to 10 respectively present requirements for each lifecycle stage of a UAS (as seen from an OWC point of view)[5], trials, normal operations, monitoring and supervision, abnormal conditions and emergencies, and continual improvement.

Information in normal text introduces the background to or rationale for the requirements, providing understanding and discussion of the issues involved.

The requirements themselves, i.e. concise statements of G+ recommendations for what OWCs should do, are numbered and shown in **bold, blue** text.

Guidance, additional information about a requirement or means of complying with it, is in light blue.

The Annexes provide additional detail and supporting information. They also include some illustrative examples of safety materials, such as a supplier evaluation questionnaire. It is essential to note, though, that these are purely illustrative – OWCs should not simply copy and paste such materials, but carefully review and adapt them for their own specific UAS applications, operations and contexts.

3 The lifecycle model is an idealised, simplistic one, adopted to provide a manageable framework for this document. In reality there will often be iteration between stages, different elements of a project will progress at different times and rates. For example, trials may usefully form part of the design process, and part of a wind farm may be in operation while part is still under construction.

2 SYSTEM DESCRIPTION

As a prerequisite to identifying and managing the associated risks, OWCs will need a clear and comprehensive understanding of how UASs could meet their specific needs. This section describes the aspects of a UAS (applications, equipment, personnel, procedures, etc.) that an OWC will need to consider when specifying and using UASs.

2.1 ELEMENTS OF A UAS

A UAS can be considered to include, but not be limited to:

- The UAV itself, with its equipment fit, capabilities and limitations.
- The remote pilots, safety observers, support crew and responsible persons on site: their training, competence and numbers.
- Ground-or vessel-based infrastructure, such as launch and landing platforms, storage facilities, communications equipment.
- Air traffic management (ATM) and communication, navigation and surveillance (CNS) systems.
- The applications of the UAS – see 2.2.
- The operational context – see 2.4.
- Operating procedures.
- Maintenance and inspection of UAVs and related equipment.
- Arrangements for storage, handling and carriage of dangerous goods and other hazardous materials.
- Emergency systems and procedures.

2.2 UAS APPLICATIONS

Current and foreseeable applications of UASs include, but are not limited to:

- site surveys,
- monitoring of operations,
- inspection,
- maintenance/repair,
- logistics, e.g. delivery of items,
- surveillance e.g. for safety and security, record-keeping, accident investigation,
- emergency support – e.g. to assist in search and rescue (SAR), and
- publicity and communications (e.g. photography, video).

As noted in 1.5, this GPG does not provide requirements for passenger-carrying UAVs other than the general caveat (in Requirement 2) that additional safety measures will be required and very careful consideration would be needed.

2.3 UAV CHARACTERISTICS

Aspects that vary between UAVs, and that will affect safety considerations and regulatory requirements, include:

– Size and weight: UAVs are available from under 1 kg to over 1000 kg (though not all sizes are currently in regular use in offshore wind).
– Power technology: battery, fossil fuel or hybrid.
– The means of providing lift and propulsion: these may be rotary (n-copter, multi-copter) or fixed wing.
– The level and type of equipment fitted, such as CNS equipment, or mission-specific equipment such as for load-carrying or photography.
– Operational capability, such as range, speed and payload.
– Operation types, for example within visual line of sight (VLOS) extended visual line of sight (EVLOS) and beyond visual line of sight (BVLOS).
– The means of control. UAVs may be controlled manually by the remote pilot or have various levels of automation (autopilot).

2.4 OPERATIONAL CONTEXTS

Context aspects that vary from site to site and that will affect safety considerations, include:

– The assets served by, or providing infrastructure for, launching and landing of UAVs, such as WTGs – fixed or floating, electrical substations and converter stations, accommodation platforms, onshore bases and vessels.
– Distance from launch/landing site.
– Whether operating onshore, offshore, from a vessel or from an installation.
– Emergency support available.
– Other aircraft traffic: fixed wing and helicopters, military and civil, SAR, etc. – see 2.7.
– Simultaneous operations SIMOPs in the vicinity, such as vessel movements and crane or jack-up barge operations.
– Electromagnetic environment and interference – this can affect the avionics and CNS of the UAS, or the UAS may affect these for other aircraft.
– Nearby infrastructure, installations and facilities – these may, for example, present obstacle hazards, or there may be airspace restrictions for safety and security reasons around sensitive and hazardous sites, both civil and military.
– Availability and level of ATM and CNS systems, for both UAVs and crewed aircraft.
– Meteorological information services.

2.5 ENVIRONMENTAL CONTEXT

Environmental factors that may affect safety include:

– Weather (wind speed and direction, visibility, precipitation, lightning, etc.)
– Lighting (night/day).

- Visual cues for pilots; cues when flying over water are less reliable than over land – with low sea states, for example, it is difficult to assess aircraft height visually.
- Sea state – a high sea state may make it more difficult or impossible to land a UAV on a vessel. Sea state will also be relevant if a UAV ditches, as it may need to be recovered.

2.6 OPERATING/CONTRACTING MODELS

The provision, operation or maintenance of UASs can be undertaken by the OWC itself or often contracted out by the OWC to an external contractor. Section 6.5 gives more detail and guidance on the various possible contract structures and arrangements.

2.7 INTERESTED PARTIES

Safety-related interfaces and obligations may arise from the needs and expectations of interested parties such as:

- Other wind farm aircraft operators (both UAS and crewed) such as survey aircraft, helicopters used for heli-hoisting and technician transfer, SAR helicopters.
- Non-wind farm airspace users: all kinds of commercial, general or military aviation may be encountered en route and in the vicinity of the wind farm.
- Other wind farm contractors, such as those engaged in surveying, construction and maintenance, cabling, diving, substation operations and meteorological monitoring.
- ATM service providers.
- Vessel operators – working on the wind farm and others.
- Emergency services and public authorities. UAS activities and flight paths may interact with SAR, marine safety or law enforcement operations.
- Clients: e.g. contractual requirements to comply with certain standards, or service level and performance level agreements, such as on reliability and availability.
- Insurers: they may for example have requirements to carry out inspection or maintenance of UASs at specified intervals.
- Standards and certification bodies, such as ISO.
- Industry bodies and trade associations e.g. SafetyOn, Global Wind Organisation (GWO), FSF, ARPAS UK and IOGP.
- Regulators – see 2.8.

2.8 REGULATION AND REGULATORS

In accordance with the scope of the GPG (see Table 1 in 1.5) this section focusses on UAS-specific legislation. It is assumed that OWCs using this GPG are already familiar with generic health and safety at work legislation in the state(s) in which they operate.

Legal duties may exist even where there is no requirement to obtain prior authorisation from a regulator, nor any proactive regulatory audit/inspection regime.

There is relevant legislation at international, European, national, and in some cases more local levels.

Many aspects of legislation are risk-based, i.e. the requirements are proportionate to the risk, as related to broad categories of UAV weight, UAS application or location.

The International Civil Aviation Organization (**ICAO**) is a United Nations agency that sets international aviation standards and recommended practices (SARPs), intended to achieve a safe and interoperable aeronautical environment.

Individual states are responsible for establishing their own regulatory framework in accordance with ICAO standards, implemented by the national aviation authority (**NAA**). A list of NAAs, with links to their websites, is available on the ICAO website at https://www.icao.int/Pages/Links.aspx. States may file differences from ICAO when justified by national circumstances.

For carriage of dangerous goods, the IATA Dangerous Goods Regulations (DGR) manual (IATA – Dangerous Goods Regulations (DGR)) is the global reference (which may be implemented in state legislation).

Within the EU, the European Union Aviation Safety Agency (**EASA**) is the responsible authority for safety across member states, plus Norway and Switzerland – see https://www.easa.europa.eu/en/domains/international-cooperation/easa-by-country. EASA also has working and co-operation agreements with non-EU states. EU states have a responsibility to comply with EASA regulation, but are also responsible for ICAO compliance. Although this has a risk of conflicting requirements, co-ordination between EASA, ICAO and the member states aims to prevents this.

Eurocontrol, the European Organisation for the Safety of Air Navigation – see https://www.eurocontrol.int/about-us, is the intergovernmental agency for harmonisation and promotion of ATM safety across Europe (both EU and non-EU).

2.9 HAZARDS AND BENEFITS

Generic hazards associated with UASs include:

- Collisions with people, other aircraft, vessels, structures, assets or equipment, birds.
- Disruption to other activities, e.g. by creating airspace conflict, distraction or electromagnetic interference.
- Dropped objects: either the UAV itself falling or a load carried by a UAV being dropped. For more information on the latter, see the G+ GPG on dropped loads – https://www.gplusoffshorewind.com/__data/assets/pdf_file/0017/641042/Web-version-G-adaptation-of-DROPS-reliable-securing_LM.pdf, which includes requirements on requirements on lifting equipment, attachments, bags etc. The SF-BARS Remotely Piloted Aircraft Systems Implementation Requirements has an appendix on external loads.
- Moving blades.
- Fire, ignition, electrocution and hazardous substances associated with UAV power sources such as fossil fuels or lithium batteries, during transit, storage, refilling/recharging as well as in use.

These and other hazards may arise from, for example, human error, loss of power, loss or degradation of control or other UAS or UAV functions, adverse weather or from deliberate, malicious acts. Deliberate, malicious acts are, however, not within the scope of this GPG – see Table 1.

There can also be safety benefits from using UASs, which can offset or outweigh the risks. This is because UAVs can be used for activities, or in conditions and environments, that present hazards to people. For example:

- Using a UAV reduces the need for technicians to work at height, by rope access or other methods, for activities such as blade inspection.
- Using a UAV rather than a crewed aircraft for site surveys eliminates the risks of flight to aircraft crew.
- Using a UAV for cargo delivery reduces the need for crane operations.

The magnitude of the potential benefits and hazards will vary greatly, depending on factors such as the application, and the size and weight of the UAVs. For example, the hazards involved in flying a small UAV to 50 m above sea level, to take a one-off publicity photograph of a vessel, are likely to be much smaller than those when using heavy UAVs for regular parts delivery to a remote wind farm where other aircraft are operating nearby.

2.10 RISK-SHAPING FACTORS

Some important factors that influence the nature of hazards and the level of risk when using UASs in the offshore wind industry are as follows:

- UAS providers are often new and inexperienced, typically coming from technological innovation or software backgrounds rather than aviation. UAS contractors can be very small companies, without an established organisational structure or roles and responsibilities to deliver safety. The need for key documents such as an Operations Manual, risk assessments and emergency procedures may not be recognised, providers have presented risk assessments that do not even identify a minimal list of hazards. As outlined further in Annex C, there is little consistency between providers: risk assessments vary widely in what hazards they do consider, how severity and probability are assessed, and what control measures are proposed.
- Where OWCs operate UASs themselves, they can do so without the same degree of regulatory control that applies to crewed aircraft.
- There is a lot of subcontracting. On site, UAVs may be operated by a second or even lower-level subcontractor, especially where the prime UAS contractor does not have a local presence in the region.
- Limitations on ATM and CNS services: offshore communication arrangements are often far from ideal, due to:
  - Poor radio and radar coverage.
  - Different radio systems and/or frequencies being used by the various aircraft and vessel operators. This requires pilots and others to monitor several channels and make many frequency changes, adding to their workload and increasing the chance of missed or unclear communication.
  - Untrained users, with poor radio discipline: not following correct protocols and phraseology.

- Regulation is having to catch up with a fast-developing industry, and so will not always be fully appropriate or proportionate to the risks. For example:
- There is no comprehensive[6] equivalent for UAVs of the certification requirements and process that are in place for crewed aircraft.
- There are no comprehensive standards for the reliability, availability and integrity and availability of communications.

Such limitations mean that OWCs cannot rely on UASs having as high a level of safety 'guarantees' as for crewed aviation.

The UAS sector is relatively new, and contractor involvement with offshore wind can be transient or intermittent – they may be engaged on one project or for one activity, then not again for a long time. Systems for occurrence reporting and analysis (see for example https://www.easa.europa.eu/en/document-library/general-publications/annual-safety-review-2022), have also not been long in place. As a result, we do not yet have good safety data (e.g. frequencies of various accident types or failure rates for UAV components) and our understanding of safety is less well-developed than that for crewed aviation. Consequently, we are less able to identify safety priorities and apply the most effective risk controls.

4 But see for example https://www.faa.gov/uas/advanced_operations/certification

3 REQUIREMENTS – ALL LIFECYCLE STAGES

The following requirements apply across all lifecycle stages.

3.1 CONSIDERATION OF FACTORS BEYOND THIS GPG

Three requirements arise from the scope of this GPG as defined in Table 1:

1. **OWCs should identify, and as a minimum comply with, all applicable local legal duties (both explicit and implicit), regulatory requirements, guidance and expectations.**

   This is in addition to following the requirements in this document. Where there are differences between sources, the more stringent should be followed.

   As noted in 2.8, legal duties may be implicit or by exception rather than explicit and proactive. That is, there may be duties even where there are no prescriptive requirements, no need to obtain prior authorisation from a regulator, and no proactive regulatory audit or inspection regime.

   The classic example of this is the ALARP requirement that is fundamental to UK law on health and safety at work – see https://www.hse.gov.uk/enforce/expert/alarpglance.htm. Employers have a duty to reduce risks to ALARP, and are open to prosecution if they fail to do so, but with relatively few exceptions the law does not tell them *how* to do this. The onus is on the employer to assure themselves, and if necessary the regulator, that they have achieved ALARP.

   To help keep up to date with legal and regulatory requirements, OWCs can subscribe to updates and bulletins from, for example, ICAO, EASA, NAAs and health and safety regulators.

2. **OWCs should consider the relevance of risks outside the scope of this GPG (as set out in Table 1), and where appropriate identify and manage them.**

   In particular, passenger-carrying UASs will require additional safety measures. Under EASA rules, for example, passenger-carrying applications would, by definition, bring the system into the 'Certified' category. OWCs would need to give very careful and specific consideration to any plan for passenger operations, engaging with regulators and other interested parties.

   The G+ Helicopter Operations GPG (https://www.gplusoffshorewind.com/__data/assets/pdf_file/0004/822739/Section-A-G-safe-helicopter-operations-in-support-of-the-global-offshore-wind-industry.pdf) could provide a starting point for OWCs wishing to begin considering what may be needed. It includes, for example, requirements on what training helicopter passengers need, helicopter hoisting and means of escape in an emergency. However, it would need thorough review and adaptation to the very different situation of unmanned aircraft.

3. OWCs should continually review how safety could be improved.

This GPG only represents a point in time: the industry, regulation and what is considered good practice will move on.

Continual self-challenge, considering whether more could be done, is an important element in respecting the ALARP principle[7]. G+ does not support a 'mere compliance' or 'safety by compliance' approach. For example, some regulatory arrangements would allow a UAV to ditch into the sea. G+ does not regard this as acceptable.

3.2 WHOLE-SYSTEM VIEW

As outlined in Section 2, the elements of a UAS include people, procedures, infrastructure and equipment, in their operational and environmental context and considering interfaces with interested parties. It is not sufficient just to consider, for example, the UAV itself.

4. OWCs should consider the safety of the whole UAS system, in its operational and environmental context and taking account of interfaces with interested parties.

Good communication with interested parties is essential at all stages, from initial planning to day-to-day operations.

5. OWCs should identify all interested parties and understand their safety needs and expectations.

3.3 INDUSTRY MATURITY

As noted in 2.10, the use of UASs is relatively new and evolving quickly, so safety management systems are not as mature as in crewed aviation. Regulation is catching up with new technologies and applications.

6. OWCs should not assume that UAS providers will have a mature or robust SMS, and should be prepared to explain concepts and expectations clearly.

The OWC's aviation specialist may need to guide and support a UAS provider to develop an appropriate aviation SMS for the operation.

7. OWCs should take opportunities to contribute to the education and development of UAS providers.

Informal contacts with UAS providers by aviation specialists, for example at exhibitions and conferences, can be used to start discussions about safety and raise its profile. It is not necessary to wait for or limit such discussions to more formal engagement at supplier qualification or tender stage. OWCs' aviation specialists can also contribute by engagement with industry safety initiatives and by contact with manufacturers and regulators as well as UAS providers.

5 In the UK, the interpretation of ALARP in law is more stringent: employers have to go beyond legislation and guidance (including this GPG), wherever it is reasonably practicable to do so – see https://www.hse.gov.uk/enforce/expert/alarpglance.htm.

3.4 ENGAGING WITH REGULATORS AND OTHER AUTHORITIES

So far as aviation-specific regulation is concerned, OWCs will primarily need to engage with the NAA(s) of the states(s) in which they operate.

Engagement may also be required with other authorities, such as those who decide on or are consultees for planning applications, or who license radio operations, and with other interested parties (see Requirement 5).

8. OWCs should identify, and engage as appropriate with, all relevant regulators and other authorities.

Offshore wind is an international industry, and it is common for OWCs to operate in, and obtain services from, more than one state. Articles 11 and 12 of the International Convention on Civil Aviation (https://www.icao.int/publications/documents/7300_orig.pdf) require that any aircraft, regardless of its nationality (i.e. the state of registration), shall obey the regulations and operational procedures of the state in which it is flying, and that a state's Rules of the Air are applicable to all aircraft registered by that state, wherever they are operating.

If a UAS provider based in one jurisdiction wishes to operate in another, they must comply with the requirements of all NAAs. For example, a German provider operating in Danish airspace must comply with the Danish regulations and also abide by the German Rules of the Air. This particular responsibility lies with the UAS provider, who may be an external contractor, but OWCs need to satisfy themselves that the provider is aware of, and has addressed, this aspect of operation.

9. OWCs who operate in, or obtain services from, more than one state should ensure that they, and their UAS providers, have identified all relevant national requirements and understand how to comply with them.

10. OWCs should ensure that the implications of any differences between the requirements of different regulators or other authorities can be satisfactorily resolved.

3.5 RISK ASSESSMENT

3.5.1 Requirement to risk assess all operations

11. OWCs should ensure that suitable and sufficient risk assessments, specific to each planned UAS operation and its operational and environmental contexts, are carried out.

UAS providers should develop risk assessments for the specific activities, locations and contexts (not merely generic assessments), together with method statements. The risk assessment and method statement (RAMS) should be made available for review by the client OWC (or OWC department) in advance of any flights taking place.

A common problem is that UAS providers or UAV operators provide risk assessments (and method statements – RAMS) at short notice, and that what is provided is of low quality. Commercial pressure for the operation to go ahead can then influence the approval process.

12. OWCs should ensure that UAS providers and UAV operators understand that the OWC will need time to review the risk assessment.

UAS providers should expect to receive feedback and may need to discuss or ask for reconsideration of the assessment. It is not enough to provide an assessment 24 hours before the operation. The OWC should decide on an appropriate timeline, taking account of their internal resources, and of any prior experience with the UAS provider.

3.5.2 Risk assessment principles

Whatever the level of depth and detail in risk assessment, and whatever tools and techniques are used, there are certain principles that should always be followed, as listed in Table 3. These principles have been identified as addressing the most common weaknesses seen in risk assessments, in the UAS field and in other sectors.

13. OWCs should follow the risk assessment principles in Table 3.

Table 3: Risk assessment principles

Topic	Principles and examples
1. Scope and boundaries	The scope and boundaries of the system being assessed should be clearly defined. For example, what life cycle stages, activities, locations and types of risk are considered? What infrastructure and communications will be in place?
2. Whole-system view	Within the defined scope and boundaries, the assessment should consider all aspects of the system: people, procedures, equipment, infrastructure, etc. Wherever the boundaries are set, interfaces with external systems also need to be considered. For example, a risk assessment focussing on wind farm UAS traffic also needs to consider other aircraft activity in the vicinity?
3. Participation	The risk assessment should be developed with input from people affected by the risks and those who have most control or influence over them. Participants should include, for example, remote pilots and UAS crew as well as planning, design, operations and project management personnel.
4. Hazard identification	There should be an effective and thorough process for identifying hazards. This can involve structured workshops, reviews of historic incident data or analytical approaches such as bowties, or failure modes and effects analysis (FMEA). A generic, high-level list of hazards is given in 2.9, but this is only a starting point. It needs to be reviewed and developed for the specific UAS, activity and environment.

Table 3: Risk assessment principles (continued)

Topic	Principles and examples
5. Likelihood and severity assessment	The risk associated with a hazard is a combination of the likelihood (probability or frequency) of the hazard actually leading to an accident or incident, and the severity of the consequences if it does. In assessing likelihood and severity, it is essential to be clear and consistent in what risk metrics are used. For example, the estimated probability or frequency of a dropped load could be expressed per flight, or per year. And are you considering all dropped loads, or only those that have the potential (due to where they occur and the weight of the object) to cause injury? This matters, both to ensure that risks are assessed on a consistent basis, and because some metrics are more useful than others in interpreting the significance of a risk. For example, a per year metric will probably be most appropriate where routine 'low risk' operations take place frequently. For an unusual, one-off operation, it would be better to consider the risk for that operation itself It is important not to rely on assessed 'low' probabilities when the consequences can be severe. There can be a tendency to under-estimate probability, on the basis that 'it hasn't happened yet' (or because the assessor is not aware of it happening), and because it is difficult to foresee all the possible failures and errors that may contribute to incidents and accidents
6. Risk tolerability	In judging whether a risk is tolerable or not, ALARP is the key consideration. The question 'would it be reasonably practicable to do more?' should always be asked Tolerability must *not* be judged on the basis of where the risk from each hazard sits in a colour-coded risk matrix (see Annex D for a detailed explanation), even though this is a widely used approach. The problems with it are that: – The fact that a risk is small does not necessarily mean that it would not be reasonably practicable to reduce it further. Conversely, a risk may be relatively large, but unavoidable. – The position of a risk in the matrix depends on the granularity with which hazards are considered. For example, if we divide a dropped object hazard into the UAV itself falling or a load being dropped, we will have two, lower-frequency hazards rather than one. This may affect which colour band they sit in, and hence their apparent tolerability. – Tolerability of work-related risk can only be assessed with any robustness for the overall risk level from work, not for the risk from each specific hazards. Traditional matrices do not show the total risk. Risk matrices are, nevertheless, a useful tool for comparing different hazards and hence prioritising the attention given to controlling them

Table 3: Risk assessment principles (continued)

Topic	Principles and examples
7. Control measures	Risk control measures should be put in place in accordance with a hierarchy of control. Different forms of hierarchy have been developed for different applications, but the following, based on that in the ISO 45001 standard, is typical and may be appropriate for UASs. In order of preference, OWCs should seek to: – eliminate the hazard, i.e. remove it altogether, – substitute – with less hazardous materials, processes, operations or equipment, – use engineering controls – isolate people from the hazard, e.g. by means of guards or interlocks on moving parts, – use administrative controls – change the way people work by training, signage, etc., and – provide and ensure use of personal protective equipment (PPE) In addition, inherent or passive safety (safety by design) is preferred over safety measures that rely on active intervention
8. Keeping up to date	The assessment should be reviewed regularly, and in the event of any potentially significant change, such as a new activity, location or UAVs or when the operational environment changes

3.5.3 Tools and techniques

The UK CAA recommends the use of barrier risk models, in particular bowties, to assist with the identification and management of risk – see https://www.caa.co.uk/Safety-Initiatives-and-Resources/Working-with-industry/Bowtie/.

However, bowtie models are just one of many approaches, tools and techniques for hazard analysis, risk assessment and evaluation. Tools should be selected and adapted, extended or enhanced if required, as appropriate and proportionate to the particular system and its hazards.

EASA (https://www.easa.europa.eu/en/domains/civil-drones) currently defines three safety categories for civil UASs:

– ‘Open’ category: lower-risk operations, for which safety is ensured provided the operator complies with the relevant requirements for the intended operation. No prior operational authorisation is required.
– ‘Specific’ category: riskier operations, for which an operational authorisation must be obtained from the NAA before starting the operation. To obtain this authorisation, the operator must conduct a risk assessment determining the requirements necessary for safe operation.
– ‘Certified’ category: for operations with the highest risk. As with crewed aviation, the aircraft will need to be certified (i.e. to have a type certificate and a certificate of airworthiness), the UAS operator will need an air operator approval issued by the competent authority and the remote pilot will need to hold an appropriate pilot licence.

EASA provides certain predefined risk assessments – see https://www.easa.europa.eu/en/document-library/easy-access-rules/easy-access-rules-unmanned-aircraft-systems-regulations-eu.

Guidance on risk assessment methods specific to UASs can be found in the JARUS requirements on Specific Operations Risk Assessment (SORA) and Pre-Defined Risk Assessments (PDRAs) – see http://jarus-rpas.org/publications/.

The SORA is comprehensive and appropriate for higher risk operations such as flights by larger UAVs, BVLOS operations, and/or those in the EASA 'specified' or 'certified' categories. The reality, however, is that for operations usually seen as 'low risk', such as photo flights, the SORA and other detailed approaches are considered too complex and demanding on time and resources.

A simpler approach, based for example on scoring the likelihood and severity of events that may result from each hazard and combining these in a risk matrix, may be adequate for inherently lower risk operations. The approach in the ICAO Safety Management Manual (Doc 9859 — Safety Management Manual (SMM) (icao.int)) is widely used in crewed aviation, and so – subject to some important caveats – is suggested as a suitable for UASs. The caveats are outlined within Table 3 – see especially items 5 and 6, which identify common failings in applying risk matrices, Annex D presents an illustrative example of the use of the ICAO SMM approach.

4 REQUIREMENTS – PREPARING TO PROVIDE A SAFE SYSTEM

This section gives requirements on what an OWC needs to do to be ready to deliver or contract out UAS services safely. External UAS contractors will have their own safety duties and responsibilities but OWCs, as clients, retain ultimate responsibility for safety on their sites, and need to provide safe systems within which UAS activities can take place.

4.1 POLICY ON USE OF UASS

14. OWCs should state their overall aims and commitments regarding safe integration of UAS operations, and the high-level means by which they intend to achieve them, in a suitable policy.

Key elements of such a policy should include statements regarding:

a) Overall safety aims, such as aiming for zero harm, going beyond mere compliance', reducing risk to ALARP, and setting targets or risk tolerability criteria.
b) Commitment to apply the same safety assurance, management approach, requirements and minimum standards to all UAS operations irrespective of geographical location. As a high-level document, the policy should be applicable across the OWC organisation, but it should also outline the governance and criteria for deciding on differences at the implementation level where appropriate, for example in response to site-specific factors.
c) How decisions about using UASs will be made – e.g. weighed against other logistic solutions, taking account of safety, operational, environmental and economic factors and of benefits as well as risks.
d) Generic means for achieving aims, such as through leadership, governance, training and competence, monitoring and auditing, learning from experience, audits and review.
e) Top management responsibilities: such as ensuring that UAS operations are considered from the outset of a project, that informed decisions are made, based on risk assessment, and that adequate resources are available.
f) Accountability and responsibilities for aviation management.
g) Oversight of UAS operations: ensuring the safe and correct delivery of services and infrastructure provided, in-house and by others.
h) Selection, induction and monitoring of personnel.
i) Use of advice from aviation/UAS specialists[8] where required.
j) Requirements for approval of UAS providers and UAV types.
k) Engagement with other airspace users and other interested parties.

The UAS policy may also be a convenient place to cover other UAS-related matters outside the scope of the present requirements, such as insurance requirements.

It may be helpful for the policy to allow for flexibility in future, especially in view of the rapid development and expansion in the range of services that UASs can provide.

The policy should also allow for UASs to be operated in and around the wind farms by external parties, such as SAR teams. Requirement 19 gives further detail on how these aspects can be allowed for in planning and design.

6 Referred to as Aviation Advisers in some documents, e.g. IOGP 696

While the points above should be covered, it is not essential to have a stand-alone document entitled 'UAS Policy'. The content could instead, for example, be integrated with the organisation's overall health and safety policy. Where and how best to document the UAS policy is a decision for the OWC. It will depend on factors such as the existing SMS documentation structure, and how safety responsibilities are allocated in the organisation (e.g. who owns the policy and signs it off). The level of detail in the policy, as against what is in supporting documents, is also a decision for the OWC. All such documentation is referred to as the 'UAS Policy' in this GPG.

4.2 INTELLIGENT CUSTOMER CAPABILITY

OWCs will need appropriate internal capabilities to manage UAS services safely. Where the OWC is itself the UAS provider, additional competence in the more detailed technical and operational safety matters will be needed – see Requirement 41.

15. OWCs should ensure that they have appropriate internal functions, roles and responsibilities, competencies, policies, arrangements and procedures in place, including access to suitably qualified and experienced aviation specialists.

Given the complexities of UAS aviation and how quickly it is changing, OWCs should ensure that they have access to suitably qualified and experienced aviation specialist(s). The specialist(s)' role would typically include technical, operational, safety, performance and compliance matters such as:

a) advising on, or creating and maintaining the UAS Policy,
b) identifying and assessing risks,
c) developing, implementing and reviewing documentation such as procedures, Operations Manuals and RAMS,
d) developing or reviewing business cases for UAS operations,
e) approving UAS providers and aircraft,
f) contract management and operational supervision,
g) ensuring appropriate training and competence of others involved in UAS operations,
h) technical authority roles, for example in relation to UAV certification, requirements for CNS infrastructure,
i) oversight and monitoring of UAS operations: ensuring the safe and correct delivery of services and infrastructure provided in-house and by others, and
j) investigation of accidents, incidents and concerns, analysis of trends, identification and dissemination of learning from experience (LFE).

UAVs share the same airspace with crewed aircraft and require integrated safety management.

16. OWCs should consolidate aviation competence and avoid dividing aviation specialists into separate groups such as for crewed or uncrewed aviation.

17. OWCs should ensure that they have resources and competences in place for day-to day management of UAS activity.

Depending on the nature, volume and complexity of UAS operations, a supervisor/coordinator role may also be required for day-to day management of UAS activity. The typical tasks involved are described in Section 8.

5 REQUIREMENTS – PLANNING AND DESIGN

This section covers the planning and design of the wind farm for UAS operation. The overall aim is to achieve safety by design, i.e. to eliminate hazards wherever reasonably practicable, and minimise them if not.

5.1 DECIDING ABOUT USING UASs

Decisions about UAS use can have a significant effect on the nature and magnitude of risks.

18. OWCs should decide how, where and when UASs are to be used, in line with their policy, as part of the planning and design of any wind project.

Even where they have no current need for UAS services, OWCs may wish to allow flexibility by making provision for future UAS operations in the planning and design of the project. This will also assist in allowing one-off requirements for UAS services should the need arise.

The decisions should involve a high-level identification and assessment of the positive and negative impacts, risks and opportunities associated with UASs, as compared to alternatives. It should then aim to maximise benefits and minimise risks.

As noted in relation to Requirement 14, OWCs should allow for UASs to be operated in and around the wind farms by external parties where appropriate. This is particularly the case for SAR. UASs are already in use for some SAR operations and this is likely to increase.

19. Where possible, OWCs should aim to ensure that wind farm design facilitates the use of UASs for SAR, and other external parties, even if they do not intend to use UASs themselves.

For helicopter SAR, there are already standards and guidance on wind farm design – for example on the layout of WTGs to optimise search patterns (e.g. in the UK Maritime and Coastguard Agency (MCA) Maritime Guidance Note (MGN) 654 (https://www.gov.uk/government/publications/mgn-654-mf-offshore-renewable-energy-installations-orei-safety-response).

Standards and guidance for helicopters have been summarised in the G+ GPG on Helicopter operations – see https://www.gplusoffshorewind.com/__data/assets/pdf_file/0004/822739/Section-A-G-safe-helicopter-operations-in-support-of-the-global-offshore-wind-industry.pdf

and

https://www.gplusoffshorewind.com/__data/assets/pdf_file/0005/822740/Section-B-G-safe-helicopter-operations-in-support-of-the-global-offshore-wind-industry.pdf.

Similar considerations will apply to UAVs, but given the immaturity of the industry and rapidity of change in UAS applications, it would be to be premature to try to adapt the helicopter guidance to UAVs, which can be very different in terms of, for example, size, manoeuvrability and risk profile. Consequently, this requirement is stated as 'where possible' The main concern that can be addressed at present is the need to deconflict UASs from SAR aircraft – see 5.8.

5.2 EARLY ENGAGEMENT OF UAS PROVIDERS

20. OWCs should, where possible, seek early involvement of UAS providers in the planning and design of the wind farm.

The extent to which early engagement will be possible or realistic may depend on contractual considerations. For example, the OWC may not have direct, formal contact with UAS providers until later in the wind farm design process. See also Requirement 7 on early, informal contact and education initiatives with UAS providers, in advance of any potential contracts.

5.3 SPECIFYING OR SELECTING A UAS SERVICE AND UAVs

Selection of UAS will be iterative with the design of the infrastructure and decisions about what UAS applications should be included. Where a UAS provider is to be contracted, this process is likely to take place in parallel with selection of the provider. The provider should be able to advise on the capabilities, advantages and disadvantages of available UAV types for the required tasks. However, each individual provider may only have access to a small number of UAV types,

21. OWCs should check that they understand the suitability of the UAS(s) offered by any supplier or contractor.

OWCs can, for example, ask for advertised UAV capabilities (e.g. 'versatile' or 'long-range') to be objectively defined and quantified where possible.

Unlike the case for crewed aircraft, UAS performance (engine-out climb rate, etc.) is not generally certified. Claims made can therefore be 'sales information' that is unreliable and unrepresentative of real-world performance.

There is a vast range of UAV types on the market, and new systems and updates are being introduced at an ever-increasing rate. Selecting a UAV is not, therefore, a simple matter. It can be challenging for OWCs to understand the advantages and disadvantages of the different UAVs available.

22. OWCs should (unless their aviation specialists have in-depth knowledge of the market) make initial requests to potential UAS suppliers or contractors in terms of proposed applications and safety requirements, rather than by directly asking for a specific UAV type.

Safety requirements can be specified in terms of:

– Equipment or features required (e.g. redundancy of safety-critical equipment, fallbacks and contingencies in the event of a failure or error, such as a homing function in the event of loss of control or communication).

– More formally, in terms of functionality, performance, reliability and integrity requirements. This is less dependent on knowledge of available technology, but requires more formal safety analysis.

The factors to be considered when specifying or selecting a UAS can be considered under three main topics as follows:

– Suitability – does the UAS have the necessary functionality and performance for the required activities? What are its airworthiness characteristics (whether certified or not)? What are the safety-related maintenance requirements?
– Resilience – is the UAS capable of continuing to operate safely and as intended despite certain internal or external failures?
– Mitigation – in the event of a failure, what prevents the UAS from causing serious harm?

Further details of these three topics are given in Annex E.

5.4 KEY PROCEDURES

23. OWCs should work with UAS providers to ensure that comprehensive and appropriate procedures and other operational documents are developed and in place.

Topics to be covered in procedure or other documents should include but not be limited to:

– UAV launch, landing and recovery/collection,
– safe transport and storage of equipment, including quarantining/ containment of damaged, faulty or suspect equipment,
– deconfliction from other aircraft (both crewed and other UAVs),
– team composition: remote pilots, 'ground' crew (on installations or vessels), safety observers,
– operating limitations (see 5.5),
– accident/incident response, and
– emergency procedures (see Section 9).

It may be appropriate for these to be combined in, or signposted from, the Operations Manual.

5.5 OPERATIONAL LIMITS ON UAS OPERATIONS

24. OWCs should ensure that there is clarity about responsibilities for providing information, and the parameters and thresholds that will be used to define weather and other limits on UAS operations.

For example, will information from the wind farm's own anemometers be provided to UAS providers?

5.5.1 Environmental constraints

25. OWCs should be aware and take account of environmental constraints when setting operational performance targets.

Key environmental factors include wind speed and direction and precipitation relative to the ingress protection rating of the UAV. Other forms of adverse weather, such as icing, thunderstorms or volcanic ash can present hazards to UASs and may require operational changes or limitations.

The UAS provider will normally be responsible for taking environmental constraints into account in day-to-day planning and operations, making use of current and forecast meteorological information. Nevertheless, the OWC needs to take account of environmental constraints at the site in order to be able to agree realistically achievable operational performance targets at planning, design and procurement stages.

5.5.2 Ambient light and visibility

Night and/or low visibility operations will require more stringent safety measures. Deconfliction and separation become more important/challenging outside of day/visual meteorological conditions (VMC).

26. OWCs should consider and implement additional safety measures for night and low visibility operations.

Given the limited uses of night/low visibility operations in the industry to date, it would be premature to define detailed standards However, key considerations are:

– Whether/how UAVs should be lit – even if the UAV's eye view does not rely on visible spectrum light, lighting the UAV may be needed to assist a remote pilot using VLOS to control it, and pilots of other aircraft.
– Obstacle criteria and minimum stand-off distances from assets.
– Whether/when/how UAVs should trigger automated aircraft detection lighting systems (ADLS) on wind farm assets.
– Night-specific training for remote pilots.

5.5.3 Operational constraints

27. OWCs should keep UAS providers updated with information on wind farm operational factors that may affect safety.

These factors include:

– SIMOPs for example, tall crane vessels used during construction can present aviation obstacles, necessitating restrictions on certain flight paths or operations.
– Unserviceability of equipment, such as a WTG that cannot be configured for UAV arrival, failure of the platform status light or a communication outage.

5.6 WIND FARM LAYOUT

As well as providing launch and landing sites, wind farm structures and their layout can affect UAS safety in other ways, including by:

- presenting aviation obstacles (see Section 5.6.1),
- obstructing lines of sight,
- affecting CNS coverage,
- generating wake turbulence, and
- electromagnetic interference.

28. OWCs should consider the layout of the farm, including all existing and planned structures around UAS routes and destinations, that could impact on safety.

Given this wide variety of ways in which wind farm layout can affect safety, early engagement with interested parties is essential.

29. OWCs should engage as early as possible with UAS providers, NAA, aviation specialists and SAR providers regarding wind farm layout.

30. OWCs should consider the effects of layout on UAS (and other) operations at neighbouring wind farms, and potential cumulative effects, as well as those for the proposed wind farm itself.

5.6.1 Aviation obstacles

31. Where possible, OWCs should consider the obstacle environment presented to UAVs (and other aircraft) as a factor in planning and design of wind farm layout.

As the use of UASs is so new, the reality is that UAS operations have to be planned, designed and conducted to fit around the existing wind farm layout, rather than the other way around. Many other factors need to be taken into account when designing the layout and spacing of structures – not least the requirements of crewed wind farm aircraft and SAR helicopters. At present, these factors are likely dominate any UAV considerations. This requirement, and the guidance below, are therefore included as 'where possible', for completeness and future-proofing, anticipating that UAS operations may become a more important and widespread element of wind farm developments.

Obstacle clearance

The areas surrounding a launch/landing platform should be free of obstacles out to certain ranges, in order to protect against UAVs collision on approach, missed approach or departure, including in the event of a motor/engine failure limiting the UAV's performance.

Obstacles below launch/landing platforms will need to be considered as well as obstacles above them, since UAVs may be carrying out inspection work on parts of the structure below the platform. Another possibility to consider is whether, in the event of degraded motor/engine performance, a UAV might need to descend initially to gain sufficient speed to safely fly away.

The applicable obstacle criteria differ according to the type of flight, being more restrictive for night and/or low visibility operations than for daytime/visual flights.

Frangibility

To protect the occupants of crewed aircraft, obstacles should be frangible wherever possible, subject to the need to withstand wind, wave and helicopter downwash forces and other structural considerations. For UASs, the considerations are different: damage to a UAV is not in itself a safety issue, although there could be consequential safety impact from a UAV crash. The safety question is, therefore, whether damage to an obstacle, potentially leading to a dropped object risk or compromising structural integrity, is preferable to causing damage to or crash of a UAV. In deciding whether it is better to make obstacles frangible or not, account should be taken of the requirements of crewed aircraft as well as UASs. See also on the frangibility of UAVs

Lighting and marking

Obstacles will need to be lit and marked in accordance with NAA requirements. However, these are typically intended for crewed aircraft, and lighting and marking considerations for UAVs – where they will be used by remote pilots – may need separate consideration. See also 5.5.2 on night operations.

Reference documents

The primary international reference on the assessment and treatment of aviation obstacles – by lighting, marking, charting or operational limitations, etc. – is ICAO Annex 14 (Annex 14 – Aerodromes – Volume I – Aerodromes Design and Operations I ICAO Store). This covers obstacles from the perspective of aviation in general (i.e. outside the scope of the present GPG), but aspects of it are also relevant to the wind farm's own air traffic and UASs.

However, this and other references do not fully cover all the questions that may arise. The assessment and management of obstacles is a complex topic, in which requirements will depend on many factors related to the aircraft and its performance, to environmental and meteorological conditions, and to the type of activity and flight procedures being carried out. OWCs should engage with the NAA, aviation specialists, UAS provider(s) and other aviation parties to ensure that obstacles have been properly considered and risks minimised.

Notification of obstacles

32. OWCs should ensure that obstacle locations, height and size are notified to UAS providers and aeronautical chart and database providers.

UAS providers and UAV operators need to be aware of the existence of obstacles that may present a hazard or constrain flight paths. Information needs to be provided to the UAS provider at organisational level and (thence, or directly, as appropriate) to all the UAV operators and individual remote pilots who may flying in the vicinity.

5.6.2 Effects on SAR

In order to maximise WTG array efficiency, to take account of geotechnical variations, and for operational reasons, wind farm developers would like to be able to position WTGs freely. Some regulators, however, prefer a gridded layout with lines of orientation, as this helps SAR pilots maintain situational awareness and enhances the probability of detecting targets such as vessels or personnel in the water.

33. OWCs should take account of the requirements of any UASs used for SAR in the design of the wind farm.

For large wind farms, refuge areas may have to be incorporated, providing a defined area of airspace in which a helicopter or large UAV can safely manoeuvre or turn within the farm.

Each state has its own planning process, and the relevant coastguard and other SAR stakeholders should always be engaged in the layout design phase, to ensure optimum layout for rescue, aligned with aviation, environmental and other considerations. Example references on these topics include the UK Maritime and Coastguard Agency (MCA) Maritime Guidance Note (MGN) 654 (https://www.gov.uk/government/publications/mgn-654-mf-offshore-renewable-energy-installations-orei-safety-response).

Where offshore installations and/or vessels have the capacity to provide refuge or refuelling for SAR aircraft, crewed or not, it will be useful to pass this information to SAR authorities and providers.

5.7 DESIGN OF LAUNCH AND LANDING PLATFORMS

34. In designing launch and landing areas on offshore assets, OWCs should consider design (and hence operational) aspects that can affect the safety of UAV operations and of the personnel who will need to be present.

Factors to consider include:

a) Dimensions appropriate to the UAV types to be accommodated.
b) OWCs should liaise with WTG original equipment manufacturers (OEMs) and UAS providers to establish likely movements for the specific WTG type, under different sea state and wind conditions, and assess how these may affect UAV operations.
c) Structural design to support the weight of the UAV and any loads it is carrying, allowing for hard landings, as well as other dead and live loads.
d) The ability of structures and attachments to resist forces from rotor downwash.
e) Access, egress and evacuation routes.
f) Non-slip surfaces, safety railings, marking and lighting of steps, etc.
g) Edging or netting to prevent dropped loads.
h) Design of railings, etc. to avoid snagging of hoist hooks and wires, or of clothing.
i) Deck/platform surface: friction, slope and drainage, suitability for hoist wire earthing (careful design and material selection is needed to ensure effective discharge, whilst also meeting requirements for protective, coloured, non-slip surfaces that are resistant to pin-prick damage where electrical contact occurs).

j) Obstacle considerations – clearance, lighting and marking, frangibility (see 5.6.1).
k) Turbulence from neighbouring structures affecting UAV operations.
l) Visual aids and indicators to remote pilots: marking and lighting, allowing identification individual WTG numbers from typical approach angles: WTG identification numbers on top of the nacelle can be masked by platform rails, etc. until almost directly overhead.
m) Fuelling and charging facilities.
n) Fire-fighting provisions.
o) Interfaces/interlocks between platform status indications to remote pilots and the control system for positioning and locking of the WTG (where required).
p) Arrangements to ensure that personnel are at a safe location during UAV arrival/departure.
q) Surfaces that facilitate removal of snow, ice, guano, etc.

Platforms on vessels or floating WTGs may need to be larger to allow for approaches to a moving platform. It will also be necessary to ensure that a parked UAV will not tip or slide due to platform movement.

It is unclear what criteria can be applied to decide whether the movement is acceptable or not. There is guidance on pitch, roll and heave (PRH) amplitude or rate limits for helicopters using helidecks on vessels but this cannot simply be applied to UAVs, or to floating WTGs where lateral movement due to tower sway may be significant. The frequency and amplitude of movements may vary greatly according to, for example, how the vessel or WTG is anchored, and resonance of the structure, as well as sea state and wind.

35. For UAV operations to vessels or floating WTGs, OWCs should establish how wind and sea state conditions may affect UAV operations.

Understanding vessel/WTG movements under different wind and sea sate conditions, and how these movements may affect UAVs, will require liaison with the vessel providers or WTG OEMs, and with UAS providers.

5.8 AIRSPACE, ATM AND CNS

The location and design of offshore wind farms raises a number of significant airspace, ATM and CNS considerations. These can impact on UAV operations in support of the wind farm (as well as on other airspace users, though that is outside the scope of this GPG).

The main issue is that UAVs operated in the EASA open category are not separated from crewed aircraft in the vast majority of windfarms. An OWC that permits the use of crewed and/or UAS needs to have an effective method to prevent confliction. At present, this is generally limited to deconfliction in time and space, by means such as setting operational times and airspace limits, rather than by proactive air traffic control (i.e. instructions from a controller to the remote pilots). A specific aspect of this issue is UAVs entering the wind farm with no knowledge of crewed aircraft operations there. Existing regulations and ATM arrangements do not ensure that these issues are sufficiently addressed so OWCs will need to consider the planning and policing of airspace in and around the wind farm.

These issues are complex and interdependent. They can affect wind farm design and the ability to integrate UAS support into the project, so it is important that engagement with the aviation authorities and interested parties is initiated early in the planning process.

The nature and importance of these issues, existing constraints and requirements and the available options for solving them will depend on the wind farm location and on what UAS operations are proposed. Consequently, it is not possible to give specific guidance to cover all possible scenarios. Instead, this guidance identifies a range of key points that should be considered, as below.

36. OWCs should engage with the relevant NAA(s), air navigation service providers (ANSP(s)), UAS providers, SAR authorities, and other airspace users at the earliest opportunity, to ensure that all relevant airspace, ATM and CNS issues are understood and addressed. This should cover UAV activities within the wind farm and in transit to and from land or other offshore destinations.

OWCs may also wish to liaise with these parties in order to assess the suitability of the existing airspace and CNS arrangements and to discuss potential improvements.

Topics that are likely to need to be covered in early engagement include:

a) Airspace characteristics, including airspace classification in the vicinity of the proposed development and affecting support operations.
b) Airspace policy and planning guidance.
c) Responsibilities for aircraft coordination and control in and around the site OWCs cannot control/prevent the use of UAVs in neighbouring farms but can as a minimum propose information-sharing with neighbours.
d) Segregation distances between UAVs and other aircraft, or vessels or assets.
e) Consultation zones in relation to airspace and offshore developments.
f) SAR airspace and CNS requirements, including for operations within a wind farm. UAVs will need to be deconflicted from or just kept out of the way of SAR aircraft.
g) ANSP and offshore ATC services – availability and roles.
h) Responsibilities for issue of Notice to airmen (NOTAMs).
i) CNS infrastructure, including Global Navigation Satellite System (GNSS).
j) Use of transponders on UAVs.
k) UAV operational topics, including flight conditions, obstacle clearance, approach, missed approach and departure procedures, and transit routes (taking account of the locations of onshore facilities, refuelling points, tasking itineraries, etc.).
l) Adjacent air activity e.g. other UAS or helicopter support to the wind farm or its neighbours.
m) Military activity and training areas, and other restricted areas.
n) The NAA's perspective on OWC responsibilities.

This is not an exhaustive list and the issues that need to be covered for any particular wind farm will be dependent on the specific circumstances. In addition, OWCs should be aware that in dealing with different national administrations there is the potential for significant variations, notwithstanding the international principles described in 2.8.

Many of these aspects will not be the direct responsibility of the OWC to resolve, but they will have implications across all aspects of a wind farm project.

Although outside the scope of this GPG, note that it may also be convenient for this engagement process to include the potential effects of the wind farm on airspace use and ATM/CNS services for other, non-wind farm, air and vessel traffic, as these topics will usually also be dealt with, initially, in the consenting process.

5.9 WTG CONTROL AND ISOLATION

37. OWCs should develop robust means for, when necessary, shutting down and restarting the relevant WTGs for UAV operations, and for communicating WTG status to pilots.

It may be necessary (though not always) to shut down WTGs when UAVs are operating in the vicinity. OWCs should engage with the UAS provider to identify the criteria for deciding when this is required.

It should be possible to communicate any change in WTG status or level of control to the UAS provider, and hence or directly to remote pilots, immediately.

Design features of WTGs to ensure safe control systems (e.g. as described in IEC 61508, BS EN 50308) are part of the design process undertaken by OEMs, and so are outside the scope of these requirements.

5.10 ONSHORE UAS FACILITIES

Onshore facilities that will be required include maintenance, storage and operational bases. Launch and landing site design is covered in 5.7.

38. OWCs should make provision for the onshore support infrastructure necessary to maintain UAS operations, engaging with the UAS providers and the appropriate authorities to determine requirements.

It may be possible to use existing facilities, rather than developing new onshore infrastructure specifically for the wind farm.

OWCs making onshore facilities available to UAS providers should ensure their suitability for UAS-specific aspects (fuelling facilities, storage and use of fuels and other hazardous materials, batteries and charging equipment) and for the general working environment and welfare.

Where one organisation provides the building shell, and another the maintenance service, there needs to be a clear agreement as to who will provide heating, lighting and welfare facilities. A poor working environment is a health and safety issue in its own right and can also impact the safety and quality of work on aircraft.

Compliance with regulatory minimum requirements alone will not be sufficient to ensure a safe working environment in onshore facilities.

The UAS provider and hence, potentially, the state of UAS operation and location of onshore facilities, may not have been selected at facility design phase. The national regulatory requirements may therefore not yet be known, so careful foresight and management are required to avoid potential problems.

5.11 CONSENTING

39. OWCs should ensure that any necessary safety-related consents for UASs have been obtained.

Safety-related consents required may include:

Land use/seabed development planning: planning permission may be required for UAV operations and supporting infrastructure and facilities (e.g. ops base, fuel facilities, etc.), lighting and marking of structures. These issues need to be considered as part of the planning application and environmental assessment process.

Air traffic matters: agreement with the NAA, ANSPs and other aviation stakeholders about matters such as airspace restrictions, and the level of air traffic and CNS service provision.

Telecommunications: frequency allocation.

Safety (and environmental) consents: for fuel storage and delivery systems, storage of dangerous goods and other hazardous materials (if not already covered under the land use planning/environmental impact assessment process).

5.12 INTEGRATION WITH OTHER ACTIVITIES

As noted in 2.7, activities that can interact with UAS operations include helicopter and other aircraft operations, the use of cranes and jack up barges, vessel movements and the construction or removal of structures.

40. OWCs should develop a Concept of Operations (CONOPS) and/or SIMOPS document setting out the relationships between UAS and other activities, ensuring deconfliction.

Typical named roles that will need to be defined include Aviation Co-ordinator, Marine Co-ordinator or Duty Operations Manager.

Specialist aviation expertise will usually be required to develop the CONOPS and provide the co-ordinator function. An aviation specialist should advise on and review or sign off any CONOPS and SIMOPS, even if they do not develop them. (OWCs typically have a large number of sites with a small central team of aviation specialists to advise on or approve locally developed procedures and documentation.)

6 REQUIREMENTS – PROVIDING UAS SERVICES

This section covers the approach to providing UAS services, either by contracting out, or by OWCs operating UASs themselves.

Where the OWC is itself the UAS provider, similar requirements will apply in how the OWC as a client engages with the internal UAS operation function or department.

41. Where the OWC is itself the UAS provider, the relevant OWC department or function should follow the requirements in this GPG themselves, with internal oversight from the OWC's aviation department.

Appropriate modifications may be needed to the implementation of the requirements to reflect the differences in organisational relationship when the UAS provider is an internal entity rather than an external contractor. For example, a pre-qualification process may not be necessary. Nevertheless, the principles are the same. Typically, the OWC's centralised Aviation department should conduct oversight of the OWC's internal UAS operators which may be operating at multiple remote sites. To ensure alignment with good practice, the centralised Aviation Department should develop and maintain common standards, procedures, and processes for UAS operations.

An internal UAS provider will need additional competence in relation to technical and operational details, beyond the requirements for the OWC as 'intelligent customer' as described in Requirement 15. They will, for example, need to understand the local regulatory arrangements and liaise with the relevant NAA, and be able to interpret and implement more formal and detailed safety guidance, such as that in IOGP 696 or FSF-BARS.

Oversight should include all aspects of the UAS – see 2.1.

6.1 SAFETY EXPECTATIONS ON UAS PROVIDERS

42. OWCs should clearly define their safety expectations and share them with potential and existing UAS providers.

OWCs should ensure that the provider has a robust, credible, high-quality and appropriate SMS. Key indicators to use include:

a) Clear governance, organisational structure and roles and responsibilities for safety.
b) Evidence of informed senior management leadership on safety.
c) Relevant approvals from the NAA. Holding such approvals requires the provider to have certain additional safeguards in place, but does not in itself guarantee safety – it is a necessary but not sufficient criterion.
d) Demonstrable qualifications, training, competence and experience in the specific intended activities, with arrangements for maintaining training and competence.
e) Have UAS crew who will need to go offshore completed accredited minimum safety training (e.g. GWO – https://www.globalwindsafety.org/)?
f) Compliance with relevant good practice. Are any deviations justified, risk assessed and recorded?
g) Satisfactory internal and external audit reports.

h) Accident/incident records, and how lessons have been learned and implemented. These will provide indications of the safety culture as well as of any specific safety topics of concern. An unusually large number of serious incidents would be a red flag, but so too would very few records of near misses and safety concerns, as this may indicate a poor reporting culture.

i) External certification to relevant standards, such as ISO 45001 or OHSAS 18001 (health and safety) and ISO 9001(quality) and/or industry-specific auditing schemes, such as described in FSF BARS RPAS.

j) Evidence of how safety performance is monitored and evaluated.

k) Company resilience and financial stability.

l) Appropriate SMS documentation including:
   - a health and safety policy and a UAS policy (see 4.1),
   - overarching and task-specific risk assessments (see 3.5),
   - an Operations Manual in line with regulatory requirements or guidance – see for example the content relating to operations manuals in UK CAA's CAP 722 (https://www.caa.co.uk/publication/download/21784) and the template operations manual, for Specific category UAVs, in CAP 2606 (https://www.caa.co.uk/our-work/publications/documents/content/cap2606/),
   - standard operating procedures (SOPs),
   - operational checklists (if not included in the Operations Manual),
   - inspection and maintenance procedures, and
   - emergency procedures.

Care will be needed to set appropriate boundaries on what the OWCs should require from UAS providers. For example, it would be appropriate for an OWC to require an effective inspection and maintenance programme to be in place. But unless the OWC has detailed knowledge of UAV technology and reliability, decisions about how often each component of a UAV needs to be inspected should be left to the (competent) UAS provider.

References on SMS include:

- The ICAO Safety Management Manual Doc 9859 — Safety Management Manual (SMM) (icao.int) although this has a lot of content more relevant to crewed aviation, and is a long (nearly two hundred page) document.
- https://www.bsee.gov/sites/bsee.gov/files/ren-sms-expectations-march-2023.pdf, which gives an overview of SMS expectations for offshore renewables in the USA.

43. OWCs should consider whether, to help UAS providers develop appropriate procedures and documentation, it would be helpful to give them examples and templates.

To illustrate the expected content of key safety documentation, OWCs could give the contractor examples and templates, such as those in the Annexes of this GPG. If so, OWCs will need to emphasise that these are not simply to be copied or filled in with minimal changes: providers will need to think carefully about the specific operations and their contexts.

6.2 SELECTION OF UAS CONTRACTORS

This subsection applies where UAS services are contracted out. The selection of suitably qualified and experienced contractors is fundamental to safety.

44. OWCs should establish the suitability of potential UAS contractors.

In the prequalification and tender process, OWCs should ask how the safety expectations (6.1) will be met, with evidence of the provider's track record in doing this.

Depending on the level of risks involved in the proposed UAS applications, and whether the OWC has prior experience with a contractor, it may be advisable to carry out pre-selection interviews, audits or inspections as well as questionnaire-based assessment.

Alternatively or in addition, OWCs could look for independent, industry scheme approvals, such as audit and registration under the BARS Program.

An illustrative example of the safety sections of a pre-qualification questionnaire (PQQ) is given in Annex F.

45. OWCs should filter out any UAS contractors that do not meet minimum safety criteria, and then assess the remaining candidates using an appropriate mix of safety and other criteria.

OWCs should **not** create a shortlist of 'safety-approved' bidders and then select purely on price and other criteria. The aim is to eliminate unacceptable bidders first but then take safety into account further when deciding between those that remain. This will help to eliminate any commercial pressure to accept the cheapest bid.

Where a weighted sum scoring system is used, the aim can also be achieved by setting a mandatory minimum safety score, such that an unacceptable safety score cannot be outweighed by good performance against other criteria.

6.3 INFORMATION TO TENDERERS

46. OWCs should provide tenderers with a clear description of the services and flexibility required, site layout, and specific hazards.

A clear definition will help tenderers understand the OWC's needs and provide assurance that they can meet them safely and effectively.

It is important to ensure that all parties have common, realistic expectations, in order to avoid situations where commercial/contractual pressures conflict with safety requirements. So, as well as defining the intended, routine tasks, the description should be open about where flexibility may be required, for example because in practice UAVs are likely to be re-tasked frequently and/or asked to fly multi-task sorties. It should also explain the OWC's expectations regarding availability and reliability, the provision of spares and back-up UAVs and the availability of qualified personnel to undertake repairs.

The OWC should be realistic about notice periods and other constraints on requests for changed or additional tasks, and for provision of back-ups.

6.4 CONTRACT CONTENT

This subsection applies where UAS services are contracted out. It outlines key safety-related topics that will need to be agreed between the OWC and the UAS contractor and documented in the contract or supporting technical documents.

6.4.1 UAS services required

A clear description of what services the OWC requires – see 6.3 for further detail.

6.4.2 What the OWC will provide to the UAS contractor

47. OWCs should inform the UAS contractor(s) of what supporting infrastructure and services the OWC will provide or make available.

For example, if the OWC expects the provider to use a particular onshore base, the OWC should provide information about its opening hours and what welfare and technical facilities will be available (see 5.10).

6.4.3 Roles and responsibilities

48. OWCs should ensure that there is a clear statement of the safety roles and responsibilities of the OWC, the UAS contractor and any relevant third parties.

Areas in which there are interfaces, such that particular clarity is needed to avoid gaps, duplication or misunderstandings about roles and responsibilities include:

a) inspection, cleaning and maintenance of launch/landing platforms and equipment,
b) provision and maintenance of fittings and equipment – e.g. lash-points and attachment points, lifting equipment (bags, nets, ropes, shackles, etc.),
c) aircraft coordination and control,
d) supply and quality of fuel,
e) supply of electrical charging points and their voltage, capacity, etc.,
f) provision of onshore bases, facilities and services (especially when the UAVs and the UAV base are supplied by different organisations),
g) provision of sea state and weather information,
h) communications plans and equipment,
i) emergency plans,
j) incident/accident management (e.g. first aiders), reporting, analysis and feedback,
k) communication and consultation about safety topics, and
l) monitoring, evaluation and review.

6.5 CONTRACT STRUCTURES AND ARRANGEMENTS

This subsection applies where UAS services are contracted out. It describes the different ways in which contracts can be set up between OWCs and UAS contractors and defines related requirements.

It covers the various contract structures (6.5.1), flow-down of requirements to contractors (6.5.2), regular contracts (6.5.3), ad hoc contracts (6.5.4), sharing of UAS services (6.5.6) and multiple UAS contractors (6.5.5).

6.5.1 Contract structures

Many different contracting models are in use. For example:

- Direct contract between OWC and a UAS contractor. The OWC may then arrange for the UAS contractor to provide a service to other contractors, for example delivering spare parts to a maintenance contractor.
- Subcontract via another contractor – the OWC contracting to, for example, a maintenance contractor or vessel provider, who in turn contracts to a UAS contractor.

In either of the above cases, it may well not be the UAS contractor who actually operates the UAV on site. Multiple layers of subcontracting are common, sometimes involving agents, or independent UAV pilots. For example, the arrangement could be:

OWC – UAS contractor – UAV agent – UAV contractor – UAV pilot & UAV supplier

In all options, the OWC, as the client, retains ultimate responsibility for safety.

The potential for safety issues increases with the number of contract layers between the OWC and the UAV operators on site. With a greater 'contractual distance', there will be more complexity, more possibility for gaps or misunderstandings, and the more difficult it will be to ensure effective communication, control and monitoring.

49. OWCs should aim to minimise the number of contracting layers, and the complexity of contract structure, between themselves and the actual UAV operator on site.

50. OWCs should set up effective arrangements for monitoring and auditing across and between all contract layers.

This requirement applies irrespective of the contract structure selected. For example, if the OWC has direct control of both the maintenance contractor and the UAS contractor, and provides the UAS service to the maintenance contractor:

- The OWC should monitor both the maintenance contractor and the UAS contractor.
- The maintenance contractor will need to monitor both the OWC and the UAS contractor.

51. OWCs should agree with the various parties on arrangements for oversight, monitoring and auditing.

The work involved in monitoring and auditing each other can be reduced for all parties when audits are jointly conducted and/or observed.

6.5.2 Flow-down to UAS contractors

Given the prevalence of multi-level subcontracting, contracts need to ensure that safety requirements on primary UAS contractors are flowed down to subcontractors at any level.

52. OWCs should include contract clauses to ensure appropriate flow-down of safety requirements to contractors at any level.

6.5.3 Regular operations

Contracts can be established for regular UAS operations, such as delivering parts and supplies for routine WTG maintenance. Such contracts can be based on the expected scope and volume of work, but include a mechanism for adjustment if more or less work is required in practice. This will help prevent commercial pressures adversely affecting safety.

6.5.4 Ad hoc operations

In addition to contracts for regular, routine activities as above, OWCs may need to contract out ad-hoc, one-off UAS operations for purposes such as specialist surveys or inspections and for unscheduled, urgent transportation of spares and equipment when reactive maintenance or repairs are needed.

The standards of safety sought for such operations should be no different from those for routine work. To give an extreme example, an OWC must not ask a UAS contractor to do something outside their competence or qualifications 'just this once'. However, questions of reasonable practicability and proportionality arise regarding how far the OWC can go in qualifying, selecting and monitoring a contractor for a one-off operation.

53. For ad hoc UAS contracts, OWCs should ensure as a minimum that a competent aviation specialist carries out a risk assessment of the UAS operation required, in its operational and environmental context, taking account of the competence of the contractor.

6.5.5 Multiple UAS providers

54. OWCs should identify and manage the potential safety implications of multiple UAS providers on one site.

Complexity increases if more than one UAS provider is working in the same airspace, and careful management will be needed to prevent risk increasing too. Areas for particular attention include compatibility between operators in relation to:

- coordination of UAV activities,
- expectations on the OWC and others, and
- communications technologies (proliferation of different means of communication, and lack of interoperability between, for example, vessels, aircraft and wind farm personnel is already an issue).

6.5.6 Common or shared UAS services and assets

As well as the multiple UAS provider case described in 6.5.5, there may be situations in which:

- One UAS company is providing a service to more than one OWC, so that, for example, they can transport cargoes to different wind farms.
- Assets (such as launch/landing platforms) are shared with neighbouring wind farm OWCs, or other parties such as oil and gas operators.
- Shared use of vessels or onshore bases (these may be provided by the OWC, a UAS provider or another party).
- Sharing of support services and facilities, such as for training.

Such arrangements can have safety benefits in terms of enabling better resource use and in maintaining the experience and recency of personnel. It may also have financial benefits, from economies of scale and more efficient use of resources.

55. OWCs should, in liaison with the UAS provider(s) and other clients involved, identify and manage the potential safety implications of common or shared services and assets.

Areas for particular attention include:

- Compatibility of safety requirements between different OWCs.
- Compatibility of different tasks assigned to a shared flight.
- Clarity of responsibilities for monitoring and auditing, and agreements regarding sharing of findings.
- Potential for conflicting commercial pressures on the UAS contractor: how tasks will be prioritised, especially in the event of delays, diversions or operational problems.
- Inter-site coordination of aviation activity and communications.

The adoption of common standards, procedures and approaches, such as those in this GPG itself, will be helpful in ensuring the safety of shared services and assets.

6.6. DOCUMENTING THE CONTRACT SPECIFICATION

This subsection applies where UAS services are contracted out.

56. OWCs should capture all of the points considered in 6.1 to 6.5 in a consolidated, detailed requirements document.

Such a document is often referred to as 'Employer's Requirements'. The Employer's Requirements should clearly articulate the safety expectations before a contract is issued.

It is important that competent UAS expertise, e.g. from the aviation specialist, is involved in developing this document.

OWCs should recognise the safety and operational constraints on UAS providers when setting Employer's Requirements, in order to ensure that there is no pressure to compromise on safety.

An example of the safety-related elements of an Employer's Requirements document is provided in Annex H.

Although outside the scope of this GPG, note that the Employer's Requirements may also be a convenient place to specify operational and commercial factors such as the number and nature of flights to be provided, cargo capacity, availability and response times.

7 REQUIREMENTS – TRIALS

Trials should not only be conducted at the end of the design and contracting process, as a 'final check'. Rather, they should be integrated into the design, informing it iteratively, and thus helping to ensure safety.

57. OWCs should use trials to validate, learn and improve safety.

A 'crawl, walk, run' approach to trialling and introducing UASs will help to minimise safety (and project) risks. For example, trials can be conducted onshore first and then offshore.

Topics that may be explored in trials can include:

- aerodynamics: how WTGs and other structures may affect air flows in their vicinity, and hence the flight of UAVs,
- adequacy of visual cues, lighting and marking for remote pilots,
- the 'flyability' of approach, departure and transit paths, and
- proof of concept or validation of specific tasks.

Many of the hazards in trials will be the same as in normal operations (Section 8) and the requirements in that section will also apply. However, hazards, risks and safety requirements for trials can be different from those for routine operations. For example, a trial may be conducted in closed airspace, with no other aircraft in the vicinity, reducing the inherent risk. On the other hand, a trial before wind farm infrastructure and communication are fully in place, may in some respects have higher risk.

58. OWCs should identify and manage any hazards specific to the trial in its context.

It is not necessarily possible to extrapolate a successful trial of an operation to routine, commercial-scale use.

59. OWCs should be cautious in drawing conclusions about the safety of commercial-scale operations from trials.

The risk in commercial, full-scale operation may be higher. For example:

- Trials may be conducted in closed airspace, with no other aircraft in the vicinity.
- Weather conditions on the trial day(s) may be more benign than those that may occur in round-the-year operation.
- Other things being equal, the workload on remote pilots, ground crew, co-ordinators and others will increase when the trialled operation is carried out more frequently. Even if the crew complement is increased pro rata, additional co-ordination will be necessary.
- Trials are often conducted with a different UAV to one that will be deployed. In contrast to the helicopter world, where there are only a few manufacturers and models and a slow rate of development, UAV types and models are numerous and being introduced at a high rate.

– The reliability/failure rate for a trial UAS is likely to be different from that of a commercially deployed system. On the one hand, the commercial system is likely to undergo more frequent use cycles and may have a lower level of maintenance/inspection. These factors will tend to increase the likelihood of failure. On the other hand, if the trial involves new technology, the likelihood of failure may (gradually) become lower for a commercial system, as problems become evident and are resolved.

8 REQUIREMENTS – NORMAL OPERATIONS

This section provides requirements for safety management in day-to-day planning and execution of normal UAS operations during construction, O&M, modification or decommissioning.

In most cases, ensuring normal operations safety involves making sure that the risk control provisions (asset and equipment features, procedures, role definitions, etc.) designed into the system (Section 5) are properly implemented in practice. This is an essential of safety management in all industries – it involves generic activities such as completing regular activity plans and logs, disseminating safety information and processing incident reports.

8.1 DAY-TO-DAY MANAGEMENT

60. OWCs should ensure that there is effective day-to day management of UAS activity.

Depending on the extent and nature of UAS operations, a dedicated supervisor/co-ordinator role (see Requirement 17) may be needed. Typical tasks would include, but not be limited to:

a) Acting as the key point of contact and general liaison with UAS providers.
b) Planning and managing UAS operations, schedules and tasking, coordinating (via any marine coordinator) with vessel activities and SIMOPS.
c) Live management of UAS activities and movements: the principal issue is maintaining separation in time and distance between UASs, and between UASs and crewed aircraft, as well as (non-air traffic control) communications with remote pilots and support crew.
d) Ensuring that only UAS crew with the required training and competence are booked.
e) Raising manifests for dangerous goods and other cargo.
f) Ensuring that the correct lifting bags and accessories are provided, correctly used, and inspected and maintained.
g) Maintaining records of flights, including e.g. sectors flown, flying hours, numbers of landings, aircraft availability (delays and causes), battery status, incidents and accidents.
h) Tracking the status of infrastructure such as weather instruments and fuel systems and ensuring that required maintenance is carried out.
i) Regular reporting to management on performance, ongoing work, any issues and lessons learned.

8.2 SOFTWARE UPDATES

The potential impacts and risks associated with UAS software updates need to be considered. Even in the more heavily regulated, certified world of helicopters, software updates cause challenges. In the UAS world this is amplified.

61. OWCs should ensure that UAS providers have, and apply, effective, documented procedures to manage software upgrades and modifications.

This procedure should include, for example, checking whether changes could have a negative effect on operations, test flights following upgrade, and recording all changes in the aircraft maintenance logbook.

8.3 MONITORING AND SUPERVISION OF NORMAL OPERATIONS

Monitoring and supervision by aviation specialists will be required, involving both:

- Periodic on-site checks on UAS operations, against specified safety performance requirements.
- Oversight of safety management more generally – e.g. auditing to establish whether operations manuals and RAMS are up to date.

It applies to both the UAS provider's systems and activities, and any aspects of the UAS for which the OWC is responsible, such as launch/landing platforms.

62. OWCs should develop and implement appropriate systems for monitoring and supervision of the UAS provider's activities.

Monitoring and supervision may be a requirement of regulatory permission.

An accountable manager could be allocated to monitoring and supervision of the UAS provider. The level of supervision and responsible person will be for the OWC to decide, but suitable persons could for example be a Duty Operations Manager, Construction Manager, Site Operations Manager or equivalent.

63. OWCs should develop and implement a regular inspection and maintenance programme for OWC-provided infrastructure and systems.

As just one example, inspection of launch/landing platforms on WTGs should include checking for:

- foreign object debris,
- surface contamination, e.g. by ice, snow, fuel or oil spills or guano,
- surface condition: non-slip, spalling paint, pitting, etc.,
- visibility of markings,
- functioning of all systems: status lights and other lighting, fire-fighting meteorological equipment, fuelling or charging systems,
- security of handrails, safety netting, etc., and
- any infringements of obstacle surfaces.

9 REQUIREMENTS – ABNORMAL CONDITIONS AND EMERGENCIES

Emergencies are events or conditions that present a significant, immediate danger to persons.

Abnormal conditions are non-routine situations which do not present sufficient immediate risk to constitute an emergency. However, they may increase risk directly, or by escalating, or because the resulting operational anomalies, delays or difficulties increase workload and stress on personnel.

There is no universally agreed set of criteria for deciding at what point an abnormal condition becomes sufficiently serious to be treated as an emergency, but the principles are similar for managing either. OWCs will in general have their own procedures and criteria setting out, for example, the points at which external emergency services need to be alerted or called out.

Examples of abnormal conditions (which may also be, or become emergencies) include:

- loss of control of a UAV,
- UAV fuel shortage or battery exhaustion,
- fire or damage to UAV batteries, fuel systems or other hazardous materials,
- an unserviceable UAS parked on a platform,
- an unauthorised UAV entering the project airspace,
- a ditched UAV: this may need to be recovered from on or below the sea surface, incurring hazards to those involved in recovery,
- a 'dead' or jammed WTG, in which the nacelle or blades cannot be placed and braked in the required configuration for UAV approach,
- loss of WTG control,
- hazards to the UAV pilot or medical emergency (and what are the contingencies in terms of ensuring safe flight if this happens while a UAV is in operation?)
- loss of communications,
- loss of power, and hence of platform lighting, and
- incorrect platform status indication provided to pilots.

64. OWCs should identify potential abnormal conditions and emergencies, working with the UAS provider(s) and other interested parties to ensure that appropriate preventive measures and emergency plans are in place.

65. OWCs should ensure that reporting arrangements for abnormal conditions and emergencies – who should report what, and to whom – are clearly defined, included in contracts and understood by all.

For example, in the case of a fly away or loss of control the immediate priority is to warn airspace users and other exposed persons in the vicinity.

Depending on the circumstances and the nature of the condition or event, external bodies, such as the NAA or other regulators may need to be informed. The OWC will need to understand the reporting criteria set by such bodies.

Lines of reporting will depend on the contractual set up and practicalities of communication. It is important to be clear about this, to avoid confusion caused by double reporting, or omission of a report.

A key reference for emergency response is the G+ Integrated Offshore Emergency Response (IOER) GPG.

66. OWCs should follow the G+ IOER requirements.

Key topics covered in the G+ IOER are as follows:

- principles of emergency preparedness and response (e.g. clarity of lines of command, control and communication, escalatory response, alignment of emergency plans between parties, arrangements for co-operation and co-ordination),
- statutory authority, legislation, guidance and responsibilities,
- planning for emergencies,
- conducting emergency response,
- training and measuring performance, and
- learning from exercises and incidents.

An example of emergency procedures is in Annex F.

10 REQUIREMENTS – CONTINUAL IMPROVEMENT

Continual improvement activities include:

- proactive consultation with personnel (noting that this is different from top-down communication to personnel),
- reporting, investigation and monitoring of safety concerns and incidents, and other proactive and reactive KPIs,
- learning from experience, positive and negative,
- audits, and
- management reviews.

Good practices in relation to these will mostly be similar to those for safety management in general. However, some key points for OWCs that are specific to UAS operations are noted as follows.

10.1 INCIDENT REPORTING AND LEARNING FROM EXPERIENCE

A weakness in current systems is that, even where there are national or regional schemes (e.g. European Co-ordination Centre for Accident and Incident Reporting Systems (ECCAIRS) in Europe), the information recorded is often insufficiently granular and detailed for the specific needs of an industry subsector, such as UAS use in offshore wind. Additionally, there is minimal cross-industry sharing of reports involving incidents related to interfaces, such as between UAS and WTG. Examples include UAS battery fires or a lack of coordination between UAS and crane operations .

As noted in 2.10 the use of UASs in the wind industry is relatively new and changing rapidly. Incident reporting schemes have not been long in place. UAS provider involvement with onshore wind can be transient or intermittent. Consequently, there is a lack of good safety information, and the gathering, monitoring, evaluation and sharing of incident data and learning from experience are of particular importance.

67. OWCs should encourage and improve systems for feedback and learning from incidents.

Practical actions that OWCs can take include:

a) Requiring UAS providers to report incidents and accidents to the relevant competent aviation authorities (e.g. NAAs, EASA or FAA).

b) Making use of, and contributing to, industry reporting schemes for the wind energy and related sectors. The G+ scheme (https://www.gplusoffshorewind.com/work-programme/hsestatistics) and the EI Toolbox https://toolbox.energyinst.org are particularly relevant. Helioffshore also has a safety intelligence programme (HeliOffshore Safety Intelligence Programme (HSIP) — HeliOffshore). Using keywords such as UAS, UAV, drone or aviation will help users searching for and analysing such reports.

c) Promoting a positive safety culture (see for example the ICAO SMM (Doc 9859 — Safety Management Manual (SMM) (icao.int) (also referred to as a just culture) to encourage open reporting (as well as for its wider benefits).

d) Ensuring that personnel are aware of confidential incident reporting/ whistleblowing schemes such as CHIRP Aviation and/or Marine (https://chirp.co.uk/).

e) Encouraging reports of safety-related occurrences even where no harm occurred and correct procedures were followed – e.g. UAS system health warnings, even if these were detected and remedied before flight.

f) Collecting baseline (denominator) data, e.g. UAV sectors flown/movements, flying hours. Such data are essential in order to calculate and compare accident/incident rates or frequencies rather than just absolute numbers of events.

g) Liaising with UAS providers to ensure that opportunities to use flight data monitoring (FDM) to learn and enhance safety are being taken. The important point for OWCs to ensure is that the operator uses FDM as effectively as possible, to detect trends or problems. FDM usage in UASs is not as mature as in crewed aviation: data are collected but not in a unified way, and not as well-used to identify deviations. The number or rate of parameter value exceedances leading to alerts is not necessarily important in itself, since alert thresholds can be defined at different levels to detect different issues.

h) Inviting and being open to capture of learning relating to OWC contracting and oversight processes, as well as day-to-day operations. This can be done regularly throughout the contractor's involvement on longer contracts, and as part of the close-out of their scope of work.

10.2 AUDITS

Generic audits against widely-applicable standards such as ISO 9001 (for quality) or ISO 45001 (health and safety) are unlikely to give adequate consideration to the details of UAS operations Specialised aviation audits should be carried out in addition.

68. When developing an audit programme and engaging auditors, OWCs should ensure that specialised audits, conducted by a competent aviation specialist auditor are included.

An illustrative example of specialised UAS audit topics is shown in Annex I.

ANNEX A
GUIDELINE DEVELOPMENT METHOD

A.1 PRINCIPLES

The principles for development of this GPG were that it should be:

- User-focussed: identifying and meeting the needs of the wind industry audience. It should be practical, highly useable, and of a manageable length.
- Aligned with the experience of stakeholders (and thereby making it more likely to be followed in practice).
- Accessible to all, including UAS providers who are not experienced in safety management and readers for whom English is not a first language. Country-specific terminology, detailed descriptions of legal/regulatory arrangements, and excessive use of technical terms, jargon or abbreviations have been avoided.
- Comprehensive but concise: filling gaps and signposting other guidance rather than duplicating material, or risking 'message creep' by too much paraphrasing or summarising of other guidance.
- Clear about its scope and relationship to other guidance, in order to avoid duplication and the risk of confusion if there are gaps or conflicting messages.
- Aligned and compatible with other G+ GPGs in terms of content, style and structure.
- Future-proofed, so far as possible. So, for example, the requirements avoid reproducing or referring to the details of specific regulations or standards (as these may be updated), but instead point to where the latest versions can be found.

A.2 DEVELOPMENT METHOD

The development of the GPG involved:

- literature review/workshops,
- regular WG meetings, and
- stakeholder engagement with the wider industry, via issue of a consultation draft of this GPG.

The requirements are currently based mainly on material and experience from regions and countries with the highest levels of installed capacity (e.g. Europe), which therefore have the most experience, and generally more mature safety regulation and practices. The availability of material in the English language has also been a factor.

Where a requirement is based only on a specific country's requirements or practices, this is noted.

A.3 LEVEL OF DETAIL

The requirements are at a high level, applicable to UAS activities of various types and in different contexts and locations. It would not be practicable, or indeed desirable, to develop detailed, prescriptive requirements on all topics. Differences in, for example, national regulations and in site-specific and project-specific factors mean that each situation should be considered on its own merits.

A.4 RELATIONSHIP WITH GOOD/BEST PRACTICE AND ALARP

The requirements set out G+ recommendations for good practice and are not merely 'nice-to-haves', and 'good practice' is not necessarily 'best practice'. G+ encourages OWCs to go beyond the requirements where reasonably practicable, in accordance with the ALARP principle, as stated in Requirements 1, 13 and 14.

In the UK at least, the ALARP principle is enshrined in law: 'relevant good practice' sets a baseline, but further improvement to safety can only stop when the cost of any additional measures becomes grossly disproportionate to the safety benefit – see Expert guidance on risk management – HSE. While this is a UK-specific view of ALARP, G+ recommends that the same approach should be taken by members in all jurisdictions.

A.5 RELATIONSHIP WITH OTHER GUIDANCE

This GPG is intended to stand as a self-contained document, rather than being part of, or needing to be read alongside, other documents. However, for brevity and to avoid the danger of distorting meanings, it signposts and references existing documents rather than quoting or attempting to summarise or paraphrase extensive content from other sources.

Unless there is good reason for differences (and recognising that diversity of approaches also has benefits), it is generally beneficial to have consistent approaches and expectations across the industry. We have therefore avoided creating new or different content except where a specific need was apparent.

ANNEX B
COLLATED LIST OF REQUIREMENTS

No	OWCs should…	Section
Generic – all lifecycle stages		
1	Identify, and as a minimum comply with, all applicable local legal duties (both explicit and implicit), regulatory requirements, guidance and expectations	3.1
2	Consider the relevance of risks outside the scope of this GPG (as set out in Table 1), and where appropriate, identify and manage them	3.1
3	Continually review how safety could be improved	3.1
4	Consider the safety of the whole UAS system, in its operational and environmental context and taking account of interfaces with interested parties	3.2
5	Identify all interested parties and understand their safety needs and expectations	3.2
6	Not assume that UAS providers will have a mature or robust SMS, and should be prepared to explain concepts and expectations clearly	3.3
7	Take opportunities to contribute to the education and development of UAS providers	3.3
8	Identify, and engage as appropriate with, all relevant regulators and other authorities	3.4
9	If operating in, or obtaining services from, more than one state, ensure that they, and their UAS providers, have identified all relevant national requirements and understand how to comply with them	3.4
10	Ensure that the implications of any differences between the requirements of different regulators or other authorities can be satisfactorily resolved	3.4
11	Ensure that suitable and sufficient risk assessments, specific to each planned UAS operation and its operational and environmental contexts, are carried out	3.5.1
12	Ensure that UAS providers and UAV operators understand that the OWC will need time to review the risk assessment	3.5.1
13	Follow the risk assessment principles in Table 3	3.5.2
Preparing to provide a safe system		
14	State their overall aims and commitments regarding safe integration of UAS operations, and the high-level means by which they intend to achieve them, in a suitable policy	4.1
15	Ensure that they have appropriate internal functions, roles and responsibilities, competencies, policies, arrangements and procedures in place, including access to suitably qualified and experienced aviation specialists	4.2

No	OWCs should…	Section
16	Consolidate aviation competence and avoid dividing aviation specialists into separate groups such as for crewed or uncrewed aviation	4.2
17	Ensure that they have resources and competences in place for day-to day management of UAS activity	4.2
Planning and design		
18	Decide how, where and when UASs are to be used, in line with their policy, as part of the planning and design of any wind project	5.1
19	Where possible, aim to ensure that wind farm design facilitates the use of UASs for SAR, and other external parties, even if they do not intend to use UASs themselves	5.1
20	Where possible, seek early involvement of UAS providers in the planning and design of the wind farm	5.2
21	Check that they understand the suitability of the UAS(s) offered by any supplier or contractor	5.3
22	Unless their aviation specialists have in-depth knowledge of the market, make initial requests to potential UAS suppliers or contractors in terms of proposed applications and safety requirements, rather than by directly asking for a specific UAV type	5.3
23	Work with UAS providers to ensure that comprehensive and appropriate procedures and other operational documents are developed and in place	5.4
24	Ensure that there is clarity about responsibilities for providing information, and the parameters and thresholds that will be used to define weather and other limits on UAS operations	5.5
25	Be aware and take account of environmental constraints when setting operational performance targets	5.5.1
26	Consider and implement additional safety measures for night and low visibility operations	5.5.2
27	Keep UAS providers updated with information on wind farm operational factors that may affect safety	5.5.3
28	Consider the layout of the farm, including all existing and planned structures around UAS routes and destinations, that could impact on safety	5.6
29	Engage as early as possible with UAS providers, NAA, aviation specialists and SAR providers regarding wind farm layout	5.6
30	Consider the effects of layout on UAS (and other) operations at neighbouring wind farms, and potential cumulative effects, as well as those for the proposed wind farm itself	5.6
31	Where possible, consider the obstacle environment presented to UAVs (and other aircraft) as a factor in planning and design of wind farm layout	5.6.1
32	Ensure that obstacle locations, height and size are notified to UAS providers and aeronautical chart and database providers	5.6.1

No	OWCs should…	Section
33	Take account of the requirements of any UASs used for SAR in the design of the wind farm	5.6.2
34	In designing launch and landing areas on offshore assets, consider design (and hence operational) aspects that can affect the safety of UAV operations and of the personnel who will need to be present	5.7
35	For UAV operations to vessels or floating WTGs, establish how wind and sea state conditions may affect UAV operations	5.7
36	Engage with the relevant NAA(s), ANSP(s), UAS providers, SAR authorities, and other airspace users at the earliest opportunity, to ensure that all relevant airspace, ATM and CNS issues are understood and addressed. This should cover UAV activities within the wind farm and in transit to and from land or other offshore destinations	5.8
37	Develop robust means for, when necessary, shutting down and restarting the relevant WTGs for UAV operations, and for communicating WTG status to pilots	5.9
38	Make provision for the onshore support infrastructure necessary to maintain UAS operations, engaging with the UAS providers and the appropriate authorities to determine requirements	5.10
39	Ensure that any necessary safety-related consents for UASs have been obtained	5.11
40	Develop a CONOPS and/or SIMOPS document setting out the relationships between UAS and other activities, ensuring deconfliction	5.12
Providing UAS services		
41	Where the OWC is itself the UAS provider, the relevant OWC department or function should follow the requirements in this GPG themselves, with internal oversight from the OWC's aviation department	6
42	Clearly define their safety expectations and share them with potential and existing UAS providers	6.1
43	Consider whether, to help UAS providers develop appropriate procedures and documentation, it would be helpful to give them examples and templates	6.1
44	Establish the suitability of potential UAS contractors	6.2
45	Filter out any UAS contractors that do not meet minimum safety criteria, and then assess the remaining candidates using an appropriate mix of safety and other criteria	6.2
46	Provide tenderers with a clear description of the services and flexibility required, site layout, and specific hazards	6.3
47	Inform the UAS contractor(s) of what supporting infrastructure and services the OWC will provide or make available	6.4.2
48	Ensure that there is a clear statement of the safety roles and responsibilities of the OWC, the UAS contractor and any relevant third parties	6.4.3

No	OWCs should…	Section
49	Aim to minimise the number of contracting layers, and the complexity of contract structure, between themselves and the actual UAV operator on site	6.5.1
50	Set up effective arrangements for monitoring and auditing across and between all contract layers	6.5.1
51	Agree with the various parties on arrangements for oversight, monitoring and auditing	6.5.1
52	Include contract clauses to ensure appropriate flow-down of safety requirements to contractors at any level	6.5.2
53	For ad hoc UAS contracts, ensure as a minimum that a competent aviation specialist carries out a risk assessment of the UAS operation required, in its operational and environmental context, taking account of the competence of the contractor	6.5.4
54	Identify and manage the potential safety implications of multiple UAS providers on one site	6.5.5
55	In liaison with the UAS provider(s) and other clients involved, identify and manage the potential safety implications of common or shared services and assets	6.5.6
	Capture all of the points considered in 6.1 to 6.5 in a consolidated, detailed requirements document	6.6
Trials		
57	Use trials to validate, learn and improve safety	7
58	Identify and manage any hazards specific to the trial in its context	7
59	Be cautious in drawing conclusions about the safety of commercial-scale operations from trials	7
Normal operations		
60	Ensure that there is effective day-to day management of UAS activity	8.1
61	Ensure that the UAS providers have, and apply, effective, documented procedures to manage software upgrades and modifications	8.2
62	Develop and implement appropriate systems for monitoring and supervision of the UAS provider’s activities	8.3
63	Develop and implement a regular inspection and maintenance programme for OWC-provided infrastructure and systems	8.3
Abnormal conditions and emergencies		
64	Identify potential abnormal conditions and emergencies, working with the UAS provider(s) and other interested parties to ensure that appropriate preventive measures and emergency plans are in place	9
65	Ensure that reporting arrangements for abnormal conditions and emergencies – who should report what, and to whom – are clearly defined, included in contracts and understood by all	9
66	Follow the G+ IOER requirements	9

No	OWCs should…	Section
Continual improvement		
67	Encourage and improve systems for feedback and learning from incidents	10.1
68	When developing an audit programme and engaging auditors, ensure that specialised audits, conducted by a competent aviation specialist auditor, are included	10.2

ANNEX C
REVIEW OF CURRENT RISK ASSESSMENT PRACTICE

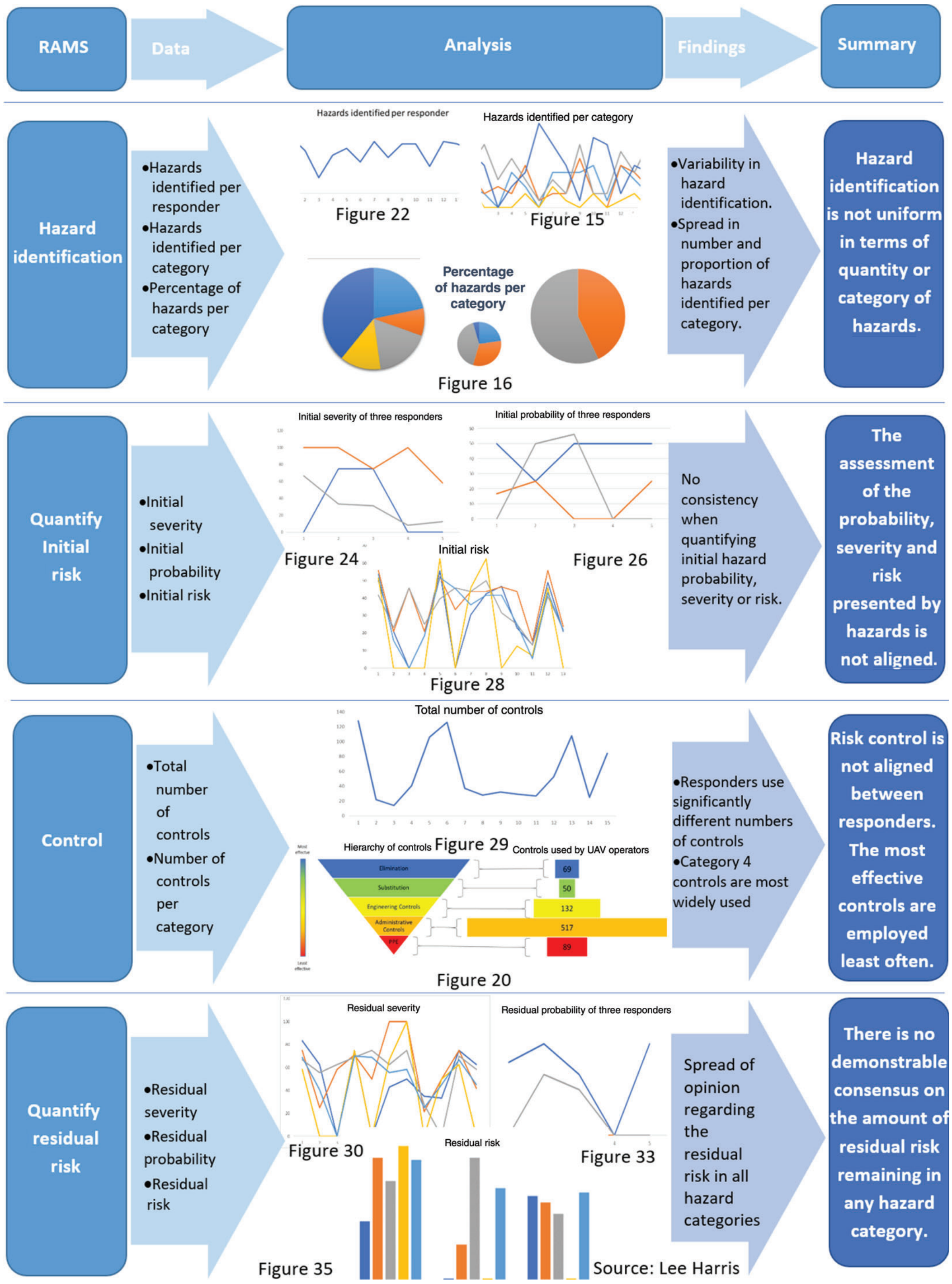
Acknowledgement: *This Annex is based on content kindly supplied by Lee Harris (currently at SGRE), summarising his (unpublished) MSc research thesis at City University, London.*

The wind industry uses UAVs extensively for inspection flights. As an industry undergoing considerable organic growth, deploying new technologies, growing in new markets and exploring ways to use UAVs in new roles such as cargo delivery, it is a market of significant interest and opportunity for operators of UAVs and wind farms alike.

With these opportunities come new challenges. The construction of larger windfarms with bigger wind turbines in ever more remote locations being developed in new regions, coupled with new roles for UAVs presents a rapidly evolving situation, meaning the emergence of new and developing hazards. For UAV operators to serve the growing wind industry demand, they must meet the requirements of the large multinational entities that typically manage wind farms, and of the safety regulators, and demonstrate the ability to manage not only current but new and emerging hazards.

A review of risk assessments by UAV operators in the on- and offshore wind industry highlighted the variability in approach. Qualitative analysis of the hazard distribution across risk categories showed no alignment between respondents and highly varied hazard identification. Quantitative analysis showed pronounced differences in both the number and severity of hazards identified as well as little to no repeatability of the effectiveness of hazard controls. Analysis showed that weaknesses were evident at each stage of the risk analysis.

An overview of the analysis and findings is shown in Figure C1 following:



Key to this review was the focus on the validity and reliability of the risk assessments, rather than their execution or predictive accuracy. Clear and significant differences were found in hazard identification, initial hazard quantification, hazard treatment and residual hazard quantification.

A risk assessment can be said to be reliable if it produces the same results when repeated by other teams. It can be said to be valid when it describes the operation that it is attempting to describe (Aven and Heide, 2009; Goerlandt, Khakzad and Reniers, 2017). It was apparent that neither of these criteria, validity or reliability, are currently being met.

References

Aven, T. and Heide, B. (2009) 'Reliability and validity of risk analysis', Reliability Engineering and System Safety, 94(11), pp. 1862–1868. doi:10.1016/j.ress.2009.06.003.

Goerlandt, F., Khakzad, N. and Reniers, G. (2017) 'Validity and validation of safety-related quantitative risk analysis: A review', Safety Science, 99, pp. 127–139. doi:10.1016/j.ssci.2016.08.023.

ANNEX D
A SIMPLE RISK ASSESSMENT APPROACH

As noted in 3.5.3, a simple risk assessment (i.e. simpler than the EASA or Joint Authorities for Rulemaking of Unmanned Systems (JARUS) Specific Operations Risk Assessment (SORA) approaches) may be adequate for inherently lower risk operations.

D.1 KEY HAZARDS

For UASs, the following generic set of hazards should always be considered as a minimum.

Additional hazards, specific to the particular system and context, should also be identified, for example by using structured workshop techniques such as Hazard and Operability Analysis (HAZOP) (see Table 3, principle 4).

- Collisions with people, other aircraft, vessels, structures, assets or equipment, birds.
- Dropped objects: either the UAV itself falling or a load carried by a UAV being dropped.
- Moving blades or other parts.
- Fire, electrocution and hazardous substance risks associated with UAV power sources (fuels or batteries) and cargoes.
- Disruption to other activities, e.g. by creating airspace conflict with other aircraft, distraction or electromagnetic interference.

D.2 ILLUSTRATION OF THE ICAO SMM APPROACH

The approach illustrated here is in accordance with that described in the ICAO SMM – Doc 9859 — Safety Management Manual (SMM) (icao.int)

This is widely used in crewed aviation, and so – subject to some important caveats – is suggested as a suitable for UASs.

It is based on scoring the likelihood and severity of events that may result from each hazard on scales of 1 to 5, and multiplying these to obtain a risk rating. This rating can then be used to identify and prioritise the highest risks. The method is described in more detail in the SMM. This Annex does not repeat that description, but presents a template for and illustrative example of the use of the ICAO SMM approach.

The caveats are outlined within Table 3 – see especially items 5 and 6, which identify common failings in applying risk matrices.

It is important to remember, that however simple or complex the assessment, and whatever risk assessment tools and techniques are used, the principles set out in Table 3 should be followed (Requirement 13).

Illustrative simple risk assessment

In order to focus attention on the assessment approach itself, rather than distracting the reader with UAS-specific considerations, we have deliberately provided (fictitious) example content for an activity unrelated to UAS operations: driving a car on a business trip.

Assessment details		
Project:		
Site/Activity/Date (describe what it is that you are assessing: when, where, the operational and environmental context):	Visit to review progress developing the pre-assembly harbour at XX. I need to be there for 0930 on dd/mm/yy (winter). It is a 150 km journey.	
Completed by (author):		
Others involved/consulted:		
Checked by:		
Signed:		**Date:**
Approved by:		
Signed:		**Date:**

Instructions: Company-specific instructions on who does what in the risk assessment process, any related procedures, references, etc.

			With existing controls				With additional controls				
Topic/Hazard	**Who might be harmed and how?**	**Existing controls** (with reference to evidence)	**Likelihood L (1-5)**	**Severity S (1-5)**	**Risk (L x S) (1-25)**	**Do you need to do anything else** to reduce the risk to ALARP? *	**Likelihood L (1-5)**	**Severity S (1-5)**	**Risk (L x S) (1-25)**	**Action**	**Action on**
All hazards	Driver, passengers, others	Competence of driver. Existence of driving licence has been checked by the company.	4	5	20	Yes, as most hazards could be eliminated by taking public transport instead	1	5	5	Consider whether other, safer modes of transport are practicable, noting company policy that driving should be the last resort. There is no train early enough that morning, but could they travel the night before and stay in a hotel? Take account of the environmental benefits of using public transport too. A hotel for the night before could be booked in any case, even if driving is the only option.	Driver
										Research nearby hotels and book if required.	Office Manager
Collision due to:											
Frozen windscreen and windows	Driver, passengers, others		3	5	15	Yes	2	5	10	Allow additional time to clear windows fully before setting off, as frost is likely at this time of year. Check windscreen wash is topped up.	Driver
Poor visibility	Driver, passengers, others		3	5	15	Yes	2	5	10	Allow additional time to travel at a safe speed, since fog, low sun or driving rain are likely at this time of year, and it will be dark for much of the journey.	Driver
Ice on road	Driver, passengers, others		3	5	15	Yes	2	5	10	Allow additional time to travel at a safe speed, since ice or snow are likely at this time of year.	Driver

			With existing controls				With additional controls				
Topic/Hazard	**Who might be harmed and how?**	**Existing controls** (with reference to evidence)	**Likelihood L (1-5)**	**Severity S (1-5)**	**Risk (L x S) (1-25)**	**Do you need to do anything else** to reduce the risk to ALARP? *	**Likelihood L (1-5)**	**Severity S (1-5)**	**Risk (L x S) (1-25)**	**Action**	**Action on**
Fatigue, loss of concentration, human error	Driver, passengers, others	Driver has avoided booking excessive meetings the day before and 'cleared their desk' .	3	5	15	Yes	2	5	10	Allow at least 30 mins additional time for a break on the way.	Driver
Mechanical breakdown	Driver, passengers, others	Driver has recently had car serviced and checked against statutory requirements.	2	4	8	No	2	4	8	n/a	n/a
Stranding due to extreme weather (or breakdown as above)	Driver, passengers	If extreme weather is forecast, the visit will be cancelled by the host in any case. Emergency 'grab bags' are available in the office, containing thermal blanket, first aid kit, water, chocolate, phone charger unit, warning triangle, torch, hi-vis tabard , etc.	2	3	3	Yes	2	2	4	Check weather forecast and emails the night before and in the morning. Take one of the 'grab bags' from the office.	Driver
										Check contents of grab bags are complete and in date.	Office Manager

* Give rationale – e.g. what would be best practice? Would this eliminate the hazard, or reduce the likelihood, or the consequences?

ANNEX E
SELECTION OF UAVS

This Annex gives additional detail of the selection factors introduced in 5.3, as follows:

Suitability (E.1) – does the UAS have the necessary functionality and performance for the required activities? What are its airworthiness characteristics (whether certified or not)? What are the safety-related maintenance requirements?

Resilience (E.2) – is the UAS capable of continuing to operate safely and as intended despite certain internal or external failures?

Mitigation (E.3) – in the event of a failure, what prevents the UAS from causing serious harm?

E.1 SUITABILITY

Key factors to consider in assessing the suitability of a UAS for the required range of tasks and environments which may have implications for safety, or at least need to be considered together with safety are:

- endurance (range or flying hours),
- equipment fit for various functions such as load-carrying or inspection,
- payload – can the UAV carry the required equipment for the mission?,
- performance (speed, climb-out past obstacles, etc.),
- maximum distance from the remote pilot/communications base at which the UAV can operate,
- operating capability and limitations (operational envelope) – see 5.5,
- infrastructure requirements on other systems, such as for launch/landing pads (see 5.7), for WTG shutdown when a UAV is operating within a certain distance (see 5.9),
- the ability of ground crew to handle loads and attach or stow them safely, noting that working in restricted space such as inside a UAV may create manual handling issues, and
- portability by helicopter, vessel or vehicle.

The functionality and performance of the UAS may also have an influence on risk. For example, if the UAV needs to be flown close to structures for visual inspection, higher quality lenses and sensors may enable the images to be captured at a greater distance, thus allowing a greater margin for error against collision with the structure.

E.2 RESILIENCE

Key questions are:

- Does the UAS have any single points of failure?
- What inspection and maintenance procedures are in place to ensure airworthiness and prevent failures?
- How is software integrity and security maintained?

In a little more detail, some of the failure considerations for critical system elements are as follows:

Power supply: UAVs of up to about 20 kg are usually powered by batteries. The failure of a battery would be catastrophic if the UAV has just one. Some multi-battery systems cannot withstand the failure of one battery. Similarly, fuel-powered UAVs may have a single point of failure in the event of fuel exhaustion.

Motors/engines and rotors: A failed motor or rotor in a single rotor or quad rotor UAV would cause a catastrophic failure. Aircraft with six or more rotors may be able to withstand the loss of at least one motor or rotor failure, but the limitations on this, for each specific UAV, should be checked before relying on such an assumption.

Flight control and communications: A failure of a main component such as the Inertial Measurement Unit (IMU) may be catastrophic. Some UAVs are fitted with dual or even triple redundant flight control systems. Failed control or communication systems may lead to loss of controls, with associated hazards to personnel and assets. Robust and multi-redundancy design is therefore important for these systems. Return-to-home and collision avoidance functions can assist in certain instances.

Navigation and positioning for control and positioning of the UAV, including placing limits on operating areas (geofencing) and emergency recovery procedures. Redundancy of navigation systems such as GPS is therefore important.

Warning systems: Can the remote pilot monitor the critical operational parameters? Are there visual and audible alerts to the pilot in circumstances such as poor or no GPS or control signal, low battery or fuel, or presence of electromagnetic interference?

E.3 MITIGATION

Recovery systems:

- What automated safety systems are available if the system is critically disabled? For example, is there a return to home function if battery state falls to a pre-determined level, if there is a lost communication link or GPS signal, or a loss of control?
- Can the UAV detect and avoid objects when returning home automatically?
- Is there a parachute recovery system to slow descent in the event of a power failure or loss of control?
- Will the UAV float to enable recovery if it lands on water?
- Are the recovery systems independent of other failures – e.g. will they still work in the event of total power loss?

Mass and speed: Other things being equal, the lower the mass and speed of the UAV, the less harm it will cause in the event of a collision.

Frangibility: Frangible construction and materials will also minimise harm in the event of collision. Materials vary from polystyrene type foam, carbon fibre and plastics, through to aluminium and other metals. However, there is a balance to be achieved between frangibility and the need for the UAV to withstand everyday loads in handling and flight. See also 5.6.1 on the balance between UAV frangibility and that of obstacles.

Physical protection: Are there protective guards around rotors or a latticework sphere around the UAV?

ANNEX F
ILLUSTRATIVE EXAMPLE: PRE-QUALIFICATION SAFETY QUESTIONNAIRE

This Annex provides an illustrative example of the safety-related elements of a PQQ.

As with all the 'Illustrative Example' annexes, it is essential to note that OWCs and UAS providers should not simply copy and paste such material, without considering the specific operations and hazards for their own UAS applications and contexts. For example, the illustrative questionnaire here is based on a UK source, and includes some UK-specific and EASA-specific requirements and terminology.

Some of these questions may already be asked within the OWC's standard contractor management or procurement system, but others will require a more UAS-specific approach. The aim should be to ask questions that will help differentiate safer UAS contractors, specifically in the offshore wind context. An aviation/UAS specialist is likely to be needed to help develop the sequence number (SEQ) and assess responses.

The sub-Annexes (F1, F2 …) give examples of the types of evidence that an OWC might wish to look for in order to support a 'YES' response.

TOPIC	Yes	No	Evidence sub-annex
Operational Capability:			
VLOS	☐	☐	
ELOS	☐	☐	
BVLOS	☐	☐	
Onshore	☐	☐	
Offshore	☐	☐	
Confined space/underground	☐	☐	
Night operations	☐	☐	
Congested area	☐	☐	
Pilot Competence (training, skills, experience and knowledge):			
Pilots are all fully qualified with an up-to-date regulatory permission for commercial operation, trained through a NAA-approved entity	☐	☐	D4
Pilots have all received training in how to perform the relevant tasks (e.g. aerial surveys and inspections of offshore structures	☐	☐	D4
Pilots are paid to undertake training	☐	☐	D4
Pilots have all the required knowledge and experience for the environment(s) that they operate in	☐	☐	D4
Pilots have all flown the minimum set hours within the last calendar month as defined by their operations manual	☐	☐	D4

Equipment and Asset Management:			
Use of an equipment and asset management system	☐	☐	D7
Equipment used to meet all the necessary safety standards and is suitable to operate within the relevant environment	☐	☐	D7
Airworthiness certificates for UAVs (if required)	☐	☐	D3
Ancillary equipment – e.g. for load lifting or tethering, has appropriate safety assurance documentation	☐	☐	D7
Use of UAV collision avoidance system	☐	☐	D7
General Health and Safety:			
The operator is insured up to an adequate value	☐	☐	D2
Safety management system in place	☐	☐	D5
Safety policy defined	☐	☐	D1
Safety meetings and awareness training for all employees	☐	☐	D1
Operations Manual available	☐	☐	D8
Operational Safety Case available, where required	☐	☐	D8
Personal protective equipment (PPE) provided	☐	☐	
Suitable and sufficient risk assessments in place	☐	☐	D9
Certification to ISO 45001 or equivalent	☐	☐	D6
Flight Planning:			
Pre-flight site survey assessment completed before conducting operations	☐	☐	D9
Geographic awareness of any nearby civilian and military airports, power lines, transmission masts, cranes or other obstructions	☐	☐	D9
Use of accurate and reliable real time aviation data including NOTAMs, Point-in-Space (PINS), Weather, No Fly Zones and High Intensity Radio Transmission Area (HIRTA) Zones	☐	☐	
Use of a reliable flight planning software	☐	☐	
Use or availability of a reliable unmanned traffic management (UTM) software and/or hardware	☐	☐	
Use of a reliable detection and collision avoidance system	☐	☐	
Use of geo fencing	☐	☐	
Pre-Flight Checklist – to include:			
Batteries fully charged and serviceable	☐	☐	
No unidentified helicopters or other aircraft operating in close vicinity	☐	☐	

Assessment of people or wildlife in the area	☐	☐	
Weather validation including check for turbulence	☐	☐	
Notification to local authorities where required	☐	☐	
UAV/Payload/GPS serviceable	☐	☐	
Appropriate failsafe configurations set	☐	☐	
Launch, landing and emergency landing areas designated	☐	☐	
Communications channels agreed and checked	☐	☐	
Flight Operations:			
Compliance to reginal/national Rules	☐	☐	
Compliance with NAA-approved Operations Manual requirements/guidance	☐	☐	
Minimum 2-person team for UAV control and observation (safety observer)	☐	☐	
Suitable means of communications established, (e.g. radio, mobile) between pilots and observers especially for EVLOS and BVLOS flights	☐	☐	
Check of latest Civil Aviation Authority (CAA) and EASA safety bulletins performed and reviewed by all appropriate staff	☐	☐	
Post Flight Checks:			
Damage checks on UAV/assets	☐	☐	D11
Recovery system (if applicable)	☐	☐	D11
Secure download of the data from the UAV	☐	☐	D11
Battery handling, charging and storage procedure in place	☐	☐	D11
Flight report and audit trail	☐	☐	D11
Emergency Response and Accident Reporting:			
Emergency response plan defined	☐	☐	D10
Investigation process defined	☐	☐	D10
Process in place for reporting to CAA Mandatory Occurrence Reports (MOR) and Voluntary Occurrence Reports (VOR) schemes	☐	☐	D10
Confidential reporting	☐	☐	D10
Visibility of safety statistics in the last 5 years	☐	☐	D10
Customer references:			
Evidence of satisfactory performance based on references	☐	☐	D11

ANNEX F1: COMPANY ORGANISATION AND STRUCTURE	
a) Company Name/Trading As	
b) Legal Entity	
c) Registered Address	
d) Registered Company Number	
e) NAA Registration ID, if any	
f) Website	
g) Primary Company Contact	
h) CEO/Managing Director	
i) UAV Manager/Chief Pilot	
j) Operations Manager/Director	
k) Accountable Manager	
l) Safety and Quality Manager/Director	
m) Technical and Engineering Manager/Director	
n) Commercial Manager/Director	
o) Training Manager/Director	
p) Number of Pilots	
q) Number of Observers	

ANNEX F2: INSURANCE COVER There may be multiple providers and policies for professional indemnity, public liability, the hardware itself and even Insurance Provider (IP) for payloads. Contractors should be able to expand the form, e.g. by adding rows, to allow for this.	
Insurance Provider	
Insurer Address	
Valid From	
Valid Until	
Amount of Third-Party/Public Liability	
Amount of Professional Indemnity Liability	
Combined Single Limit	
Named Co-Insured Parties	
Attach copies of insurance certificate(s) to support	
Total number of claims (last 3 years). Please outline the events to which they relate.	

ANNEX F3: AIRWORTHINESS CERTIFICATES
Provide scanned copy of relevant certificate(s).

ANNEX F4: PILOT MANAGEMENT, TRAINING AND EXPERIENCE RECORDS	
How many UAVs does the company operate for each UAV pilot? Describe the process of pilot management for utilisation of these different platforms	
Average pilot monthly flying hours	
Minimum permitted monthly flying hours	
Maximum permitted monthly flying hours	
Describe the system that records how flights and flight hours are managed for all pilots	
Describe how pilots are managed for the delegation and selection of jobs (e.g. availability vs. technical competence)	
Describe how pilots remain current with latest safety information? (e.g. safety bulletins issued by the NAA)	
Describe how the company determines if pilots are medically fit for duty (e.g. implementation of random drugs testing)	
Describe the process of training and the re-integration of the pilot into live operations after prolonged periods (minimum 1 month) no flying	
Describe the process for pilot recruitment and selection criteria	
Describe the process for pilot training conversion	
Describe the process for the integration of newly hired pilots into the company for live operations	

Pilot Name	UAV Manager	Employment	Permissions and Exemptions	Total Hours Operating UAS (On/ Offshore)	Experience Rating

Training Description (Theory and Technical)		Proficiency Check?	Pass Date	In-House/ Supplier	Hours Trained
Accountable Manager					
Pilot					
Observer					
Engineer					
… ,etc.					
Provide scanned copy of training completion.					

ANNEX F5: SAFETY MANAGEMENT RECORDS, POLICY AND EMERGENCY PROCEDURES	
Total Accidents in the last X years	
Total Incidents in the last X years	
Example incident report showing analysis of causes and learning from experience	
Describe procedure in the event of a loss of control of a UAV	
Describe procedure if a pilot loses contact with their observer	
Describe procedure if an observer loses sight of the UAV	
Describe procedure in the event of pilot incapacitation during flight	

ANNEX F6: QUALITY AND HEALTH AND SAFETY MANAGEMENT SYSTEM CERTIFICATION
Provide scanned copy of relevant certificate(s) – e.g. for ISO 9001 and ISO 45001

ANNEX F7: UAS ASSET MANAGEMENT AND MAINTENANCE RECORDS					
	Asset 1	Asset 2	Asset 3	Asset 4	Asset 5
Asset Type					
Asset Ownership					
Asset Manufacturer					
Model					
Serial Number					
Year of Purchase and Registration					
Primary Use					
Airworthiness Approved					
Total Flying Hours					
Total Service History Log					
Battery Logs					
Date/Location of next Service					
Repaired in accordance with technical library or manual?					
Accountable Pilot(s)					
Accountable Manager					

ANNEX F8: DOCUMENTATION
Provide copy of relevant document(s) or equivalent: Safety Policy (relevant to UAS) Operations Manual Operational Safety Case as required Documentation of new approvals or exemptions by the CAA for operations beyond the current Operations Manual

ANNEX F9: PRE-FLIGHT SURVEY AND RISK ASSESSMENT FORMS
Please provide examples of completed pre-site survey and risk assessment forms.

ANNEX F10: ACCIDENT AND INCIDENT REPORT FORM
Please provide example report forms and/or incident register.

<table>
<tr><th colspan="4">ANNEX F11: CUSTOMER REFERENCE/TESTIMONIALS</th></tr>
<tr><td colspan="4">Please ensure when filling this section in that the customer has consented to the sharing of information complying with data protection regulations. Alternatively, customer contact details can be provided for direct referral.</td></tr>
<tr><td>Customer Name</td><td></td><td>Start date of works</td><td></td></tr>
<tr><td>Customer Reference Contact Details</td><td></td><td>End date of works</td><td></td></tr>
<tr><td>Customer Site</td><td></td><td>Evidence of works</td><td>Post flight log evidence</td></tr>
<tr><td colspan="4">Description of UAS Services</td></tr>
<tr><td colspan="2">1. Scope of work required
2. Processes followed
3. Teams involved
4. Risk approach taken
5. Number of flights performed</td><td colspan="2">6. Types of flights performed
7. Delivered to requirements?
8. Delivered on time?
9. Any issues or flight/operational incidents?
10. Would they use again/recommend?</td></tr>
<tr><td colspan="4">Customer Testimonial Summary:</td></tr>
</table>

ANNEX G
ILLUSTRATIVE EXAMPLE: PRE-FLIGHT SITE SURVEY

As with all the 'Illustrative Example' annexes, it is essential to note that OWCs and UAS providers should not simply copy and paste such material, without considering the specific operations and hazards for their own UAS applications and contexts.

Section 1: Job Details			
Date of Flight:		Job Number:	
Pilot in Command:		Mission Summary:	
Support Pilot:			
Observer:			
Site Details:			
Landowner/Client:		Site Address	
Tel:			
Email:			
Permission Received:	Y ☐ N ☐		
Site Coordinates:			
Vehicle Access:	Y ☐ N ☐		
Site Altitude (ft. amsl):			
Local Hospital:			
Contact Number:			
Local Police:			
Contact Number:			
Section 3: Airspace			
3A: Airspace (within 10NM)			
Controlled/Uncontrolled:	C ☐ U ☐	Airspace Classification:	
ATC Permission Required:	Y ☐ N ☐		
3B: Airports/Heliports (within 10NM)			
Airport Name	Operation in (M)ATZ	Permission Required	Contact Name/Number
1:	Y ☐ N ☐	Y ☐ N ☐	
2:	Y ☐ N ☐	Y ☐ N ☐	
3:	Y ☐ N ☐	Y ☐ N ☐	
3C: Airspace Hazards (within 10NM)			
Item	Airspace Ref Number(s)	UAS Prohibited	Comments/Restrictions
Danger Areas:		Y ☐ N ☐	
Restricted Areas:		Y ☐ N ☐	
Prohibited Areas:		Y ☐ N ☐	
Conservation Areas:		Y ☐ N ☐	

Other Airspace:		Y ☐ N ☐	
NOTAM Restrictions:		Y ☐ N ☐	
Section 4: Ground Assessment			
Item	Comments/Restrictions/Mitigations		
Congested Areas:			
Isolated Structures:			
Third Party Infringement			
Risk and Site Control:			
Roads and Rights of Way:			
Fauna:			
Recreational Spaces:			
Other Restrictions:			
Section 5: Weather Forecast			
Item	Comments		
Wind Strength:			
Temperature (max/min):			
Humidity (approx.):			
Sunrise/Sunset (If limiting):			
K Index (space weather):			
General Forecast:			
Section 6: Notes and Comments			

ANNEX H
ILLUSTRATIVE EXAMPLE: EMERGENCY PROCEDURE

As with all the 'Illustrative Example' annexes, it is essential to note that OWCs and UAS providers should not simply copy and paste such material, without considering the specific operations and hazards for their own UAS applications and contexts.

Site Incursion

Incursion of 50m (30m t/o or ldg) radius by person or vehicle not under the control of the PIC.

- REPOSITION AIRCRAFT
  Reposition aircraft to increase separation and hold until third party is clear.

If third party continues to encroach site or approaches pilot:
- LAND ASAP
  Land at first available safe location

Airspace Incursion

Aircraft noise heard in the vicinity of the site.

- ATTEMPT TO LOCATE AIRCRAFT

If unable to locate aircraft:
- REDUCE ALTITUDE
  Bring aircraft to low level hover

If aircraft located:
- ASSESS THREAT

If no threat:
- CONTINUE FLIGHT AND MONITOR

If threat:
- REDUCE ALTITUDE OR LAND

GPS Flyaway

Operating in GPS mode control of aircraft is lost or becomes erratic.

- SELECT 'ATTI' MODE (or equivalent where fitted)
  This disables the GPS
- LAND ASAP
  Once control has been recovered, discontinue flight

If unsuccessful:
- LAND ASAP
  Reduce throttle to increase rate of descent. Attempt to land in safe location
- RAISE DEFECT and MOR
  A defect should be raised for troubleshooting - consider filing a MOR

Loss of Engine Power

Partial or complete loss of power of one or more engine.

- LAND ASAP
  Land aircraft at the nearest available safe location

Transmitter Battery Failure

Failure of the transmitter battery

- AIRCRAFT ENTERS FAILSAFE MODE

Loss of Control Link

Failure of the signal between the transmitter and aircraft

- AIRCRAFT ENTERS FAILSAFE MODE

Aircraft Battery Failure

Failure of a battery on an aircraft.

- ESTABLISH FLIGHT TIME
  Determine remaining flight time and monitor endurance
- RETURN AIRCRAFT HOME
  Return the aircraft to the landing zone if it has enough charge.

If remaining endurance is insufficient to return home:
- LAND ASAP
  Land aircraft in nearest available safe location

Pilot Incapacitation

Pilot becomes unwell to the extent that the safety of the flight is/will be compromised.

- ADVISE GROUND CREW MEMBER
- LAND AIRCRAFT
  Return the aircraft to the landing zone or land in nearest safe location

If unable to maintain control of aircraft:
- SWITCH OFF TRANSMITTER
  This will active failsafe mode

If unable to switch off transmitter:
- GROUND CREW ALERT
  Ground crew should switch off transmitter

Fire or Smoke

Smoke and/or fire coming from aircraft.

- LAND AIRCRAFT ASAP
  Land at nearest available safe location
- ENGINES OFF
  Shut engine(s) down and make safe
- CLEAR AREA
  Clear people and hazards from around the aircraft
- REQUEST ASSISTANCE
  Raise the alarm and request assistance (emergency services if required)
- GATHER SAFETY EQUIPMENT

If safe to approach and to do so:
- EXTINGUISH FIRE
  Use CO2 or a powder extinguisher
- DISCONNECT BATTERY
- LEAVE TO COOL

ANNEX I
ILLUSTRATIVE EXAMPLE: AUDIT TOPICS

As with all the 'Illustrative Example' annexes, it is essential to note that OWCs and UAS providers should not simply copy and paste such material, without considering the specific operations and hazards for their own UAS applications and contexts.

Figure 7 – Questionnaire

Questionnaire completed by…on behalf of….

Senior Management consists of… including:
Manager
Accountable Manager
Flight Ops Director
Chief Remote Pilot
Training manager
Flight Safety Officer
Ground Operations Manager
Technical Director
Chief Engineer
Quality Manager
Safety Manager

Documents to be provided, to include:
UAV Operator's certification
Operations Manual
Operational Safety Case
Maintenance approval
Incident/Accident Reports
Completed Pilot/ Engineer details e.g. qualifications
Quality Assurance Accreditation
Insurance
Safety Policy
Flight Log with evidence of operations in comparable environment

Approvals held:
Regulatory authority
UAV Operators Certificate
Permission for Commercial Operations PfCO
Maintenance Approvals
Quality Assurance Accreditation

Insurance:
Public Liability
Professional Indemnity
UAS hardware cover

UAV Information:
Type
Payload
Owned/leased/shared
Registration
Year of manufacture
Current hours
Primary use
Airworthiness

Personnel
Staff - numbers
Remote operation
Pilot recruitment
Pilot utilisation
Types flown
Hours flown

Technical Staff Utilisation
Shift system
Duty Periods

Selection
New hire onboarding
Training programmes
Type conversion
Personal Safety Training – e.g. HUET, GWO

Engineer and technician training
Basic
Type technical
Continuation

Management Staff General Development
Management skills
Safety
Investigation

Dangerous goods
Engineers

Safety
Safety Management System
Safety Programme
Safety Awareness
Safety Policy
Safety Manual
Safety Meetings
Investigation process
Confidential reporting

Safety Statistics

Licence and Medicals
Operations
Operations manual
Flight Safety Instructions
Charts
SAR cover Hospital/medical cover
EASA OPS compliance

HUMS
PPE
Checklists in use
Weight and balance
Freight handling

Maintenance
Publications
Inspection regime

Facilities
Overhaul and repair
Technical library
Recharging/ refuelling

ANNEX J
ILLUSTRATIVE EXAMPLE: WATCH LIST

As with all the ‘Illustrative Example’ annexes, it is essential to note that OWCs and UAS providers should not simply copy and paste such material, without considering the specific operations and hazards for their own UAS applications and contexts.

The following is a check list of actions for remote pilots before, during and after a flight.

Pre-flight:

- Site-specific training/induction undertaken – e.g. WTG transfer training if necessary.
- Your qualifications to fly should be checked e.g. PfCO, recent experience.
- Risk assessment and method statement in place and approved.
- Insurances provided.
- Personal protective equipment worn and correctly fitted – buddy check.
- Task for today.
- Toolbox talk.
- Emergency procedures reviewed.
- Dangerous goods manifest.
- Dangerous air cargo.
- Pre-flight briefing, including weather, SIMOPS, communication protocols.

During the mission

- Monitor work environment for new hazards or divergence from brief and conduct dynamic risk assessment or Stop Work as necessary.
- Monitor fitness for task and conduct dynamic risk assessment or Stop Work as necessary.

After flight

- Return of equipment if applicable.
- Daily debrief/progress report completed.
- Required flight logs/records (as set out in Operations Manual or elsewhere) updated.
- RAMS updated to include any unforeseen occurrences witnessed during flight.
- Debrief to supervisor/management.

ANNEX K
IMPLEMENTATION ASSESSMENT FORM

Click here

ANNEX L
ABBREVIATIONS

ALARP	as low as reasonably practicable
ANO	Air Navigation Order
ANSP	air navigation service provider
AOC	Air Operator Certificate
ARPAS UK	Association of Remotely Piloted Aircraft Systems UK
ATC	air traffic control
ATM	air traffic management
ATS	air traffic service
BLOS	beyond line of sight
BVLOS	beyond visual line of sight
CAA	(UK) Civil Aviation Authority
CAP	Civil Aviation Publication
CDM	Construction (Design and Management) Regulations 2015
CEN	European Committee for Standardisation
CENELEC	European Committee for Electrotechnical Standardisation
CNS	communications, navigation and surveillance
CONOPS	concept of operations
EASA	European Union Aviation Safety Agency
ECCAIRS	European Co-ordination Centre for Accident and Incident Reporting Systems
ERCOP	emergency response co-operation plan
ERP	emergency response plan
EVLOS	extended visual line of sight
FDM	flight data monitoring
FAA	Federal Aviation Administration
FSF	Flight Safety Foundation
GNSS	global navigation satellite system
GPS	global positioning system

GWO	Global Wind Organisation
HAZID	hazard identification (study)
HAZOP	hazard and operability study
H&S	Health and safety
HIRTA	high intensity radio transmission area
HSE	Health and Safety Executive (of the UK)
ICAO	International Civil Aviation Organization
IEC	International Electrotechnical Commission
IMO	International Maritime Organisation
IMU	Inertial measurement unit
IP	insurance provider
ISO	International Organization for Standardization
ITT	invitation to tender
JARUS	Joint Authorities for Rulemaking on Unmanned Systems
KPI	key performance indicators
LFE	learning from experience
LOS	line of sight
MCA	Maritime and Coastguard Agency (of the UK)
MGN	Marine Guidance Notice
MOR	Mandatory Occurrence Report
MOU	memorandum of understanding
NAA	National Aviation Authority
NATS	National Air Traffic Services
NOTAM	notice to airmen
NSO	non-standard operations
OEM	original equipment manufacturer
O&GUK	Oil and Gas UK
O&M	operations and maintenance
OWCs	offshore wind companies
PINS	Pipeline Inspection Notification System

PPE	personal protective equipment
PQQ	pre-qualification questionnaire
RAMS	risk assessment and method statement
RPA	remotely piloted aircraft
RPAS	remotely piloted aircraft (or aerial) system
RUK	RenewableUK
SAR	search and rescue
SARPs	Standards and Recommended Practices (of ICAO)
SEQ	sequence number
SIMOPS	simultaneous operations
SMM	(ICAO) Safety Management Manual
SMS	safety management system
SOP	standard operating procedure
SORA	specific operations risk assessment
SOV	service operations vessel
SQEP	suitable qualified and experienced personnel
SUA	small unmanned aircraft
SUSA	small unmanned surveillance aircraft
UAS	unmanned aircraft system
UAV	unmanned aerial vehicle
VLOS	visual line of sight
VMC	visual meteorological conditions
WTG	wind turbine generator

ANNEX M
REFERENCES AND USEFUL WEBSITES

References include version numbers/dates only where these references were explicitly used in the development of this GPG. In all cases, though, readers should consult the latest versions when using these documents for practical information and guidance.

Confidential Reporting Programme for Aviation and Maritime (CHIRP) – https://www.chirp.co.uk/

EASA – https://www.easa.europa.eu/en/home

Easy Access Rules https://www.easa.europa.eu/en/document-library/easy-access-rules/easy-access-rules-unmanned-aircraft-systems-regulations-eu

Eurocontrol – https://www.eurocontrol.int

FAA – https://www.faa.gov/uas

FSF – https://flightsafety.org

FSF Basic Aviation Risk Standard (BARS) – Remotely Piloted Aircraft Systems. Version 4, Oct 2022

FSF-BARS Remotely Piloted Aircraft Systems. Implementation Requirements. Version 4, Oct 2022

G+/EI – https://www.gplusoffshorewind.com/

GPG: Helicopter operations (in two parts):

Part A: https://www.gplusoffshorewind.com/__data/assets/pdf_file/0004/822739/Section-A-G-safe-helicopter-operations-in-support-of-the-global-offshore-wind-industry.pdf. First Edition, Feb 2021.

Part B: https://www.gplusoffshorewind.com/__data/assets/pdf_file/0005/822740/Section-B-G-safe-helicopter-operations-in-support-of-the-global-offshore-wind-industry.pdf. First Edition, Feb 2021.

GPG: Integrated offshore emergency response https://www.gplusoffshorewind.com/__data/assets/pdf_file/0008/671399/G-integrated-offshore-emergency-response-G-IOER.pdf

Industry health and safety reporting scheme – https://www.gplusoffshorewind.com/work-programme/hsestatistics

Energy Institute Toolbox – https://toolbox.energyinst.org

Helioffshore – https://www.helioffshore.org/

Incident data and analysis. https://www.helioffshore.org/activity/helioffshore-safety-intelligence-programme

IATA – https://www.iata.org

IATA Dangerous Goods Regulations (DGR) manual. (IATA – Dangerous Goods Regulations (DGR)).

ICAO – https://www.icao.int

Articles 11 and 12 of the International Convention on Civil Aviation https://www.icao.int/publications/documents/7300_orig.pdf

ICAO Safety Management Manual. https://www.icao.int/safety/safetymanagement/pages/guidancematerial.aspx. Fourth Edition, 2018.

ICAO Annex 14 Aerodrome Design. Annex 14 – Aerodromes – Volume I – Aerodromes Design and Operations l ICAO Store

IOGP – https://www.iogp.org

IOGP Report 696 – Remotely Piloted Aircraft Systems. https://www.iogp.org/bookstore/product/remotely-piloted-aircraft-systems/

JARUS

JARUS requirements on Specific Operations Risk Assessment (SORA) and Pre-Defined Risk Assessments (PDRAs) – see http://jarus-rpas.org/publications/.

(UK) CAA – https://www.caa.co.uk

Rules and categories. https://www.caa.co.uk/drones/rules-and-categories-of-drone-flying/introduction-to-drone-flying-and-the-uk-rules/

Bowties: https://www.caa.co.uk/Safety-Initiatives-and-Resources/Working-with-industry/Bowtie/

CAP 722: Unmanned Aircraft System Operations in UK Airspace – Guidance. https://www.caa.co.uk/publication/download/21784

CAP 2606: PDRA01 Operations Manual template. https://www.caa.co.uk/our-work/publications/documents/content/cap2606/

(UK) Health and Safety Executive (HSE) – https://www.hse.gov.uk/index.htm

Expert guidance on risk management – HSE

https://www.hse.gov.uk/enforce/expert/alarpglance.htm

(UK) MCA – https://www.gov.uk/government/organisations/maritime-and-coastguard-agency

MGN 654 https://www.gov.uk/government/publications/mgn-654-mf-offshore-renewable-energy-installations-orei-safety-response

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