



MARITIME
TECHNOLOGIES
FORUM

LEADING THE MARITIME WORLD FORWARD

GUIDELINES TO DEVELOP AND IMPLEMENT A SAFETY MANAGEMENT SYSTEM FOR SHIPS USING WIND ASSISTED PROPULSION SYSTEMS





Executive Summary

The Maritime Technologies Forum (MTF) is a group of flag States and classification societies which aims to bridge the gap between technological progress and regulatory process. MTF has previously published reports on guidelines for developing and implementing a Safety Management System (SMS) for ships using alternative fuels.

This report provides a step towards strengthening the operational safety management for all types of ships using Wind Assisted Propulsion Systems (WAPS), which are considered a promising solution to reduce fuel consumption and help meet greenhouse gas emissions regulations. Based on the uptake of WAPS and industry experience at present, this report considers the three most installed technologies today, rotor sails, suction sails and wing sails, and is limited to ships that are wind assisted as opposed to primary wind powered. While the guidelines may be relevant for ships using other WAPS technologies, there may be technology specific risks and features not captured in the present work.

MTF brought together experts on WAPS and experts on the International Safety Management (ISM) Code, merging the necessary competencies to develop the recommendations in the new guidelines. In addition, several external industry stakeholders have contributed towards the development of these guidelines. A list of these industry stakeholders can be found at the end of this document.

Proposed guidelines can be used to develop a new SMS or strengthen an existing SMS

Companies can use these guidelines to strengthen their existing SMS, in the case of retrofitting or equipping a newbuild ship with WAPS. Continuous development of technologies, as well as regulatory and classification society frameworks, necessitates these guidelines to be used together with existing or upcoming documentation and guidelines.

Understanding the safety principles of the WAPS technology lays the foundation for managing operational risks

As safety principles vary between WAPS technologies, understanding these principles is crucial to identify the technical and human risks associated with WAPS operation. This knowledge should be reflected in the SMS through the implementation of appropriate and adequate measures to protect crew and shore-side personnel, and to minimize risks related to WAPS operations.

SMS development should be based on rigorous risk assessment(s) and tracked developments of WAPS technologies in industry and research

WAPS can have significant impact on shipboard operations, which differs depending on e.g. design layout, the WAPS technology, and operational profile. With currently limited published operational data and established safety standards to support the development of fully comprehensive procedures, it is essential to base procedure development on structured risk assessment methodologies.

WAPS have the potential to both cause an emergency and exacerbate emergencies originating from unrelated circumstances. The scope of emergency planning may differ on a case-by-case basis, considering the vessel type, the specific WAPS technology, their interaction, and whether the system is installed at newbuild or retrofit stage.

Learning and continuous improvement are essential during initial stages of technology uptake and development

The strength of the company's SMS shall be in the ability to proactively identify improvements in the SMS through learning from non-conformities, accidents, and hazardous occurrences (including near misses) related to WAPS operation and maintenance. Reporting templates should be adapted to capture WAPS-specific information, and a process for identification of recurrent failure modes and opportunities for improvement should be established. This will facilitate the closing of the gaps that may exist initially due to limited operational data.

Role-specific competence and training on WAPS are critical to ensure safe operation and maintenance of WAPS

With the current lack of WAPS-specific competence certifications, the related training should follow industry best practice, not a regulatory requirement. The company should ensure that relevant personnel have the role-specific competence and familiarisation for safe operation and maintenance. Training should incorporate representative ship- and WAPS-specific scenarios. Maintenance personnel should be appropriately trained in the specific characteristics of WAPS.

The human element and associated risks should be addressed to enhance the SMS

While most WAPS technologies utilise automation to a high degree, the human factors remain central to ensure safe operation and effective maintenance of WAPS. Structured communication protocols during deployment, feathering, shutdown or emergency operation, as well as periodic emergency drills and refresher training should be an integral part of preventive measures to minimize human errors. Emergency drills should involve not only shipboard teams but a shore-based emergency response, where relevant, ensuring that effective response and coordination with external parties is established during emergencies.

Table of Contents

Executive Summary	2
Background and Objectives	6
Overview of WAPS and Their Characteristics	8
Rotor Sails	8
Wing Sails.....	8
Suction Sails.....	9
Technical and Operational Implications	9
Application of Rules and Regulations	11
Introduction to the Guidelines.....	12
1. General	13
2. Safety and Environmental Protection Policy	14
3. Company Responsibilities and Authority.....	15
4. Designated Person(s).....	16
5. Master's Responsibilities and Authority	17
6. Resources and Personnel.....	19
7. Shipboard Operations	21
7.1 Open Water Navigation.....	22
7.2 Port Operations	23
8. Emergency Preparedness.....	24
9. Reports and Analysis of Non-conformities, Accidents and Hazardous Occurrences	26
10. Maintenance of the Ship and Equipment	28
11. Documentation.....	30
12. Company Verification, Review and Evaluation	31
Conclusions.....	33
References.....	34
Acknowledgements	35

List of acronyms

Acronym	Definition
CCTV	Closed-Circuit Television
DP	Designated Person
EEDI	Energy Efficiency Design Index
EMSA	European Maritime Safety Agency
GHG	Greenhouse Gas
HMI	Human-Machine Interface
ISM	International Safety Management
IWSA	International Windship Association
MOC	Management of Change
MTF	Maritime Technologies Forum
OOW	Officer of the Watch (Officers in Charge of Navigational Watch)
PMS	Planned Maintenance System
PPE	Personal Protective Equipment
PTW	Permit To Work
SEP	Safety and Environmental Protection
SMS	Safety Management System
STCW	Standards of Training, Certification and Watchkeeping
WAPS	Wind Assisted Propulsion System

Report citation

Please refer to this report as follows: Tranell, Johanna et al. (2026): Guidelines to develop and implement a safety management system for ships using wind assisted propulsion systems, available at www.maritimetechnologiesforum.com

Background and Objective

The Maritime Technologies Forum (MTF) is a group of flag States and classification societies which aims to bridge the gap between technological progress and regulatory process. It has been established to provide technical and regulatory expertise and offer unbiased advice to the maritime industry.

MTF has previously published reports on guidelines for developing and implementing a Safety Management System (SMS) for ships using alternative fuels, and more specifically, ships using ammonia as fuel.

This report is next in line, aiming to provide a step towards identifying and filling gaps in operational safety management for ships using Wind Assisted Propulsion Systems (WAPS). It seeks to provide guidelines to help companies, as defined in the International Safety Management (ISM) Code, strengthen the SMS for all types of ships using WAPS, thereby encouraging safe application in the maritime industry. The project team brought together experts on WAPS and experts on the ISM Code, combining the necessary competencies.

WAPS has, over the past decade, become a promising solution to reduce fuel consumption. As wind is an inexhaustible and direct source of energy at no cost, the WAPS technologies may help shipowners to comply with increasingly stringent greenhouse gas emissions regulations. The number of installations has increased rapidly in the past years. As of February 2026, WAPS technologies have been installed onboard around 90 vessels ^{[1] [2]} and the orderbook is of the same magnitude, indicating momentum in uptake.

While wind has been used for propulsion over many centuries, the WAPS technologies introduce some new operational challenges to the modern shipping industry. In a maritime stakeholder survey, conducted by the International Windship Association (IWSA) with 59 respondents, operational concerns were identified as the one of the biggest barriers to the uptake of WAPS ^[3]. However, because reducing fuel consumption is the main motivation for installing WAPS in shipping today, the literature is heavily focused on performance of the systems. There are limited publications on operation and safety management with WAPS onboard, although contributions such as ^{[4], [5], [3]} offer experience and guidance on e.g. installation, operation and related risks.

Based on the uptake as of February 2026, the scope of this work is focused in two ways. Firstly, the report considers the three most installed technologies today, rotor sails, suction sails and wing sails. While the guidelines may be relevant for ships using other WAPS technologies, there may be technology specific risks and features not captured in the present work. Secondly, it focuses on vessels that are wind assisted as opposed to primary wind powered. While there is no industry-wide definition of these two terms, the ITTC ^[6] suggests the distinction of Table 1 for general use in initial design and vessel classification. Based on the current fleet and industry experience, as well as targeted audience, these guidelines are developed for application to wind assisted ships.

Term	Description
Primary Wind Power	A Primary Wind Powered Ship is one which is designed to maintain service speed the majority of time using wind propulsion only.
Wind Assisted Ships	A Wind Assisted Ship is a motor ship which is adapted such that in favourable wind conditions, the propulsive power to maintain service speed is reduced by utilising wind powered technology.

Table 1: Proposed distinction between wind powered and wind assisted ships ^[6]

This report is organised in the following way. Firstly, it includes a general section giving an overview of WAPS, including a brief introduction to the three main technologies used today and their characteristics. It highlights potential implications a WAPS installation may have on technical and operational aspects of the vessel. Secondly, the guideline-specific section aligns with chapters of the ISM Code. The implications of WAPS to each ISM Code chapter is described, and recommendations for updating the SMS are given.

Several industry stakeholders representing different maritime sectors contributed towards the development of these guidelines. Their contributions were in the form of workshop discussions and document reviews, representing input from different sectors, which helped to strengthen these guidelines. MTF is grateful for their contribution, and the full list of these industry stakeholders can be found at the end of this document.

Disclaimer

The findings and recommendations in this report represent a collaborative effort between participating MTF members. While the advice given in this report has been developed using the best currently available information, it is intended to be used solely as guidance. No responsibility is accepted by MTF or its members for any consequences resulting directly or indirectly from the adoption of any of the recommendations in this report. This report does not stop MTF members from having independent opinions or conclusions.

Overview of WAPS and Their Characteristics

These guidelines refer to WAPS installed on seagoing ships to help meet increasingly stringent Greenhouse Gas (GHG) emission regulations. By generating direct thrust through aerodynamic forces, the operation of WAPS may reduce fuel consumption and lower GHG emissions.

The use of sails to propel ships is not new. However, the technologies offered today have been tailored to fit the needs of modern ship operations. They utilise automation to a high degree, as well as state of the art control systems and materials. This introduces equipment and operational procedures less known to traditional shipping. There are several different WAPS technologies offered today. All operate based on the same fundamental physical principles. The technologies generate air pressure differentials which creates aerodynamic forces named “lift” and “drag”. As shown in Figure 1, the lift and drag forces are acting perpendicular and in parallel to the incoming wind direction, respectively. The total resultant of the lift and drag forces can be decomposed into the thrust force, used for propulsion, and the side force, acting perpendicular to the ships course.

The aerodynamic forces generated by these systems are typically orders of magnitude higher than those produced by traditional sails. However, the exact magnitude depends on the specific technology, so the sail area required to achieve an equivalent thrust can vary significantly.

These guidelines are limited to the three main WAPS technologies rated by the current market uptake as of February 2026. In the following, these technologies are briefly described. Schematic drawings of the systems are presented in Figure 2.

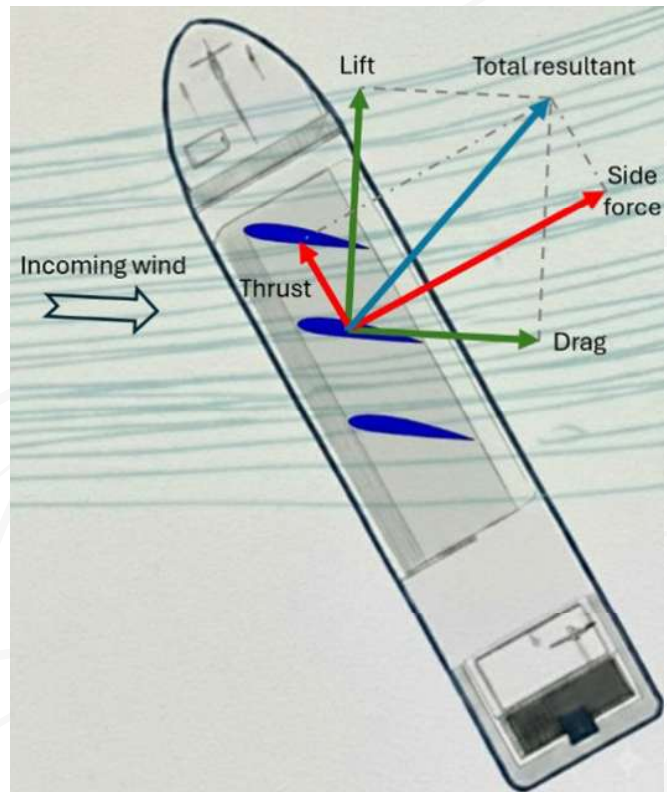


Figure 1: Aerodynamic principles. The total resultant force, in wind direction coordinates (“lift” and “drag”) and in ship coordinates (“thrust” and “side force”). Image: ABS.

Rotor Sails

A rotor sail, sometimes referred to as a 'Flettner rotor', is a cylindrical structure rotating around its own axis. The rotor does not need trimming against the wind angle, making operation relatively simple. Clockwise and anticlockwise rotation is required when wind is coming from port or starboard side. Rotor sails need a continuous supply of electrical power to generate lift. This magnitude is, however, small compared with the (thrust-) power output. Cutting off electrical power supply stops rotor operation and lift generation. They are available with a tilting mechanism to facilitate port operations or reduce air draft.

Wing Sails

A wing sail is a foil-like structure, often equipped with high-lift devices such as flaps to increase the generated lift force. Wing sail aerodynamics are very similar to those of aeroplane wings. Rigid wing sails are made of hard shells, while soft and hybrid wing sails are made of modern textile material. This gives some different characteristics, for example in terms of weight. Wing sails need to be aligned to the incoming wind direction with an optimum angle of attack. If it consists of multiple elements, a wing sail can also be cambered to maximize aerodynamic forces. Wing sails often need to be tilttable for port operations, to reduce air draft, or to protect them from high winds.

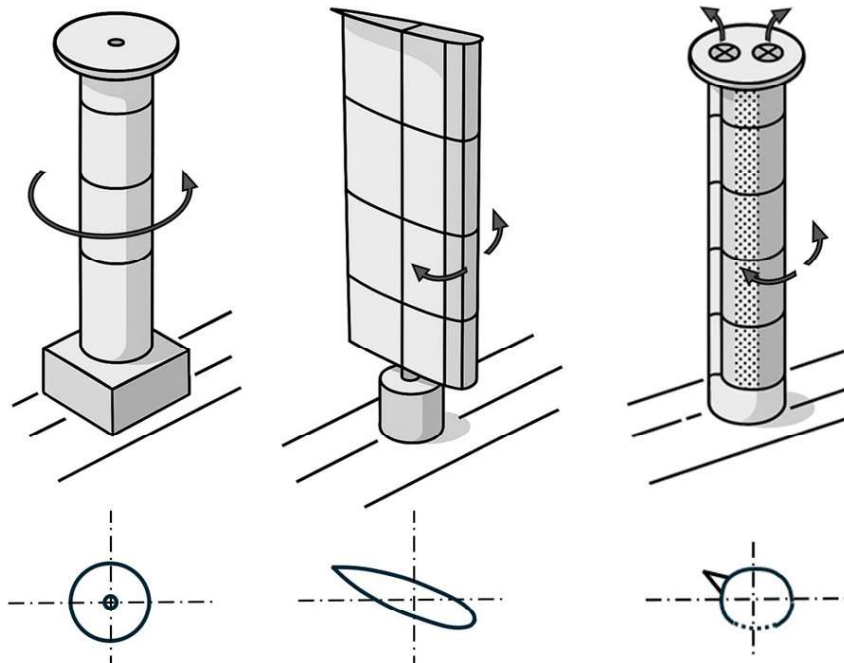


Figure 2 : Schematic drawings of the three WAPS technologies rotor sail (left), wing sail (middle) and suction sail (right). Image: DNV.

Suction Sails

The suction sail is a short-span wing- or oval-shaped vertical structure, sometimes also referred to as 'ventilated foil' or 'turbo sail'. An electric-powered suction system sucks air through the leeward perforated surface. Suction sails need to be aligned to the incoming wind direction with an optimum angle of attack. Due to the suction fan operation, they need a continuous supply of electrical power to operate, though it is small compared with the power output. Cutting off electrical power supply stops operation and lift generation. Suction sails are available with a tilting mechanism to facilitate port operations or reduce air draft.

Technical and Operational Implications

Depending on the planned thrust contribution as well as economical evaluations, WAPS are available in different sizes. Table 2 gives typical ranges of dimensions. Numbers should be read as indicative as developments of systems and technologies are continuously ongoing in the industry. One or more units can be installed on board.

	Rotor sail	Wing sail	Suction sail
Height	up to 35 m	up to 50 m	up to 26 m
Width / chord length	4 m – 5 m	10 m – 20 m	3 m – 6 m
Weight, incl. foundation	34 – 90 t	45 – 100 t	15 – 55 t

Table 2: Typical dimensions of WAPS technologies ^[5]. The values should be understood as indicative.

Some WAPS have deployment and retraction systems enabling them to be moved on deck, tilted or folded. This is to facilitate port operations, reduce air draft, improve bridge visibility or protect them from high winds.

WAPS may introduce implications or requirements for the design and onboard integration, and the installation may include operational considerations, see lists below. Further implications and requirements may exist, and the significance of each depends on e.g. the WAPS technology, its relative size compared to the ship and the ship type in question. As safety principles vary between WAPS types, understanding these principles is crucial to identify the technical and human risks associated with WAPS operation.

Technical Design and Integration Requirements (not in prioritised order):

- Structural integration and reinforcements
- Stability calculations
- Bridge visibility
- Installation of electrical equipment in hazardous zones
- Added weight
- Air draft
- Obstruction of mooring configuration
- WAPS location: undisturbed airflow and available deck space
- Fire and electrical safety
- Weather and environmental limits for operation
- Safe access for maintenance

Operational Considerations (not in prioritised order):

- System robustness and reliability
- Interference with deck/cargo handling
- Heeling moments (intact stability)
- Manoeuvrability
- Crew education
- Local requirements for port operations, pilots, towage, channels, locks etc.
- Interference with helicopter/evacuation procedures
- Voyage planning

- Power management and integration with existing propulsion
- Depowering and shutdown procedures
- Engine and propeller derating (in case of retrofiting)
- Failure mode handling

Application of Rules and Regulations

Safety, operational and training standards which need to be complied with are provided by the International Maritime Organization through their relevant instruments. Requirements that may be particularly affected by a WAPS includes, but is not limited to:

- the Safety of Life at Sea (SOLAS) Convention,
- the Convention on the International Regulations for Preventing Collisions at Sea,
- the International Code on Intact Stability Code, and
- the Standards of Training, Certification, and Watchkeeping (STCW) Convention.

Furthermore, classification societies provide additional requirements through their relevant rules, standards and guidelines. Table 3 lists standards from the classification societies in MTF. Other classification societies may have similar rules.

Classification society	Standard(s)	Edition
ABS	Requirements for Wind Assisted Propulsion System Installation	July 2022
DNV	DNV-ST-0511 Wind assisted propulsion systems DNV-RU-SHIP Pt.6 Ch.2 Propulsion, power generation and auxiliary systems	July 2025
LR	LR-GN-044 Guidance Notes on Wind Assisted Propulsion Systems	Aug. 2025
ClassNK	Guidelines for Wind-Assisted Propulsion Systems for Ships	June 2025 (Ed. 2.2)

Table 3: Published standards on WAPS from MTF classification societies.

It should be noted that as the use of WAPS in modern shipping is in its development, updates to both the regulatory framework and classification society rules may be expected.



Introduction to the Guidelines

These guidelines are developed following a review of the ISM Code Part A, in the light of public literature on WAPS. The guidelines are structured to mirror the chapters of the ISM Code and aim to explain the updates needed to apply to an SMS when a WAPS is installed onboard a ship. The goal is to help the reader by highlighting the new updates to each ISM Code chapter:

1. General
2. Safety and environmental-protection policy
3. Company responsibilities and authority
4. Designated person(s)
5. Master's responsibility and authority
6. Resources and personnel
7. Shipboard operations
8. Emergency preparedness
9. Report and analysis of non-conformities, accidents and hazardous occurrences
10. Maintenance of the ship and equipment
11. Documentation
12. Company verification, review and evaluation

Some chapters of this report provide more detailed content than others, due to the varying applicability of the ISM Code to WAPS and related SMSs. Where relevant, recommendations for updating the SMS are presented at the end of each chapter.

It should be noted that the guidelines in this document are based on the current state of regulatory development and industry experience. These guidelines should therefore be seen as a progressive step in the interim, to identify and fill gaps in operational governance for ships using WAPS for wind assistance. Once regulatory requirements are published, they should take precedence.

As explained in 'Background and Objectives', the current industry experience and published work is heavily weighted by wind assisted ships using rotor sails, suction sails or wing sails. Updates to these guidelines are likely needed with further development in industry, in terms of ship design, degree of wind propulsion and uptake of other WAPS technologies.

While the goal is to explain what should be updated in an SMS when a ship is using WAPS, some content within these guidelines is more generic. It is crucial to interpret this through the lens of operating a ship equipped with WAPS.

1. General

The integration of WAPS marks a significant advancement in maritime technology, offering substantial benefits in fuel and emissions reductions. As the adoption of WAPS accelerates, it is essential that Safety Management Systems are robustly updated to reflect the unique operational, technical, and organisational requirements of these systems in accordance with the functional requirements (Section 1.4) of the ISM Code.

Any updates should address the identification of new hazards associated with WAPS, the implementation of appropriate mitigating measures, and ensure that risk assessment, emergency preparedness, and continuous improvement procedures reflect the operational realities of WAPS-equipped vessels.

Technical considerations for WAPS should encompass the evaluation of aerodynamic forces, structural integration, fatigue strength, and the impact on vessel manoeuvrability, as outlined in recent classification society standards, Table 3. Additional factors should be considered when determining which vessel types are suitable for WAPS implementation, whether for newbuild vessels or retrofits.

Companies should ensure that personnel both ashore and aboard are adequately trained in operations and emergency response procedures specific to WAPS, reflecting the ISM Code's emphasis on competence and safety culture.



2. Safety and Environmental Protection Policy

The rapid development and deployment of WAPS represents a transformative shift in maritime technology, necessitating targeted updates to the company's Safety and Environmental-Protection (SEP) policy as required under Ch. 2 of the ISM Code. The SEP should be updated to explicitly reference WAPS and alternative propulsion technologies, aligning with international sustainability goals and regulatory frameworks such as the Energy Efficiency Design Index (EEDI) and the Carbon Intensity Indicator.

It is therefore recommended that the SEP policy clearly outlines protocols for the safe integration and operation of WAPS throughout the fleet. This should encompass a thorough risk assessment process, detailed evaluation of hazards relevant to WAPS installation, operation, and maintenance, and the incorporation of systematic risk management and continuous improvement measures within organisational procedures. The policy should also outline mechanisms for ongoing monitoring of WAPS performance and safety considerations. Regular reviews and feedback loops to shore-based management will support continual learning and operational refinement.

Incorporating these provisions will demonstrate a clear commitment to adopting alternative propulsion technologies and ensuring their safe and effective use. As the technology landscape continues to evolve, the SEP should remain current with emerging industry best practice and regulatory changes.

While WAPS offers notable environmental benefits, the SEP policy should also recognise and address the risks associated with technical integration and operational hazards, establishing the company's commitment to risk management. This will vary depending on the WAPS technology installed on the vessel, whether that be rotor, suction or wing. More details on potential risks associated with operation is given in Ch. 7 of this report.

By systematically identifying, assessing, and mitigating these risks, the company can ensure safe, compliant and sustainable operation of vessels equipped with WAPS.

No.	Recommended actions
2.1	Update the SEP policy to reflect the new propulsion technology and regulatory developments, maintaining alignment with international sustainability goals such as the EEDI.
2.2	The company will ensure that crew receive structured and comprehensive training in WAPS-specific operational and emergency procedures, reinforcing a safety culture throughout the fleet.
2.3	Explicitly acknowledge the unique safety and environmental risks associated with WAPS and emphasise strict adherence to SMS processes and procedures.
2.4	Ensure environmental protection commitments by focusing on minimising emissions and operational risks during routine operations, maintenance, and emergencies, and by establishing robust monitoring and reporting systems for WAPS performance.

3. Company Responsibilities and Authority

The integration of WAPS into the company's fleet introduces new operational complexities and safety considerations, requiring a clear and robust framework of responsibilities as mandated by the ISM Code. The introduction of WAPS should be treated as a significant operational change and managed through the company's Management of Change (MOC) process. More details are provided in Ch. 11 of this report.

Companies should ensure that all onboard and shore-based personnel involved in the installation, operation, maintenance, emergency response and monitoring of WAPS have clearly defined roles and responsibilities. This necessitates a thorough review and update of job descriptions across all relevant functions, ensuring that expectations are unambiguous and that everyone understands their specific duties in relation to WAPS.

While details of the below recommended updates to an SMS are given in later chapters of this report, it is important to acknowledge the company's ultimate responsibility under the ISM Code:

- The ISM Code places a strong emphasis on the provision of adequate resources and shore-based support. Companies are required to allocate sufficient personnel, technical expertise, and financial resources to support the safe and effective operation of WAPS. This includes ensuring that Designated Person(s) (DP) and all staff engaged with WAPS have access to the necessary training, guidance, and operational support to fulfil their responsibilities.
- Companies should foster a culture of continuous improvement and safety by regularly reviewing the effectiveness of these arrangements. This involves monitoring the implementation of WAPS-related procedures, gathering feedback from both shipboard and shore-based personnel, and making timely adjustments to address any gaps or emerging risks.
- Companies should be proactive in providing oversight, facilitating communication between ship and shore, and responding promptly to any operational challenges or deficiencies identified in relation to WAPS.

By embedding these principles into their management systems, companies will not only comply with the ISM Code but also demonstrate a commitment to operational excellence and the safe, sustainable adoption of innovative propulsion technologies.

No.	Recommended actions
3.1	The company is responsible for updating the SMS to include WAPS procedures for operation, maintenance, and emergency response.
3.2	The company is responsible for providing adequate resources, including trained personnel onboard and ashore, technical support and associated funding, for WAPS operations.
3.3	Ensure clear communication and oversight between ship and shore to address WAPS-related issues promptly.
3.4	Review WAPS roles and responsibilities regularly and update job descriptions as needed.
3.5	Monitor WAPS procedures and feedback to drive continuous improvement and manage emerging risks.

4. Designated Person(s)

The DP play a vital role in the development, implementation, maintenance, and continual improvement of a company's SMS. The role is critical in bridging the gap between onboard operations and shore-based management.

The adoption of WAPS within the maritime sector marks a significant evolution in vessel technology, introducing both opportunities and new responsibilities under the ISM Code. To ensure the safe and effective integration of WAPS, companies should conduct a thorough review of their SMS, with particular attention to the roles and support structures surrounding the DP.

The job description of the DP should be amended to explicitly reference WAPS, in line with recommendations of Ch. 3. The DP is entrusted with monitoring the safe operation of each vessel, and as WAPS technology introduces new operational parameters, the DP's responsibilities should be clearly defined to include oversight of WAPS operation, and emergency response. The DP should ensure compliance with the SMS, verify that vessels are adequately manned, equipped, and maintained for WAPS operations, and take all necessary steps to uphold safety and environmental standards.

In addition to the essential criteria provided in MSC-MEPC.7/Circ.6, desirable suitability criteria for the DP role should be based on the following training and experience (not exhaustive):

Training:

- DP training should align as much as practically possible to WAPS safe operational practices.
- Appropriate knowledge of the WAPS technology specific to each vessel in the fleet, associated risks and how the WAPS impact ship handling.

Experience:

- Familiarity with the technical, operational, and safety characteristics of WAPS, including that of system functionality, operating limits, associated hazards, and the interaction between WAPS and existing vessel systems.

It is the responsibility of the company to provide the DP with sufficient authority, resources, and access to senior management. By undergoing the appropriate training and possessing the necessary experience as outlined above, the DP can act decisively in matters of safety, escalate concerns when necessary, and contribute to the ongoing refinement of company policies and procedures.

No.	Recommended actions
4.1	Integrate WAPS-specific training into the DP role, focussing on WAPS related risks, and ensuring relevant experience or familiarity of WAPS-related operations, systems and components.
4.2	Develop clear lines of communication to the DP for onboard personnel, and from the DP to the highest level of onshore management, ensuring WAPS safety performance is monitored and communicated, and timely actions are taken to address any issues that arise.
4.3	Establish structured mechanisms to periodically review WAPS-related safety performance, using digital dashboard and incident tracking systems to provide actionable insights to management.
4.4	The company should ensure that the DP participates in industry-level WAPS working groups, staying up to date on regulatory changes and incidents in the field.
4.5	The company should provide targeted WAPS emergency training for DPs and key staff to strengthen preparedness and ensure effective response in emergency situations.

5. Master's Responsibilities and Authority

If the SEP policy is updated to include WAPS, it is essential that the Master fully understands the revised policy and ensures that all crew members are briefed and comply with the changes. The Master is responsible for overseeing the effective rollout, communication, and understanding of all updates to the SMS related to WAPS. Regular reviews and monitoring of these changes are necessary to identify and address any issues or gaps in understanding, reflecting the evolving operational context brought about by WAPS.

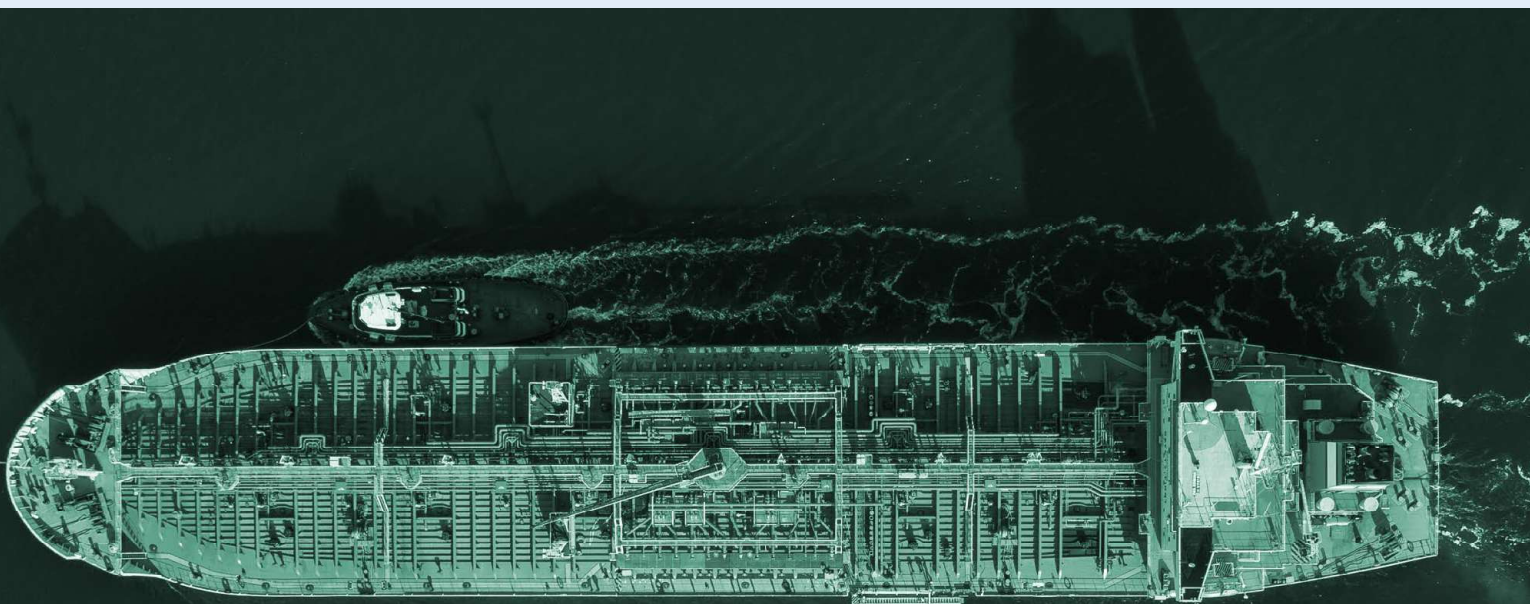
The Master should ensure that the crew understands their individual roles in maintaining compliance, as well as WAPS-related operational changes compared to conventionally propelled vessels. Structured briefings should be provided, and adherence to updated procedures should be reinforced during voyage planning and operational activities. This approach fosters a culture of safety and ensures that all personnel are actively engaged in upholding the revised SEP policy.

To account for the potential operational impact of WAPS and any new procedures and responsibilities arising from this technology, updates to the following may be relevant (list not exhaustive):

- Standing Orders
- Voyage planning
- Vessel's specified requirements (WAPS-specific operating envelopes)
- Enhanced watchkeeping arrangements
- Explicit instructions to the Officer of the Watch (OOV)
- Master-Pilot exchange

Ongoing monitoring of compliance with WAPS-related SMS updates and operational procedures is essential, supported by structured reporting and feedback loops to ensure performance and safety standards are maintained.

Regular review and monitoring of the effectiveness of WAPS-related changes are fundamental to maintaining high safety standards. The Master should promptly report any deficiencies or operational challenges to shore-based management, ensuring that issues are addressed and continuous improvement is achieved.



In line with the ISM Code paragraph 5.2, the Master has overriding authority to make decisions with respect to safety and pollution prevention. Clear guidance should be provided in the SMS, including escalation criteria to support consistent decision-making. Actions relevant for overriding authority may be related to e.g. malfunctions, heavy weather, or loss of situational awareness, and include to (list not exhaustive):

- Override automation and place WAPS in the required mode.
- Alter planned course of Estimated Time of Arrival.
- Restrict entry into WAPS hazardous zones.
- Suspend WAPS before e.g. towing, pilotage or rapid manoeuvres.
- Isolate power or hydraulic systems connected to WAPS.

Effective communication and a well-defined command hierarchy are essential. Crew members should be encouraged to promptly report any unsafe conditions to the Master. Consequently, the Master plays a pivotal role in maintaining safe operations onboard WAPS-equipped vessels.

No.	Recommended actions
5.1	The company should ensure that the Master's responsibilities are updated to explicitly address the safe integration, operation, and emergency management of WAPS. This includes to ensure that clear communication and structured reporting requirements are in place.
5.2	The SMS should define the responsibility and authority of the Master in relation to WAPS-related operations and delegating specific responsibilities to certified personnel.
5.3	Through their responsibility for the rollout, communication, and understanding of updates to the SMS, the Master should ensure that the WAPS is integrated in clear operational procedures through e.g. updated Standing Orders, explicit instructions to the OOW and in the Master-Pilot Exchange.
5.4	Procedures should be developed for the Master to periodically review and evaluate the SMS, with a specific focus on WAPS-related operations. This review should ensure that the Master's authority, operational procedures, and safety measures for WAPS are clearly defined, up to date, and effective for both safety and pollution prevention.

6. Resources and Personnel

The existing regulatory framework provides general requirements for manning under the SOLAS Convention, and training and familiarisation through the ISM Code and STCW Convention. At present, however, there is no equivalent structured approval mechanism that directly addresses the operational characteristics of WAPS. While European Maritime Safety Agency (EMSA) and several classification societies have begun developing preliminary guidance, internationally standardised WAPS-specific training requirements remain absent.

At present, there are no WAPS-specific certifications, endorsements or structured approval pathways. The WAPS-related training should, for now, follow industry best practice, not a regulatory requirement, with the focus placed on ensuring competence through company SMS procedures, supplier guidance and role-specific familiarisation.

The training should, however, be consistent with the principles set out in STCW.7/Circ.25 Generic Interim Guidelines on Training for Seafarers on Ships Using Alternative Fuels and New Technologies^{1 [7]}, which provides a reference for development and approval of role-based basic and advanced training, and familiarisation prior to assignment of duties. Application of these guidelines to WAPS should be on a non-mandatory basis and tailored through company SMS arrangements, taking into account the specific characteristics of the installed technology and associated risks.

For companies operating vessels fitted with WAPS, the main objective is to ensure that personnel have the competence, familiarisation and role-specific understanding necessary to operate and monitor the system safely. This includes being familiarised with applicable Permit To Work (PTW) requirements and associated protocols. Training should reflect the characteristics of the installed WAPS technology, including aerodynamics, deployment/feathering functions, control interfaces, emergency modes and any consequential navigational implications. It should be commensurate with the individual's role, responsibilities, and level of interaction with WAPS, and should be incorporated into the company's existing training, familiarisation, and competency management processes.

Given the novel elements introduced by WAPS, including sensor-dependent control logic, variable load paths, abnormal vibration characteristics and potential visibility constraints, companies should ensure that shipboard personnel are adequately trained in system-specific operation, monitoring and failure response, taking into account supplier documentation and operational guidance. Table 3 Further references which may be useful include:

- IWSA (2024) Wind Propulsion: Zero-Emissions Energy Solution for Shipping, Sec. 5.5 and 5.9 (MEPC 81/Inf.39)
- WASP Interreg North Sea Region (2023) D2.4c Best Practice Manual, Ch. 7
- EMSA (2023) Potential of wind-assisted propulsion for shipping, Sec. 3.1–3.6

Industry-led familiarisation initiatives, such as ^[8], may be used as upstream baseline training to support understanding of WAPS concepts. Such initiatives are not intended to replace equipment-specific training, onboard practical instruction, or supplier-provided guidance, but may complement company SMS arrangements for familiarisation and competence development.

Shipboard personnel should be able to demonstrate competence in the following WAPS-related areas:

- **Understanding WAPS operations:** Operating modes, deployment/feathering logic, aerodynamic effects, aerodynamic forces at varying wind angles, and how these factors influence manoeuvrability, visibility and stopping characteristics.
- **Identifying operational risks:** Abnormal vibration, increased structural loads, restricted visibility, emergency shutdowns, sensor or automation faults, and interactions with other ship systems.
- **Performing critical tasks safely:** Routine operational checks, monitoring system responses, deployment/feathering actions, securing arrangements and executing emergency modes (STOP, FEATHER, SAFE MODE, LOCKOUT) in accordance with supplier and SMS guidance.

Training and familiarisation should incorporate representative ship-specific scenarios, such as deployment or securing during heavy weather, vibration or noise deviations, or navigating with reduced visibility due to WAPS positioning.

The training should be equipment-specific where the safe operation, monitoring or emergency response associated with WAPS depends on the characteristics of the installed system. Such equipment-specific training aligns with ISM principles on competence and familiarisation, particularly where WAPS introduces novel control logic, operating modes or risk profiles not addressed through generic training. Accordingly, companies should ensure that WAPS-related familiarisation and training are tailored to the installed technology and documented within the SMS as part of the vessel's competence management arrangements.

Responsibility for WAPS-related oversight should be assigned in a structured manner appropriate to the task and operational context. WAPS responsibilities may be distributed among one or more suitably trained personnel, covering system monitoring, operational control, and emergency response.

Role allocation should take account of the navigational workload, system status, and operational conditions. Assignment of WAPS-related tasks should not compromise primary navigational or safety duties, and clear limits of authority and escalation arrangements should be defined.

Role-specific considerations include:

- Deck personnel: hazardous-zone awareness, inspections, securing arrangements.
- Bridge personnel: WAPS monitoring, alarm interpretation, visibility assessment, integration into navigational decisions.
- Engineering personnel: mechanical/electrical interfaces, control-system behaviour, safe-mode transitions and system integrity.

The human element remains central. Preventive measures should seek to minimise unintentional errors through:

- Periodic drills and refresher training.
- Reduced personnel presence in hazard zones.
- Structured communication protocols during deployment, feathering, shutdown or emergency operation.

No.	Recommended actions
Training-related recommendations	
6.1	Document competence gaps related to WAPS and identify required certifications, if developed, training and operational experience. Use competence programmes to conduct assessments and define appropriate follow-up actions.
6.2	Develop targeted training covering WAPS operational hazards and emergency shutdown scenarios. Verification or certification may be applied based on role-specific responsibilities.
6.3	Provide structured training for maintenance and engineering personnel on WAPS mechanical, electrical and control-system behaviour, including safe-mode transitions and fault handling.
6.4	Personnel should be trained and familiarised with WAPS-related PTW requirements and associated checklists relevant to their assigned duties.
6.5	Maintain a rank-wise WAPS Training Matrix including refresher training intervals, onboard demonstrations and (where available) simulation-based training.
6.6	Maintain auditable records of all WAPS-specific training and drills to demonstrate compliance with ISM Code 6.5 regarding the identification of training needs.
Training-related recommendations	
6.7	Establish familiarisation procedures covering hazardous zones, WAPS interfaces and associated equipment, with the aim of reducing unnecessary exposure to moving or load-bearing elements.
6.8	Issue simplified operational cards and pictorial guides outlining routine operations, alarms, hazardous zones and emergency modes in the working language of the crew.

7. Shipboard Operations

The integration of WAPS on ships, whether as part of a retrofit or on newbuild vessels, may bring substantial changes to shipboard operations that the crew should manage effectively.

The company should take responsibility for creating and applying clear procedures to manage all shipboard operations that involve or are affected by WAPS, ensuring that new complexities and safety risks are properly addressed. These procedures should be tailored to each vessel, taking into account its specific design layout, the type of WAPS technology installed, operational profile, and trade routes.

Given the emerging nature of WAPS technologies in the maritime industry, there is currently limited operational data to support the development of fully comprehensive procedures. This limitation, combined with the absence of mature regulations and established safety standards, makes it essential to base procedure development on structured risk assessment methodologies. Frameworks such as ISO 31000:2018 may be consulted as an example of a systematic approach to identifying, analysing, and evaluating risks. The company should track emerging developments in the sector, incorporate lessons learned, and ensure that risk assessments are regularly reviewed and updated as operational experience evolves.

Useful insights can be drawn from early pilot projects and ongoing research, which can provide practical experience in utilising WAPS. A list of useful references, including existing guidelines and best practices related to WAPS can be found below. This list is not exhaustive.

- WASP Interreg North Sea Region (2023), D2.4c Best Practice Manual
- EMSA (2023), Potential of wind-assisted propulsion for shipping
- ITTC (2024), Report of the Wind Powered and Wind Assisted Ships Committee

The following sections provide an overview of potential risks associated with shipboard operations on vessels equipped with WAPS, avoiding references to specific technologies or configurations to maintain broad applicability.

For the purpose of this chapter, risks are categorized by when and where they occur during a vessel's operations:

- 1. Open Water Navigation:** Risks that arise while the vessel is underway.
- 2. Port Operations:** Risks that occur during berthing, mooring, and cargo handling.



7.1 Open Water Navigation

Air Draft

Conflicts related to the WAPS air draft may impose operational risks, such as when navigating under bridges or other overhead structures. The consequences may include e.g. property damage and reduced safety for onboard personnel. Where WAPS are retractable or can be partially or fully stowed, the proper operation and configuration of these systems should be verified well in advance of any transit under overhead obstructions.

Weather Routing and Localised Conditions

WAPS performance is highly dependent on the wind field. Because of this, strategic route planning should explicitly consider expected wind direction, strength, and variability along the entire passage, not just local conditions. However, weather routing models may fail to capture localized effects and their quick evolution. The Master should therefore combine forecast-based routing with current onboard weather observations (e.g. wind instruments, barometer trends, radar and satellite imagery, nearby weather reports) and be prepared to adjust WAPS settings and ship course whenever conditions require it.

Propulsion System Performance

For WAPS-equipped ships deriving a large share of their propulsion from the system, high aerodynamic thrust may force the conventional propulsion system to operate outside its optimal operating envelope. This may lead to inefficiencies or even increased wear on critical components such as the main engine, shafting, and rudder; issues that are particularly significant for WAPS-retrofitted vessels ^[9].

Reliance on CCTV for Visibility

Some flag States have considered the use of Closed-Circuit Television (CCTV) as an alternative technical solution to mitigate visibility obstructions created by WAPS. While CCTV can enhance situational awareness, they may also introduce their own failure modes, including power loss, hardware faults, and reduced effectiveness when severe weather, low light, or glare degrades image quality. Shipboard operating procedures should incorporate relevant safeguards.

Stability

The aerodynamic forces generated by WAPS may affect a vessel's stability behaviour, leading to e.g. static heel and changes in roll response characteristics. The safe operating envelope for a WAPS-equipped vessel is not fixed; it varies with the weather conditions. A vessel-specific WAPS operating manual should be kept on board, detailing the permissible weather envelope based on the vessel's particular WAPS configuration, ship design, and operational scenarios. The Master and OOW should be fully aware of these limitations to ensure informed decision-making regarding WAPS deployment.

Course-keeping and Manoeuvrability

The operation of WAPS can influence a vessel's manoeuvrability and its ability to maintain course. The effect may be both positive and negative, as described in e.g. ^[6], ^[10] and ^[11], and are generally more pronounced when the vessel operates at low speeds while experiencing a high level of wind assistance. Relevant precautions should be considered during critical manoeuvres. The time required to reduce wind assisted propulsion should be factored in. This is particularly important for systems with rotating components, such as rotor sails, which require substantial time to decelerate due to inertia ^[12].

Cold Weather Conditions

Operating WAPS in cold weather conditions may introduce hazards related to ice and snow accumulation on system components. These hazards may affect the aerodynamic characteristics of the system and can create loads that may compromise its structural integrity. Ice buildup can impair the functionality of moving parts and if detached unexpectedly pose risks to personnel and other equipment.

Green Water

Green water effects during heavy seas present a significant risk for WAPS installations. As with all weather-exposed equipment, green water can damage structural components, compromise stowage systems where fitted, and affect the integrity of electrical, mechanical, and hydraulic systems associated with the installation. Prolonged exposure may also accelerate corrosion and shorten the service life of critical parts. Adherence to the supplier requirements or other best practices for protecting WAPS against green water exposure is essential.

7.2 Port Operations

Berthing and Unberthing

Port operations should explicitly account for risks associated with WAPS, including potential effects on vessel manoeuvrability, visibility, and air-draft constraints. In those cases that wind propulsion devices can be fully retracted or stowed, their impact on manoeuvrability is expected to be negligible. For installations that remain upright even when deactivated, the increased windage and associated aerodynamic forces may still have a noticeable effect on handling, particularly in strong wind conditions.

Mooring and Anchoring

The presence of WAPS equipment, particularly in retrofit installations, can impact the vessel's typical mooring and anchoring arrangements. WAPS may physically interfere with mooring and anchoring equipment, obstruct line leads, or restrict crew access to mooring stations. Non-retractable WAPS units that remain upright increase the vessel's windage, thereby imposing additional loads on mooring/anchor lines and fittings ^[13].

Cargo Handling

WAPS installation may interfere with cargo operations by restricting the movement of lifting appliances or other cargo-handling systems. Particularly for WAPS-retrofitted vessels, cargo handling procedures should address any operational constraints related to WAPS ^[4].

Where vessel arrangements permit the retraction/lifting and secure stowage of WAPS components, detailed procedures for these operations should be incorporated into the ship's cargo handling plans ^[14].

No.	Recommended actions
7.1	Shipboard operations that involve or are affected by WAPS should be identified, monitored, and updated to address safety risks imposed by WAPS. Risk assessment activities should be specific for each vessel and WAPS technology.
7.2	A vessel-specific operational manual should be available, detailing all WAPS procedures and the allowable weather conditions (including extreme low temperature, high seas conditions) for safe operation.
7.3	Assess the need for additional personnel during deployment, feathering, securing or heavy-weather adjustments to ensure adequate oversight and safe conduct of operations.
7.4	To exercise good seamanship, Masters and crew should be aware of the WAPS system specifications and the influence of WAPS on vessel safety.
7.5	Any WAPS-related constraints affecting port operations, such as berthing and cargo handling, should be clearly communicated and coordinated with external stakeholders.

8. Emergency Preparedness

The presence of WAPS onboard a ship can both cause an emergency to arise and exacerbate emergencies originating from unrelated circumstances. Although it is possible to address many of the risks associated with WAPS through robust design, some risks can only be mitigated by operational controls. It is therefore essential that there are comprehensive emergency response procedures in place to manage risks effectively and minimise harm to the ship and crew. A list of useful references, including existing guidelines and best practices related to WAPS emergency preparedness can be found below. This list is not exhaustive.

- IWSA (2024) Wind Propulsion: Zero-Emissions Energy Solution for Shipping, White paper (MEPC 81/Inf.39)
- EMSA/Wind – 2022/2023 – 4837444 Potential of Wind-Assisted Propulsion for Shipping
- WASP Interreg North Sea Region (2023), D2.4c Best Practice Manual
- Relevant classification society guidelines and standards as given in Table 3

Examples of potential emergency shipboard situations associated with or affected by WAPS are given in Table 4:.

Cause	Example scenario / risk
Control system failure	Automation malfunction, loss of sensor input, software error, cyber attack
Electrical/hydraulic failure	Power outage, short circuit, hydraulic leak
Mechanical failure	WAPS collapse, actuator jam, bearing failure
Dropped objects	Dropped objects from lifting operations (where WAPS permit lifting and secure stowage of components)
Fire/explosion	Electrical fire, hydraulic fluid ignition, battery fire/explosion, hazardous cargoes
Extreme weather	High winds, storms, rogue waves, ice accumulation
Lightning strike	Damage to tall WAPS structures, electrical systems
Human error	Incorrect operation, maintenance mistake, procedural lapse, inadvertent disconnection of non-permanent connection(s)
Working at height	Fall, dropped object, injury during maintenance or emergency intervention
Navigation hazard	Obstructed visibility, radar blind spots, blocked navigation lights, CCTV malfunction
Unintended deployment/stowage	Accidental activation, accidental stowage, failure to stow during adverse conditions
Loss of manual override	Inaccessible or malfunctioning manual controls
Integration failure	Poor connection to ship systems, delayed emergency response
Escape route obstruction	Failure of WAPS may lead to blocking lifeboat launching, access to helipad or changing escape paths
Abandon ship	No explicit procedure for securing WAPS during evacuation
Flooding, collision, grounding etc.	Inclusion in shore-based emergency response considerations
Company policy gap	Outdated emergency planning, lack of scenario-based procedures

Table 4: Potential emergency shipboard situations. Not limited and not in prioritised order.

Note that specific ship types and WAPS systems may have different or additional risks associated with them. For example, a ship which is carrying a dangerous or hazardous cargo will have cargo specific risks which could interact with the WAPS system in an emergency scenario. In such cases, it is likely that a risk assessment will have been carried out as part of the design review and hence the emergency planning should take account of these risks.

Another important consideration is that, at present, the majority of WAPS are installed on existing ships where it may not be possible to design out the risks as comprehensively as on a newbuild design. Therefore, the scope of emergency planning for a newbuild ship may differ to that for an existing ship.

The SMS should include WAPS specific, detailed response procedures including but not limited to:

- Emergency shutdown: Test manual override and fail-safe functions at bridge and local stations. Ensure that all crew know emergency shutdown procedures. Redundant power and control systems should be maintained and tested regularly.
- Fire response: Confirm fire detection and suppression coverage for all WAPS components. Train crew in WAPS-specific fire response, including firefighting at height and safe securing of devices.
- Heavy weather: Develop and drill rapid stowage or feathering procedures for WAPS in heavy weather, storms, or rogue waves.
- Lightning: Maintain and inspect lightning protection systems on tall WAPS structures as preventive measures for emergencies arising from lightning and heavy weather.
- Crew safety: Enforce Personal Protective Equipment (PPE) and drop protection for maintenance, operation and emergency situations.
- Escape: Integrate WAPS securing into abandon ship drills.
- Emergency drills and exercises: Conduct regular drills for WAPS related scenarios including system failures, fires, loss of control, ship casualty and abandon ship. Where the ship is enrolled in a shore-based emergency response service, ensure that the response service is also drilled in WAPS related scenarios.
- Chain of command: Define roles and responsibilities for WAPS emergencies.
- Company-level response: Incorporate remote guidance and external expertise into emergency procedures.
- Continuous improvement: Analyse drills outcomes, incidents, and near-misses to refine procedures, identify additional training needs and ensure plans remain effective and relevant. Keep records of procedural enhancements based on feedback and incident analysis. Regularly review emergency procedures to ensure that emergency procedures reflect best practice and are up to date with industry developments.

No.	Recommended actions
8.1	The company should develop detailed WAPS-emergency response procedures tailored to each foreseeable potential emergency. The protocols should include immediate crew actions and escalation plans to ensure rapid and effective mitigation of hazards. The emergency response procedures should incorporate the recommendations of the risk assessment.
8.2	The company should ensure that the SMS incorporates procedures for WAPS emergency shut down and establishes clear actions in the event that both the automatic fail-safes and the manual override fail.
8.3	Emergency drills and exercises, which may be conducted based on reported incidents and near-misses, should involve shipboard teams and, where relevant, shore-based emergency response. The company should ensure that it is prepared to respond effectively and coordinate with external parties during emergencies.

9. Reports and Analysis of Non-conformities, Accidents and Hazardous Occurrences

The SMS should include documented procedures for the reporting, investigation, analysis, corrective action and follow-up of all non-conformities, accidents and hazardous occurrences associated with the operation, maintenance and integration of WAPS.

Given the relatively limited operational experience of WAPS compared to conventional propulsion arrangements, the reporting framework should adopt a precautionary and inclusive approach. Reportable events should include not only accidents and equipment failures, but also near-misses, abnormal system behaviour and degraded performance that could, if repeated or combined with other failures, adversely affect ship safety, personnel safety or navigational integrity.

Scope of Reportable Events

WAPS-related reportable events should include, but are not limited to:

- Abnormal vibration, noise or structural response outside approved operating envelopes.
- Unintended deployment, feathering, partial stowage or failure to stow.
- Failure, degradation or loss of control, sensor, automation or communication functions.
- Loss, inaccessibility or malfunction of manual override or emergency stop functions.
- Electrical, hydraulic or mechanical failures affecting WAPS availability, controllability or structural integrity.
- Dropped objects, near-misses or hazardous conditions arising during inspection, maintenance or adjustment of WAPS.
- Obstruction or impairment of navigation lights, radar performance, visibility, CCTV coverage or lookout effectiveness attributable to WAPS configuration or failure.
- Operation outside approved limits, including wind speed, wind angle, sea state or load limitations.
- Human-Machine Interface (HMI) issues, procedural deviations or misinterpretation of system status or alarms.
- Any WAPS-related condition that affects emergency response capability, escape routes, muster arrangements or access to lifesaving appliances.

Reporting Framework

The SMS should establish a structured and consistent reporting process that defines clear criteria for WAPS-related non-conformities, accidents and hazardous occurrences, specifies reporting timelines and escalation requirements, and identifies responsible persons for initiating, reviewing and closing reports.

Reporting templates should be adapted, where necessary, to capture WAPS-specific information, including as applicable (not exhaustive):

- WAPS type, age of system, configuration and operating mode at the time of the event.
- Environmental conditions such as wind speed, wind direction and sea state.
- System status, including automatic or manual control, active alarms and override status.
- Interfaces with other ship systems affected by the event.
- Immediate actions taken and the observed system response.

Roles and Responsibilities

While roles for incident reporting are typically outlined in the SMS, responsibilities for WAPS-related reporting, investigation, review and follow-up should be explicitly defined within the SMS. Such personnel should have sufficient technical understanding of WAPS operation to ensure accuracy, clarity and usefulness of the information provided.

Investigation and Analysis

Investigations of WAPS-related incidents and hazardous occurrences should be conducted in a structured and proportionate manner, commensurate with the severity and potential consequences of the event.

Investigations should aim to identify immediate technical or operational causes, contributing human, procedural, organisational or environmental factors, and any latent conditions within the SMS, training arrangements, design assumptions or system interfaces.

Analysis should not be limited to hardware failure but should also consider system integration, human-machine interaction, procedural clarity, workload management and decision-making under operational conditions.

Root cause analysis methods appropriate to the complexity of the event should be applied to support objective identification of underlying causes and prevent recurrence.

Data Review and Trending

The company should maintain a centralised record of WAPS-related non-conformities, accidents and hazardous occurrences. Periodic review of this data should be undertaken to identify recurrent failure modes, emerging trends indicating increased risk exposure or reduced system margins, and opportunities for procedural, training or design improvements.

Where applicable, findings should be reviewed against original design assumptions and risk assessments to verify that the safety philosophy remains valid throughout the operational life of the vessel.

Corrective Actions and Preventive Measures

Based on investigation outcomes, the company should define, implement and track corrective and preventive actions addressing identified root causes. Such actions may include revision of operational or emergency procedures, targeted training or refresher programmes, updates to checklists, PTW or operating limits, enhanced inspection, monitoring or maintenance measures, and clarification of roles, responsibilities or escalation pathways.

Where relevant, corrective and preventive actions should be assessed for applicability across other vessels fitted with the same or similar WAPS installations.

Learning and Continuous Improvement

Lessons learned from WAPS-related non-conformities, accidents and hazardous occurrences should be communicated to shipboard and shore-based personnel, as appropriate, and incorporated into training and familiarisation programmes, drills and exercises, and SMS documentation. Where appropriate, they should also be shared, anonymised if necessary, with relevant industry stakeholders, including equipment suppliers, to support a collective improvement.

In line with risk-based approval and certification principles, incidents should be assessed against original acceptance criteria to validate the continued adequacy of the safety philosophy and to support ongoing improvement of WAPS operations.

No.	Recommended actions
9.1	Establish SMS procedures for reporting all WAPS-related non-conformities, accidents and hazardous occurrences, including near-misses, abnormal behaviour and degraded performance affecting safety or navigation.
9.2	Ensure reporting templates capture WAPS-specific information, including (as applicable) system configuration, operating mode, environmental conditions, system status and immediate response actions.
9.3	Maintain a centralised record of WAPS-related events and periodically analyse data to identify trends, recurrent issues and emerging risks, with review against original design assumptions and risk assessments where applicable.
9.4	Define, implement and verify corrective and preventive actions arising from WAPS-related investigations, communicate lessons learned, and assess applicability across vessels with similar WAPS installations.

10. Maintenance of the Ship and Equipment

The company should implement a Planned Maintenance System (PMS) that covers all systems and components related to WAPS, including the management of spare parts inventory.

WAPS installed on seagoing ships often require the installation of additional equipment related to safe operation, such as wind anemometers, CCTV systems, electrical cabinets installed in the control room, HMI devices etc. The guidelines on maintenance and inspection provided in this chapter refer to all associated equipment and installations. The term “supplier” that is referred to in this chapter includes those for WAPS and for related supplementary equipment.

Incorporating WAPS Specific Requirements

The company should acquire product-specific maintenance and inspection manuals from the supplier, covering their equipment, components, and installation on the vessel. These manuals should be used in conjunction with the operational manual.

Maintenance should cover, but not be limited to, the following technical areas:

- Structures
- Mechanical systems
- Machinery systems
- Aerodynamic surface
- Control and automation system
- Safety system

Effective maintenance and operation of WAPS require close alignment with supplier guidance and recognized industry best practices. This includes adhering to supplier-specified maintenance intervals and procedures, using only supplier-approved materials and components for replacements, unless such work is required to be carried out directly by supplier representatives. Furthermore, maintaining comprehensive documentation of all maintenance activities to satisfy regulatory and insurance requirements. In addition, recommendations from relevant industry standards and classification societies should be systematically incorporated to ensure continued compliance with evolving best practices.

In addition to suppliers' maintenance recommendations, the company should employ condition-based monitoring methods to assess the operational status of each component and enable proactive maintenance. These methods support the early detection of malfunctions, corrosion, and wear-and-tear.

A risk-based approach should be adopted, and consultation with the supplier should be sought whenever maintenance or inspection requirements are not adequately addressed by generic procedures.

Critical Equipment Identification

In line with the requirements under paragraph 10.3 of the ISM Code, all equipment and systems related to the WAPS, which is essential to its safe and efficient operation should be systematically identified and documented. This process includes maintaining an up-to-date inventory of spare parts for critical systems to ensure operational readiness and minimise downtime. In addition, priority levels should be assigned to critical equipment within the PMS based on risk assessments and their operational significance.

Safety and Competence

Maintenance of WAPS require that critical tasks such as valve replacements, system repairs, and sensor calibrations are carried out under the supervision of suitably qualified and experienced senior personnel. This level of oversight is essential to ensure that maintenance activities are performed correctly and in accordance with technical specifications, reducing the risk of equipment failure, system malfunction, or unsafe operating conditions. Proper supervision also helps to identify potential hazards at an early stage, ensures compliance with regulatory and classification society requirements. Furthermore, it supports knowledge transfer and skill development among maintenance staff, thereby contributing to the long-term reliability, safety, and efficiency of the WAPS installation.

Human Element

Human element considerations are essential to the safe and effective maintenance of WAPS. Maintenance personnel should be appropriately trained in the specific characteristics of WAPS, including system functionality, individual equipment and components, material properties, safe handling practices, and approved means of access. Personnel should also be provided with suitable PPE to ensure safe access and safe working conditions, particularly when working at heights. In addition, clear emergency protocols should be established and communicated to address potential accidents during maintenance activities, including procedures for system isolation, ventilation, and emergency response, thereby minimizing risks to personnel and equipment.

In line with the recommendations of Ch. 6 of this report, specific maintenance tasks should be clearly assigned to suitably trained personnel to ensure accountability and consistency in execution. Individuals responsible for these tasks should possess the necessary qualifications, skills, and training relevant to the equipment and systems involved, enabling them to perform the work safely, correctly, and in accordance with established procedures. Clear role allocation helps prevent errors, reduces the risk of unsafe practices, and ensures that maintenance activities meet operational, regulatory, and manufacturer requirements, thereby supporting the overall reliability and safety of the installation.

Continuous Improvement and Effective Feedback Mechanisms

Improvement and feedback are key to the reliable operation of WAPS. Feedback from inspections and maintenance activities should be systematically used to refine maintenance procedures and improve system performance.

Maintenance procedures should be periodically reviewed and updated to reflect advancements in handling techniques and best practices, while data analytics should be leveraged to optimize maintenance intervals and enable predictive maintenance, reducing the likelihood of unexpected failures.

No.	Recommended actions
10.1	Establish and maintain a Planned Maintenance System for all WAPS systems, equipment, components, and spare parts, applying supplier maintenance and inspection manuals and incorporating relevant industry standards and classification society recommendations.
10.2	Maintain comprehensive records of all WAPS maintenance activities to meet regulatory, classification society, and insurance requirements.
10.3	Apply a risk-based approach to WAPS maintenance planning and consult suppliers where generic procedures appear insufficient.
10.4	Maintain an up-to-date inventory of spare parts for all critical WAPS equipment and ensure that critical maintenance tasks are supervised by suitably qualified personnel.
10.5	Ensure critical WAPS maintenance tasks are assigned to and supervised by suitably trained and qualified personnel, and that they are equipped with appropriate PPE, including gear for working at height.
10.6	Periodically review and update WAPS maintenance practices using operational experience, inspection findings and regulatory developments to support predictive maintenance.

11. Documentation

According to the provisions of Ch. 11 of the ISM Code, the company should establish procedures and maintain records of all data relevant to the SMS. All documentation related to safe operation, maintenance and management of the WAPS should be incorporated into these procedures. As a minimum, the following documentation should be considered, as applicable:

- Certification of WAPS equipment and its vessel integration.
- Procedures covering all aspects of WAPS operation and maintenance.
- Training of crew and shore-side personnel.
- Operational and maintenance records related to WAPS.
- The applicable regulatory and classification society frameworks.

Where relevant, all documentation should be vessel-specific to the design, installation, operation, or management of the WAPS system.

The company should ensure that all documents remain relevant and up to date, especially as the regulatory framework, classification society standards and industry best practices related to WAPS continue to develop.

To ensure the continued adequacy of the SMS, WAPS procedures shall be updated by incorporating findings from incident reviews (ref. Ch. 9), feedback from shipboard personnel, and evolving industry recommendations.

Where WAPS is installed as part of a vessel's retrofit, or when modifications are made to an existing WAPS installation, components, operational procedures, or personnel responsibilities, the MOC process should include, but not limited to, the following items:

- A risk assessment should be conducted during the planning phase of the modification, addressing the full range of potential hazards and associated consequences resulting from the change.
- Identification of all personnel involved or affected by the change.
- Identification of any training needs arising from the implementation of WAPS for both shipboard and office personnel.
- Identification of all procedures, documentation, records, manuals, drawings, and templates that need to be updated. This includes notifying the relevant authorities (ship's Flag, Classification Society etc.) and stakeholders (e.g. ports and terminals).
- Any change in technology should undergo thorough evaluation.
- Any change in regulatory compliance either by introduction of new regulations or by application of local requirements should undergo a review to identify deviations from the original risk assessment.
- Effective communication and coordination among all stakeholders are essential, keeping the impacted parties updated on the resulting changes.
- Key aspects include evaluating equipment changes, reviewing operational protocols, updating emergency response plans, ensuring environmental compliance, and conducting comprehensive risk assessments.

No.	Recommended actions
11.1	WAPS-related certifications, procedures, and records should be integrated into the company's existing SMS structure and document control system. Documentation should be developed on a vessel-specific basis where required by the system design, installation, and operational arrangements.
11.2	Documentation should be periodically reviewed and updated to reflect current regulations, industry best practices, operational feedback, and lessons learned from incidents.
11.3	The introduction of WAPS should be accompanied by an MOC procedure that identifies all personnel, procedures, documentation, regulations, training requirements, and vessel systems that are affected by the change. A plan to mitigate the identified risks should be followed to ensure the safe use of WAPS.



12. Company Verification, Review and Evaluation

The integration of WAPS into a company's fleet necessitates a proactive approach to verification and evaluation to ensure that the SMS remains effective despite the novel technical and operational challenges introduced by these systems. Continuous review, audit, and improvement of the SMS are essential, ensuring that feedback is promptly addressed.

Strategic Planning and Management Review

The company should maintain a strategic plan focused on WAPS operations to drive continual improvement in safety and environmental performance. This may include:

- Quarterly management meetings, both shore-side and onboard, should include dedicated sections for targets related to WAPS operations.
- Establishing and tracking WAPS-specific milestones, such as the number of WAPS-related incidents or near-misses, to quantitatively assess improvements and identify areas needing additional attention.
- Encouraging operators, supervisors, and managers to submit ideas and suggestions to improve operational excellence, specifically focusing on the unique challenges of WAPS.
- A clear mention or separate section should be dedicated to the handling of WAPS in the Master's review of the SMS.

Monitoring and Inspection

Regular verification is essential to ensure that shipboard practices remain consistent with WAPS-specific requirements.

- All onboard inspections by shore-side personnel should include time dedicated to reviewing the WAPS equipment and verifying associated procedures, including risk assessments, PTW and condition-based monitoring methods for proactive maintenance.
- A formal feedback system should be established to capture input from vessel personnel regarding best practices, identified hazards, and unsafe acts related to WAPS.
- There should be a formalised process for distributing relevant findings from internal audits across the fleet to ensure that lessons learned on one vessel are quickly shared elsewhere.

Auditor Qualifications and Training

The complexity of WAPS technology requires a re-evaluation of auditor qualifications to address new operational risks.

- The company should be able to demonstrate that proper training has taken place for onboard and shore-side personnel involved in WAPS verification and auditing.
- Internal auditors should be duly trained on aspects associated with WAPS to ensure audits focus on effective implementation of corrective and preventive actions.
- Incorporating scenario-based evaluations and WAPS-specific hazard reviews ensures that audits address elevated risks and confirm practical readiness.
- Findings from external or third-party audits specific to WAPS (e.g. from classification societies or flag States) should be used to supplement the internal audit scope.

No.	Recommended actions
12.1	The company should include dedicated sections covering WAPS operations in quarterly management meetings, Master's review of the SMS, management reviews, and onboard safety meetings.
12.2	The company should be able to demonstrate training records for personnel involved in the auditing and verification of WAPS operations.
12.3	Shore-side personnel inspections and audits should include time dedicated to WAPS equipment, with allocated sections within their reports.
12.4	Internal auditors should be duly trained on WAPS-specific risks and characteristics, incorporating scenario-based evaluations and hazard reviews.
12.5	Establish a formalised process for distributing internal audit findings and lessons learned across the fleet to accelerate knowledge transfer.

Conclusions

The uptake of WAPS has increased in the past years, and market growth projections indicate significant utilisation in the years to come. However, with limited experience of the application for modern shipping, it is important that companies use their SMS to manage associated risks. Identification of the hazards and risks for safe operation of ships fitted with WAPS is essential in developing an SMS which nurtures a safety culture, and establishes updated procedures suited for each individual company.

This report aims to encourage the safe application and operation of WAPS by providing guidelines for strengthening an SMS for ships using rotor, wing or suction sail(s). Companies can use these guidelines in the case of retrofitting or when equipping a newbuilt ship with WAPS.

These guidelines are based on the current industry experience of WAPS through publicly available information. Developments in the technologies and regulatory and classification society frameworks are expected to continue with the market uptake. This report should therefore be used alongside existing or upcoming documentation and guidelines on operation and safety management of ships using WAPS.

Combining expertise on WAPS and on safety management, the MTF review includes the following highlights:

- As WAPS may introduce significant aerodynamic forces and bridge visibility restrictions impacting operation of the ship, the Master should ensure that the crew and, when relevant, others involved such as the pilot, understand these operational changes with WAPS. The responsibility should be clearly defined by the company.
- To monitor the safety and pollution-prevention aspects of ship operation, the Designated Person(s) should be trained to possess appropriate knowledge of the WAPS technology specific to each vessel in the fleet. The DP should be familiarised with the technical, operational, and safety characteristics of WAPS to ensure they are able to oversee, assess, and evaluate the effectiveness of the SMS, as per the ISM Code.
- With the current lack of WAPS-specific certifications, the related training should, for now, follow industry best practice, not a regulatory requirement. The company should ensure that all personnel have the role-specific competence and familiarisation for safe operation and maintenance. This includes to understand WAPS operations by e.g. having appropriate knowledge about the aerodynamic effect on manoeuvrability, being able to identify operational risks such as increased structural loads and performing critical tasks such as deployment and feathering actions safely.
- Depending on e.g. the size and type of the system, the WAPS can have significant impact on shipboard operations during both navigation and port operations. With currently limited operational data and established safety standards to support the development of fully comprehensive procedures, it is essential to base procedure development on structured risk assessment methodologies.
- WAPS have the potential to both cause an emergency and exacerbate emergencies originating from unrelated circumstances. The scope of emergency planning may differ on a case-by-case basis, considering the vessel type, the specific WAPS technology, their interaction, and whether the system is installed at newbuild or retrofit stage. The company should develop detailed WAPS-emergency response procedures tailored to each foreseeable potential emergency. Emergency drills should involve shipboard teams and, where relevant, shore-based emergency response.
- Given the relatively limited operational experience of WAPS compared to conventional propulsion arrangements, the reporting framework should adopt a precautionary and inclusive approach. Periodically reviewing a record of non-conformities, accidents and hazardous occurrences can help identify recurrent failure modes and opportunities for improvement. Reporting templates should be adapted, where necessary, to capture WAPS-specific information.
- Effective maintenance of WAPS require close alignment with supplier guidance and recognized industry best practices. This should also include all additional equipment related to safe operation, such as CCTV systems and HMI devices.
- Given that the regulatory framework, classification society standards and industry best practices related to WAPS continue to develop, the importance of effective control of documents within the SMS should be emphasised.

References

- [1] Clarksons Research, "Green Technology Uptake, World Fleet Register," 2026. [Online]. Available: <https://www.clarksons.net/wfr/>. [Accessed 25 02 2026].
- [2] IWSA, "Vessel List," IWSA, 12 2025. [Online]. Available: <https://www.wind-ship.org/vessel-list/>. [Accessed 23 02 2026].
- [3] IWSA, "Wind Propulsion: Zero-Emissions Energy Solution for Shipping," MEPC 81/Inf.39, London, 2024.
- [4] WASP Interreg North Sea Region, "D2.4c Best Practice Manual," 2023.
- [5] EMSA, "Potential of Wind-Assisted Propulsion for Shipping," EMSA, Lisbon, 2023.
- [6] ITTC, "Report of the Wind Powered and Wind Assisted Ships Committee," 30th International Towing Tank Conference, Hobart, 2024.
- [7] IMO, "STCW.7/Circ.25 Generic Interim Guidelines on Training for Seafarers on Ships Using Alternative Fuels and New Technologies," IMO, London, 2025.
- [8] Association Wind Ship, "CREwWind," 2024. [Online]. Available: <http://crewwind.wind-ship.fr/>. [Accessed 10 02 2026].
- [9] R. Eggers, "Operational Performance of Wind Assisted Ships," in High-Performance Marine Vehicle, Cortona, 2016.
- [10] N. Mizutani, N. Nakadozono, A. Masutani, Y. Arai, T. Aono and V. Paakkari, "Navigating a Sustainable Future with Wind-Assisted Ship Technology," 2023.
- [11] LR, "Guidance Notes on Wind Assisted Propulsion Systems," 2025.
- [12] A. Kisjes, R. Eggers and A. Bedos, "Steering with wind propulsion," Istanbul, 2023.
- [13] ABS, "Requirements for Wind Assisted Propulsion System Installation," 2022.
- [14] N. Contopoulos, B. Jiang, H. Jiang and R. Tustin, "Key Features of 'Wind Ready' Retrofit of a Kamsarmax Bulk Carrier," London, 2023.
- [15] DNV, "DNV-ST-0511 Wind assisted propulsion systems," DNV, Høvik, 2025.
- [16] DNV, "DNV-RU-SHIP Pt.6 Ch.2 Propulsion, power generation and auxiliary systems," DNV, Høvik, 2025.
- [17] ClassNK, "Guidelines for Wind-Assisted Propulsion Systems for Ships, Ed. 2.2," Class NK, Tokyo, 2025.

Front cover images courtesy of:

BAR Technologies and Berge Bulk (top), Anemol Marine Technologies (leftmost), and Chemship (rightmost).

Acknowledgements:

Organization	Name
ABS	Spyros Hirdaris
	Vassilis Zouzoulas
ClassNK	Michiyo Fuda
	Shugo Kitta
	Naoki Saito
	Vikrant Sharma
DNV	Hasso Hoffmeister
	Kjetil Kåsamoen
	Johanna Tranell (project manager)
LR	Elizabeth McCaig
MCA	John Booth
	David Campbell
	Katy MacDonald
	Shiv Ralhan
MPA	Hafiz Ramli
Norwegian Maritime Authority	Trond Kvande

MTF wishes to extend their gratitude for the below listed industry stakeholders that helped to strengthen these guidelines with their invaluable feedback (listed in alphabetical order).

Industry stakeholder	Name
BIMCO	Jakob P. Larsen
ICS	Sunil Krishnakumar
	Arvind Natrajan
	Gregor Stevens
InterManager	Kuba Szymanski
IWSA	Gavin Allwright
THE NAUTICAL INSTITUTE	Aly Elsayed
	John Lloyd
INTERTANKO	Carlos Gonzalez
	Emma Scheiris

Contact

Please contact contact@maritimetechnologiesforum.com in case of questions or comments.



**MARITIME
TECHNOLOGIES
FORUM**

LEADING THE MARITIME WORLD FORWARD