Safety Bulletin

Reducing safety risks in the deployment, maintenance and recovery of F-LiDAR buoys


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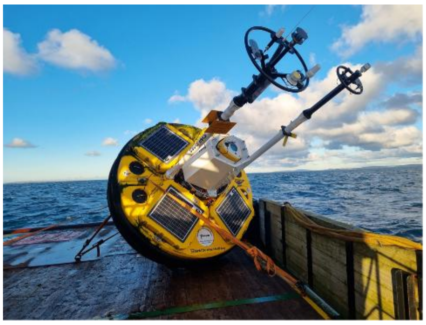
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Introduction

Floating light detection and ranging (F-LiDAR) buoys are used in the offshore wind energy industry for metocean data collection. Concerns have been expressed in the industry about the safety risks involved in their deployment, maintenance and recovery.

Significant hazards include:

- dropped or moving loads, entrapment/crushing between buoys and other objects. These hazards can arise during mechanical or manual lifting and handling, e.g. when lifting a buoy onto or off a vessel, when towing, when deploying or recovering a buoy from the water, or when attaching moorings/anchors and securing the buoy whilst doing so.
- fire, explosion and toxicity hazards associated with power sources - e.g. methanol (which is flammable) or hydrogen from degassing of lead-acid batteries
- line of fire: being struck by a whiplashing cable or line that has snapped under tension

- moving machinery (many buoys have small wind turbines on board to provide power)
- potential confined space hazards, if personnel need to work inside a buoy
- vessel-buoy collisions (the vessel could be one towing, deploying, collecting or providing personnel access to the buoy, or another vessel)
- risk to eyesight from LiDAR laser radiation, if a laser is left on, turned on or comes on automatically whilst personnel are working on the buoy. Some but not all units are "eye-safe", but nevertheless not necessarily entirely risk-free.

This bulletin aims to raise awareness of the safety risks associated with F-LiDAR buoys and wider F-LiDAR systems, and to identify key areas for attention in aiming to reduce the risks. It draws on the findings of a workshop arranged by the Global Offshore Wind Health and Safety Organisation (G+), the International Marine Contractors Association (IMCA), and the Workboat Association, in June 2025. The participants included developers, original equipment manufacturers (OEMs) of buoys and mooring equipment, vessel owners/operators and survey contractors.

What are the key challenges?

The following factors have been identified as leading to particular complexities and difficulties in controlling safety risks related to F-LiDAR buoys. They are listed here under subheadings reflecting the sources of challenge (buoy characteristics, supplier/stakeholder challenges and external challenges), rather than in order of importance.

Changes in buoy characteristics

In parallel with the development of the offshore wind industry, buoys have become much larger and heavier. While the wave/meteorological buoys that have been used for many years typically weigh 250 to 500 kg, some F-LiDAR buoys now weigh over 10 tonnes. Associated equipment, such as taglines, mooring lines, sinkers and sea-fastenings, is becoming proportionately larger too, with anchor spreads weighing up to tens of tonnes. These increases in size and weight, and changes in buoy concepts and functions, bring additional challenges to lifting, sea fastening, transferring, deployment and recovery.

- Having heavier, sometimes unbalanced, awkwardly shaped and non-standardised objects, whose lifting and sea-fastening points are not always easily accessible, increases the lifting and handling hazards, both onshore and on the vessel.
- These larger buoys need more power than previous devices, and so carry bigger battery packs, solar panels, wind turbines and/or (methanol) fuel cells. Methanol (which can be present in quantities of up to hundreds of litres in current buoys) is a particular concern. It presents a fire hazard, and is toxic and environmentally harmful. A leak may not be easily noticed, because methanol is transparent and can easily be confused with water. And it burns with a transparent flame, making a fire hard to spot. It is classified as a dangerous substance under the International Maritime Dangerous Goods (IMDG) Code (IMDG code), and there are safety obligations relating to its use under the Code as well

as any local regulations. However, there is relatively little experience in handling methanol, as it has not historically been used in the marine industry, and variable experience of working to IMDG requirements.

- **Personnel transfer** between vessels and buoys: this may be needed when, for example, maintenance is required but recovery to a vessel is not reasonably practicable.
- F-LiDAR buoys have **fragile, protruding or sensitive components** such as data transmission and communications antennae, wind turbines and solar panels. If such components are damaged during handling, additional visits may be needed to repair or replace them, increasing personnel exposure to offshore risks. There may also be conflicts between the safest lifting/handling method and the need to protect such equipment.
- **Increasing automation and integrated functionalities.** These may affect the safety of those working on or around buoys.

Supply chain and stakeholder challenges

These relate mainly to the rapid growth of the offshore wind industry and the management of associated change.

- New entrant stakeholders, and those in new regions for the offshore wind industry, typically have **smaller teams, with fewer dedicated safety resources and/or less experience** than established companies.
- Even for established stakeholders, the larger buoys require **changes to requirements and procedures** and there are **variations in levels of experience**.
- **Variations in safety (and other) requirements and expectations** amongst developers, OEMs and vessel operators, in relation to aspects such as:
  - specifying vessel requirements
  - pre-qualification processes and questionnaires - expectations on what contractors are expected to be able to demonstrate
  - Inspection/auditing approaches and standards. Supplier auditing systems may be seen as disproportionately onerous for short (e.g. two-day) jobs.
- **Variations and complexities in contracting approaches**, for example in which party (developer, survey contractor or OEM) charters the vessel(s), and in how project risks, such as from adverse weather, are shared between parties.
- There is **pressure on vessel availability**, as fewer vessels are suitable for handling the larger assets or managing the specific hazards associated with F-LiDAR. Operators of potentially suitable vessels who do not already meet safety requirements (e.g. IMDG compliance for methanol) will need to prepare their management systems and arrangements (vessel facilities, crew training documentation etc.) and it can take months to receive any necessary external assurances or certifications.

- As buoy deployment, maintenance and recovery tend to be one-offs or infrequent, **vessels are typically hired on short or spot charters**. Relative to the supply chain for more regular, long-term work, this further limits the number of vessel operators willing to provide services. It also makes it more difficult to ensure effective qualification, selection and oversight/monitoring of vessel operators and other contractors, and to develop collaborative relationships, harmonised approaches and shared safety cultures.
- Because operations with F-LiDAR buoys are likely to be infrequent, personnel may be subject to **lack of practice** and **skill fade**.
- Contract criteria and KPIs. **Time, cost and operational pressures** (aiming to minimise data acquisition downtime for example), coupled with short weather windows for operations at sea, potentially conflict with safety.
- Time, cost and operational pressures, together with wind farms being developed increasingly far from shore, can also make **providing adequate welfare and briefing and preparation time** challenging.
- Differences between regulations and regulatory guidance in **different jurisdictions,** and understandings of these - especially by new entrants.

External party challenges

Damage to buoys or loss of data may occur due to the actions of external parties, for example by:

- **deliberate damage**, such as cutting of mooring lines
- **vessel impacts** by non-wind farm traffic
- fishing vessels or others **mooring to buoys**
- **fishing gear entanglement**, including with lost or abandoned ('ghost') nets.

Such damage or data loss may necessitate longer deployment times, or repair or recovery visits, increasing overall personnel exposure to the hazards of offshore work. Repair and recovery operations may introduce additional hazards.

Risk reduction - what can the industry do?

The following are some key areas for attention that stakeholders should consider in order to manage the challenges identified above and reduce safety risks.

Safety by design

Wherever possible, risks should be eliminated or minimised as early as possible, in the concept or design stages. Key areas in which safety by design can be implemented are as follows.

1. Design of physical and operational aspects to optimise reliability, availability and maintainability, or otherwise reduce the need for personnel to lift, handle, transfer to or work on buoys offshore. For example, consider:

a) Extending service frequencies and refuelling intervals (note: power requirements are affected by, amongst other factors, the frequency of data updates).

b) Automated fault-reporting and SCADA systems to enable remote detection and reporting of failures or condition deterioration, and re-setting of certain faults. Again, there are risks, such as a component being re-energised while personnel are working on it. Robust systems (similar to lock-out tag-out) will be needed to ensure clarity over who can have control.

c) Redundancy of system elements such as sensors and data acquisition or processing systems, ideally with the ability to switch to the backup system automatically or remotely.

d) Inspection and/or repair by remotely operated vehicles/vessels (ROVs) or unmanned/uncrewed aircraft systems (UASs). Note however that ROVs and UASs can introduce new risks.

e) Towing buoys from shore for deployment (rather than carrying them aboard vessels), and back to shore for maintenance (rather than working on them offshore). However, the safety benefit of reducing the need for lifting should be balanced against the risks associated with towing.

f) Holding spares and supplies on the buoy itself, minimising the need to transfer tools, parts, supplies etc from vessel to buoy.

2. Design for human operators, e.g. by engaging vessel operators and deck crew in the design process. This is particularly important in relation to the design of system elements that have a direct human interface, such as lifting and securing points or personnel access arrangements. And, where buoys have automated functions, the design will need to ensure that automated operations do not create hazards for those working on or around a buoy.
3. Design of taglines, moorings, sea fastenings etc. These need to be robust against operational loads, wear and accidental or deliberate damage, but not so large and heavy that the risks in lifting and handling them outweigh the benefits.
4. Logistics planning. For example, can buoy-related tasks be combined with others, to mitigate the effects of limited vessel availability?
5. Providing guard buoys against vessel collision (but balancing the benefits against the additional risks in deploying the guard buoys as well as the F-LiDAR buoys).
6. Where personnel may need to work on or inside a buoy, the planning of emergency arrangements should include consideration of factors such as how an ill or injured person could be safely recovered, and how to provide first aid or medical treatment in situ and/or take them to a place of safety for continued or more advanced care.

Supply chain and stakeholder risk reductions

7. Standardisation/harmonisation, information sharing and adoption of good practices, between and amongst developers, OEMs and vessel operators, in relation to safety

requirements and expectations and to contracting approaches. For example, standardising vessel inspections by using IMCA's electronic Common Marine Inspection Document (eCMID) https://www.ecmid.com/ could help to achieve uniform and acceptable levels of safety.

8. Safety-led decisions on which party should charter the vessel(s). Survey contractors or OEMs are likely to be best placed to select the most appropriate vessels for their work, as they will have the practical experience.
9. Development of ways to share project risks between parties that also reduce safety risks. For example, poor weather is a risk to deployment operations. Parties should agree how to share this risk in ways that minimise any perceived or actual pressure to work in marginal/unsuitable weather.
10. Development of contract targets and KPIs that drive safe decisions and behaviours, and allow for good preparation and welfare, despite time, cost and operational pressures.
11. Encouraging understanding & collaboration between stakeholders from as early as possible. For example, early involvement of vessel operators/crews in buoy design, or in development of deployment and recovery plans. As experience with F-LiDAR buoys grows, sharing of experience and harmonisation of approaches to design, operations, training etc will be beneficial.
12. Raising the competence levels of vessel crews and wind farm personnel. All of those involved should have standard offshore training (e.g. International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) or Basic Offshore Safety Induction and Emergency Training (BOSIET), and health and safety and leadership training appropriate to their roles. Additional training may be needed in topics such as advanced/complex/heavy lifting and slinging, anchor handling, methanol awareness or wider Dangerous Goods training. Changes in buoy characteristics, and larger and heavier mooring components have led to the work becoming more complex.
13. Personnel who need to board F-LiDAR buoys at sea will need competences similar to those for wind turbine generator (WTG) technicians (such as Global Wind Organisation training). However, differences from WTG activities and arrangements should be taken into account - for example in relation to vessel-asset transfer, asset climbing and emergency arrangements (see point 6 above).
14. Regular refresher training, safety shares, exercises etc to mitigate against lack of practice and skill fade for operations that personnel only carry out infrequently.
15. Ensuring that vessel crews and wind farm personnel have adequate rest and welfare, as well as time for thorough vessel inductions, kick off meetings (pre-mobilisation and on the vessel), toolbox talks, walk/talk-throughs and deck preparations (e.g. layout and testing of equipment).

External party risk reductions

16. Communication and consultation with local communities and users of the sea, such as fishers and other vessel operators, during planning and consenting, and throughout operation. Effective engagement can reduce the likelihood of accidental and deliberate damage.

Acknowledgments

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Feedback? Questions?

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Further information

The G+ website, has a wide range of Good Practice Guidelines and other resources on relevant topics, including lifting, dropped loads, small service vessels and safe by design recommendations and framework.

The signposting page on the G+ website signposts health and safety publications by organisations other than the G+, which may be helpful to the offshore wind sector.

IMCA's extensive library of technical and safety publications can support vessel assurance activities and provide guidance on, for example, offshore lifting or diving operations.

The Workboat Association offers guidance to members on, for example, training, Dangerous Goods and towing. Some of these are publicly available.

Institute of Marine Engineering, Science and Technology (IMarEST) Special Interest Groups: IMarEST | Offshore Renewables and IMarEST | Operational Oceanography, as well as the International Association of Oil & Gas Producers (IOGP) Metocean Committee, offer guidance on FLiDAR buoys, including on health and safety aspects.

The following sites enable sharing of incident information and learning from experience:

- EI Toolbox - https://toolbox.energyinst.org/
- Step Change - Step Change in Safety | Improving safety through engagement
- IMCA Safety Alerts https://www.imca-int.com/resources/safety/safety-flashes/

In addition, we encourage stakeholders to have internal Learning from experience sessions as part of their routine safety management activities.