



MARITIME
TECHNOLOGIES
FORUM

LEADING THE MARITIME WORLD FORWARD

OPERATIONAL
MANAGEMENT TO
ACCELERATE SAFE MARITIME
DECARBONISATION



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. This report provides recommendations to industry stakeholders toward safe adoption of alternative fuels onboard ships in line with MTF's purpose.

Safe operation of alternative fuels such as methanol and ammonia requires sound safety management procedures and trained personnel onboard ships. MTF undertook this study which identifies potential gaps to achieve safe maritime decarbonisation within three existing Conventions / Codes: The International Safety Management (ISM) Code, International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) and The Maritime Labour Convention (MLC); and makes suitable recommendations to close these gaps for future safe use of alternative fuels.

The report also highlights the perceived urgency to close these gaps so that the maritime industry can prioritise where they need to channel their limited resources. Finally, the report also identifies barriers that prevent closing and actors that help closing these gaps for use of alternative fuels towards a safer decarbonisation.

Summary of identified key gaps and recommendations for closing:

	Gap	Recommendation for Closing
ISM-1	Uncertainty related to Safety Management System requirements development and implementation.	The development of a guidance document which can be produced by the industry and submitted to the IMO.
ISM-2	Uncertainty related to emergency procedure development	IMO may require industry stakeholders to develop a list of emergency scenarios, drills and associated guidance.
ISM-3	Uncertainty related to maintenance measures	IMO may need to define, potentially based on industry proposals, and mandate the inclusion of measures to address maintenance of alternative fuel systems within the Safety Management System
ISM-4	Lack of familiarity of risks, hazards and control measures	All relevant industry stakeholders may need to identify training needs, develop training materials and provide training
STCW-1	Regulatory uncertainty	Industry guidelines for model courses may be developed to encourage and support swift regulatory change.
STCW-2	Insufficiencies within model courses	Incentivise relevant industry stakeholders to collaborate with training providers.
STCW-3	Lack of incentives for training course developers	Public and private funding may be provided to training course developers.
STCW-4	Inconsistent implementation of training	Flag states could review the training materials and audit the training providers to ensure consistent delivery in line with the IMO model courses.
MLC-1	Lack of reference to alternative fuels	Reference to alternative fuels could be made in Part B of the Code and international guidelines.

Note: numbering above indicates perceived urgency to close the identified gaps.

MTF's review demonstrates that the maritime industry is not ready for the safe adoption at scale of alternative fuels yet. To be able to meet the required decarbonisation targets, all industry stakeholders should collaborate towards safe adoption of alternative fuels including issues detailed in this report.

MTF would like to emphasise the importance of safety culture in the maritime industry. Safety culture is an organisational culture that places a high level of importance on safety beliefs, values, behaviours and attitudes, and is vital for safe implementation of alternative fuels onboard ships. Safety culture should be encouraged through Safety Management System implementation and onboard health and safety protection and accident prevention programmes, and it will reduce the potential health and safety risks which may be caused due to the introduction of alternative and more hazardous fuels.



Introduction 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. MTF has been established to provide technical and regulatory expertise for the maritime industry. MTF's role is to publish research based on its member's expertise and offer unbiased advice to the maritime industry. The current research focuses on the common challenge of maritime decarbonisation and the safe adoption of new technologies, including alternative fuels.

Alternative fuels¹ will be one of the key measures to reduce GHG emissions from shipping, and their importance will increase with a potential net zero emission target for shipping by 2050. The industrywide introduction and use of alternative fuels in shipping, with some of them more hazardous than conventional fuels, will lead to new safety hazards and associated risks. These risks can be mitigated by appropriate technology and operational ship management, including adequate training of the crew and other personnel.

The international public-private alliance "Zero-Emission Shipping Mission" highlighted this challenge in their recently published industry roadmap [Ref 1] and raised safety and operational risk management, addressing safety, guidelines, training, and methodologies for handling and the storage of new fuels as one of five innovation areas. The scale of the training needed to support a decarbonised shipping industry was highlighted in a recent report commissioned by the Maritime Just Transition Task Force Secretariat [Ref 2]. They found that there is an immediate need for training seafarers and that the pace depends on the decarbonisation

pathway. Potentially, up to 750,000 seafarers need to be trained by 2050 to operate with alternative fuels. A recent industry position paper entitled "Green Curriculum" [Ref 3] outlined future crew knowledge and skills that need to be acquired and how they might be assessed and accredited to a globally accepted and consistent standard.

In line with its purpose, MTF explored whether crew and ship management personnel are sufficiently enabled to manage new risks arising from operating with alternative fuels which includes bunkering, onboard storage and usage, maintenance and being prepared for possible emergency situations. Therefore, this study evaluates whether existing regulations are sufficiently detailed and can support the acceleration of safe maritime decarbonisation: The International Safety Management (ISM) Code [Ref 4], International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) [Ref 5]; and The Maritime Labour Convention (MLC) [Ref 6].

This report makes suitable recommendations to close these gaps for future safe use of alternative fuels. The report also highlights the perceived urgency to close these gaps so that the maritime industry can prioritise where they need to channel their limited resources. Finally, the report also identifies barriers that prevent closing and actors that help closing these gaps for use of alternative fuels towards a safer decarbonisation.

MTF's recent work can be found on our website: www.maritimetechnologiesforum.com. One recent study, for example, focuses on "Fuels evaluation through the MTF framework for assessing decarbonisation technologies and alternative energy carriers."

¹ In this report, we use the term Alternative Fuels to describe low carbon, carbon neutral and zero carbon fuels.

ISM Code – Assessment and Findings

The ISM Code [Ref 4] is an international standard that is intended to ensure the safe operation of ships, to prevent human injury and loss of life at sea, and protection of the environment. One of the objectives of the ISM Code is to ensure compliance with international, national and other requirements and recommendations as applicable. As alternative fuels requirements are adopted by the industry, and national and international regulations are adopted by regulators, shipowners and operators will be required to address them through their Safety Management System (SMS) to comply with these mandatory provisions which then become subject to verification through sampling during ISM Code audits.

The ISM Code is primarily focused on ensuring the safe operation of ships and does not directly address design requirements, energy efficiency and the reduction of emissions from shipping in a comprehensive manner. There is a significant reliance on classification and statutory certifications to confirm that design of the bunkering, storage and processing equipment has been verified to meet specified international, national and industry requirements and that the equipment is fit for the intended service.

The ISM Code can address alternative fuels in several ways:

- **SMS:** The company, through its SMS, is required to identify, assess, and control all hazards that may arise during shipboard operations. The SMS should include procedures for the handling, storage, and transfer of hazardous fuels, inspection and maintenance of equipment, reporting of incidents and accidents as well as emergency response procedures in the event of a spill or other emergencies involving alternative fuels.
- **Training:** The ISM Code requires that crew members be properly trained for shipboard operations. Crew members who handle alternative fuels must be properly trained in the safe handling and storage of alternative fuels. This training should include information on the properties of fuels, the risks and hazards associated with them, and the precautions that must be taken to prevent health and safety incidents or accidents. Shipboard personnel handling such fuels should be required to obtain Statutory training. Additionally, companies should establish and provide shipboard training based on the equipment and type of fuel being carried on board.
- **Maintenance:** The ISM Code requires that the shipboard equipment be inspected and properly maintained in order to ensure its safe operation. The company's planned maintenance schedule should include all equipment used for handling, storage and use of alternative fuels to ensure availability and reliability.

- **Emergency response:** The ISM Code requires that ships have plans and procedures in place for responding to all identified hazards and emergencies. The company will be expected to develop an SMS procedure which includes hazards and emergency situations involving alternative fuels.

Therefore, the ISM Code already has the framework for safe handling of hazardous fuels from the perspective of safety and pollution prevention. Provided that the equipment for handling, processing and storage of such fuels is certified as meeting all classification and statutory requirements when installed, the following SMS enhancements/mitigating measures should be implemented:

- 1) An additional risk assessment carried out by the company must identify and assess all hazards posed by these fuels. Once these hazards are assessed, the SMS must be updated to include necessary measures to control identified risks, mitigate consequences of an unexpected event, and prevention measures as applicable. This includes establishing inspection and maintenance schedules and development of emergency response plans.
- 2) Crew must be certified as per national and international requirements (when developed). Additionally, the crew must be trained in the new risks and SMS procedures to control/mitigate such risks. Drills should be carried out to ensure that the emergency response plans are understood and the crew is prepared for any emergency situation at all times.
- 3) Internal audits and periodic reviews should be carried out to confirm that the crew is adequately trained and familiar with the SMS procedures for handling alternative fuels and that the SMS has been implemented effectively.

MTF has identified some gaps in relation to alternative fuels and ISM Code's implementation which are detailed in Table 1 below. For each gap, a description is provided, listed in the form of perceived urgency to close. Perceived urgency should not be seen as level of importance as they all lead to safe onboard operation. However, their adoption may need to follow a sequence (and the limitation in resource to deliver the results) hence they are numbered as perceived urgency to close. The table also outlines pathways to address and close the gaps. It is noted that there may be other pathways to close the gaps; however, MTF believes that these recommendations will lead to a smooth and effective transition to safe decarbonisation. Finally, the table presents actors that help closing the gaps; and barriers that limit or prevent them being closed. Understanding these actors and barriers are helpful to achieve a smooth and accelerated transition to safe decarbonisation. These actors listed might help industry stakeholders to collaborate and achieve safe decarbonisation.

Table 1: Summary of identified gaps and recommendations for closing

Gap	Definition	Recommendation	Actors	Barriers
ISM-1: Uncertainty related to Safety Management System requirements development and implementation	Due to its risk-based nature and level of familiarity with risks associated with alternative fuels, some elements of safe operation/hazards may be overlooked; and the SMS procedures might be insufficiently developed and implemented for each company. Identification of hazards and risks for safe operation and management of alternative fuel systems is essential for the development of SMS procedures and safety culture which may differ for each company.	One way of encouraging safe application of alternative fuels may be the development of a guidance document which can be produced by the industry and submitted to the IMO. This guidance document would help towards the development of a Maritime Safety Committee (MSC) circular for industry wide application; acceptance; and consistent development and implementation.	All relevant industry stakeholders may be able to prepare draft submissions to help speed up the process of regulatory change. Flag States or other relevant stakeholders may lobby to prioritise this topic which may help to speed up the process of regulatory change.	This is a complicated subject and there is lack of depth of knowledge, expertise and experience within maritime industry which typically requires longer time frame to establish.
ISM-2: Uncertainty related to emergency procedure development	Lack of awareness of risks associated with alternative fuels may lead to certain emergency scenarios being overlooked or inadequate SMS procedures.	To ensure safe application of alternative fuels, IMO may require industry stakeholders to develop a list of emergency scenarios and drills (involving alternative fuels) and associated guidance (this may happen via an MSC circular).	Collaborative approach between the working groups at the IMO and industry stakeholders.	Ownership of the action required to close the gap is unknown. If ownership is shared by multiple IMO committees, this may lead to additional delays.
ISM-3: Uncertainty related to maintenance activities	Planned maintenance facilitates ship operators to plan, perform and document onboard inspection and maintenance at intervals complying with Class and manufacturer requirements. Currently, there are no requirements for inclusion of alternative fuel systems in the SMS (such as in a Planned Maintenance System) which may cause relevant equipment being overlooked resulting in system failures.	To ensure safe application of alternative fuels within the SMS, IMO may need to define, potentially based on industry proposals, and mandate the inclusion of measures to address alternative fuel systems within the SMS (this may happen via an MSC circular).	Collaborative approach between the working groups at the IMO and industry stakeholders.	Ownership of the action required to close the gap is unknown. If ownership is shared by multiple IMO committees, this may lead to additional delays.
ISM-4: Lack of familiarity of risks, hazards and control measures	Alternative fuels in maritime industry are new, therefore, there is a lack of familiarity related to alternative fuel management for various stakeholders. Hence, some elements may not be recognised and overlooked by relevant industry stakeholders during the introductory period.	To ensure safe application of alternative fuels, the identification of training needs, the development of training materials and the provision of training are needed for all relevant industry stakeholders (those not covered by STCW requirements).	All relevant industry stakeholders may be able to help towards development of model training courses and delivery of training.	There may be dependence on other identified gaps being addressed beforehand therefore delaying this gap to be closed.



STCW – Assessment and Findings

The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers 1978 (STCW) as amended [Ref 5] provides minimum standards for training and certification of seafarers. The last comprehensive review of the STCW was started in 2006 and adopted in 2010 which demonstrates the long time required to undertake such a review. During this review, there were no discussions on the implications of alternative fuels onboard ships. However, a model course on handling of fuels subject to the International Code of Safety for Ship Using Gases or Other Low-flashpoint Fuels (IGF Code) [Ref 7] has been developed, adopted and is effective since 1 January 2017.

Unfortunately, a scheduled comprehensive review was postponed during 2020 due to the COVID pandemic. In the year 2023, a working group for the comprehensive review of the Convention and Code was formed and a newly formed correspondence group under the Sub-Committee on Human element, Training and Watchkeeping (HTW 9) [Ref 8] was tasked to develop a roadmap; and identify relevant items for consideration in the comprehensive review. Onboard usage of alternative fuels is identified as one of the areas which is to be reviewed under this comprehensive review. This

revision is likely to bring the Convention and Code up to date with developments regarding alternative fuels and latest technologies by 2028. It is expected that IMO may task relevant stakeholders for the development of model courses for alternative fuels.

MTF has identified some gaps in relation to alternative fuels and STCW which are detailed in Table 2 below. For each gap, a description is provided, listed in the form of perceived urgency to close. Perceived urgency should not be seen as level of importance as they all lead to safe onboard operation. However, their adoption may need to follow a sequence (and the limitation in resource to deliver the results) hence they are numbered as perceived urgency to close. The table also outlines pathways to address and close the gaps. It is noted that there may be other pathways to close the gaps; however, MTF believes that these recommendations will lead to a smooth and effective transition to safe decarbonisation. Finally, the table presents actors that help closing the gaps; and barriers that limit or prevent them being closed. Understanding these actors and barriers are helpful to achieve a smooth and accelerated transition to safe decarbonisation. These actors listed might help industry stakeholders to collaborate and achieve safe decarbonisation.

Table 2: Summary of identified gaps and recommendations for closing

Gap	Definition	Recommendation	Actors	Barriers
STCW-1: Regulatory uncertainty	The intended output from the comprehensive review is unknown at this point therefore it is not known what changes will be made to the Code and what model courses and their timeline will be adopted regarding alternative fuels.	Industry guidelines for model courses may be developed by industry stakeholders to encourage and support swift regulatory change.	Effective communication between industry stakeholders emphasising the need for urgent action.	Willingness to develop and collaborate by the industry stakeholders. Lack of recognition of urgency at the IMO working groups.
STCW-2: Insufficiencies within model courses	Future model training courses only addressing competencies and not including behaviour aspects may not be sufficient to mitigate the risks posed by alternative fuels. Necessary details might not be available possibly because of lack of collaboration from system suppliers due to commercial sensitivities.	Incentivise relevant industry stakeholders to collaborate with training providers on various alternative fuel types and to include behaviour aspects within model training courses may help close this gap.	Business decisions made by the shipowners in selection of OEMs. If flag States approve these training courses, they can encourage OEMs to include behaviour-based training.	Collaboration by system suppliers might be limited by commercial sensitivity. OEMs might feel that the behaviour aspects are not their responsibility to address.
STCW-3: Lack of incentives for training course developers	As it is unclear which fuel will be more dominant globally, and which fuel related technologies will be adopted, the training course developers may not have the commercial incentive to develop alternative fuel courses in advance and for all potential alternative fuels.	Public and private funding may be provided to training course developers. Outcome based phased funding could be based on delivery of training outcomes.	Public and private funding to training developers and shipowners.	Lack of funding and infrastructure; uncertainty on dominant alternative fuel type; unclear regulatory landscape and demand.
STCW-4: Inconsistent implementation of training	Delivery of training based on model training courses may vary from provider to provider which could cause inconsistencies. OEM training courses are typically supplementary to the model training courses (as industry best practice, these are not mandatory) and do not require statutory approval from both delivery and content perspective. This also may cause inconsistencies as there are no minimum requirements. † should be highlighted that the importance of consistency is crucial for shipboard deployment of the alternative fuels due to high level of health and safety risks.	Flag States could review the training materials and audit the training providers to ensure consistent delivery in line with the IMO model courses. Consideration should be made to require OEM training course to be audited to improve consistency and alignment.	Safety culture enhancement, encouragement and support from the flag States.	There is no known precedent for approval of OEMs training courses.



MLC – Assessment and Findings

The Maritime Labour Convention (MLC) 2006 [Ref 6], establishes minimum requirements for working and living conditions for seafarers. MLC is an international requirement which applies to all ships regardless of their trading areas (as long as the relevant flag State Administrations have ratified the Convention).

ISM and STCW only applies to ships trading in international waters and, therefore, including reference to alternative fuels within the MLC is vital, as impacting working and living conditions of seafarers also in national waters. One other way MLC differs from ISM and STCW is how it places the responsibility on the flag state to develop or adopt relevant health and safety protection legislations to fulfil MLC objectives.

MTF has identified one gap in relation to alternative fuels and MLC which is detailed in Table 3 below. For this gap, a description and a pathway to address and close it is provided. It is noted that there may be other pathways to close the gap; however, MTF believes that this recommendation will lead to a smooth and effective transition to safe decarbonisation. Finally, the table presents actors that help with closing the gap; and barriers that limit or prevent the closing of gaps. Understanding these actors and barriers are helpful to achieve a smooth and accelerated transition to safe decarbonisation. These actors listed might help industry stakeholders to collaborate and achieve safe decarbonisation.

Table 3: Summary of identified gap and recommendation for closing

Gap	Description	Recommendation	Actors	Barriers
MLC-1: Lack of reference to alternative fuels	Currently, MLC and international guidelines referred to therein do not address alternative fuels which may lead to certain health and safety considerations being overlooked by member States.	Reference to alternative fuels could be made in Part B of the Code and international guidelines which will ensure that the member States will address the relevant requirements in their national legislation.	Flag States, seafarers' organisations and shipowners forum could make submissions to special tripartite committee to include references of risks posed by alternative fuels to the seafarers working and living conditions.	Working with the International Labour Organization convention (ILO) tripartite structure*.

- The tripartite structure provides management and labour, a status equal to that of representatives of governments in the ILO. This principle aimed at inspiring confidence among workers' and employers' representatives and associating them with governmental action in order to achieve and maintain social peace.



Conclusions and Future Work

The assessment of ISM, STCW and MLC regulations reported herein highlights critical gaps that exist related to safely operating alternative fuels that need to and can be closed to accelerate a safe maritime decarbonisation. These gaps relate to safety management, crew training and safety culture.

IMO and industry need to collaborate to close the identified gaps. In several areas, industry including MTF can take a lead to provide regulators with appropriate proposals on how the gaps can be closed. This will help to achieve the necessary acceleration in the process of closing the gaps.

MTF would like to emphasise the importance of safety culture in the maritime industry. Safety culture is an organisational culture that places a high level of importance on safety beliefs, values, behaviours and attributes and is vital for safe implementation of alternative fuels onboard ships. Safety culture should be encouraged through SMS implementation, onboard health and safety protection and accident prevention programmes, which will reduce the potential health and safety risks which may be caused due to the introduction of alternative and more hazardous fuels.

This report provides recommendations to all industry stakeholders towards safe operational management of alternative fuels onboard ships. The key findings in relation to the three regulations that are discussed in this report, may be listed as below:

ISM	STCW	MLC
Identification of hazards and risks from operation of alternative fuels is essential for the development and implementation of the safety management system, emergency procedures and related maintenance activities.	Industry collaboration is needed to address current regulatory uncertainties, insufficiencies within model courses and inconsistent implementation of training. Considering the need for funding the future training course development and delivery, a fraction of future revenues from market-based measures might be earmarked appropriately.	Reference to alternative fuels could be made in Part B of the Code and international guidelines which will ensure that the member States will address the relevant requirements in their national legislation.

References

1. Zero Emission Shipping Mission: Industry Roadmap for Zero Emission Shipping, available at <http://mission-innovation.net/wp-content/uploads/2022/04/Zero-Emission-Shipping-Mission-Roadmap-1-1.pdf>, April 2022.
2. Kaspersen, Raymond Antoni, Henning Ødeby Karlsen, Henrik Helgesen, Georg Giskegjerde, Christine Lagerstedt Krugerud and Peter Nyegaard Hoffmann: Insights into Seafarer Training and Skills Needed to Support a Decarbonized Shipping Industry, DNV report 2022-0814, November 2022.
3. Green Curriculum, Position Paper on Green Seafarer Safety Needs, Chamber of Shipping, International Transport Workers Federation, Institute of Marine Engineering Science and Technology, The Nautical Institute, and Ocean Technologies Group, August 2022.
4. The International Safety Management (ISM) Code was adopted in 1993 by resolution A.741(18) and was made mandatory with the entry into force, on 1 July 1998, of the 1994 amendments to the SOLAS Convention, which introduced a new chapter IX into the Convention.
5. International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) adopted in 1978 and entered into force in 1984 with major revisions in 1995 and 2010.
6. The Maritime Labour Convention (MLC) is an International Labour Organization (ILO) Convention established in 2006.
7. International Code of Safety for Ship Using Gases or Other Low-flashpoint Fuels (IGF Code).
8. Sub-Committee on Human Element, Training and Watchkeeping (HTW 9) dated February 2023.
9. Guidance on implementing the Maritime Labour Convention, 2006 - Model National Provisions [2nd impression (with modifications), 2014]

Acknowledgements:

MTF Member Organisation

ABS

ABS

ClassNK

ClassNK

DNV

DNV

Lloyd's Register

Lloyd's Register

Maritime and Coastguard Agency, UK

Maritime and Coastguard Agency, UK

MLIT*

MLIT*

MLIT*

Norwegian Maritime Authority

Norwegian Maritime Authority

Norwegian Maritime Authority

Participant

Dinesh Thareja

Jesse Lashbrook

Naoki Saito

Vikrant Sharma

Pierre Sames

Wenche Lunde

Andrew Sillitoe

Yildiz Williams (Project Manager)

Siva Thevaruvattath

Saskia Dagett

Hiroataka Taoguchi

Takayuki Hasegawa

Yo Shibata

Bjorn Mikkell Rygh

Dale Konrad Odd

Simen Mildal

* MLIT: The Ministry of Land, Infrastructure, Transport and Tourism, ministry of the Japanese government

For any enquires about this report, please send a message to:
contact@maritimetechnologiesforum.com.



**MARITIME
TECHNOLOGIES
FORUM**

LEADING THE MARITIME WORLD FORWARD