



MARITIME  
TECHNOLOGIES  
FORUM

LEADING THE MARITIME WORLD FORWARD

GUIDELINES TO DEVELOP  
AND IMPLEMENT A  
**SAFETY MANAGEMENT SYSTEM**  
FOR ALTERNATIVE FUELS  
ON BOARD SHIPS



## Abbreviations and Definitions

Abbreviation	Definition
BIMCO	The Baltic and International Maritime Council
DP	Designated Person
ICS	International Chamber of Shipping
IGC Code	The International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk
IGF Code	The International Code of Safety for Ship Using Gases or Other Low-flashpoint Fuels
IMO	International Maritime Organization
INTERTANKO	International Association of Independent Tanker Owners
ISM Code	International Safety Management Code
ISO	International Organization for Standardization
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MEPC	IMO's Marine Environment Protection Committee
MLC	The Maritime Labour Convention, 2006
MOC	Management of Change
MSC	Maritime Safety Committee
MTF	Maritime Technologies Forum
OCIMF	Oil Companies International Marine Forum
OEM	Original Equipment Manufacturer
PMS	Planned Maintenance System
SEP	Safety and Environmental Protection Policy
SGMF	The Society for Gas as a Marine Fuel
SIGTO	The Society of International Gas Tanker and Terminal Operators
SMS	Safety Management System
STCW Code	The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978

## 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's relevant recent study identified three potential gaps within the implementation of The international safety management (ISM) code in relation to the application of alternative fuels on board ships. Consequently, MTF took an initiative to develop guidelines for use by industry as a first step to close previously identified gaps to contribute accelerating the maritime industry's safe decarbonisation.

In these guidelines, MTF members followed a method to assess these gaps by reviewing ISM Code's Part A implementation for each section, and identifying areas that may be relevant to alternative fuel implementation on board. Industry stakeholders were consulted during the development of these guidelines to strengthen the document with their different sector experiences. The list of these industry stakeholders can be found at the end of this document.

### **Proposed guidelines can be used to develop new or strengthen existing SMS.**

Based on MTF's review, recommended actions for each section mirroring ISM Code's Part A can be found within the main body of this document. Companies can use this guideline to develop new SMS and/or strengthen their existing SMS for alternative fuels on board their fleet. MTF recommends that these guidelines may be used in addition to other similar existing and/or upcoming guidelines (of which some are already referenced within this document) to ensure a safe application of alternative fuels on board ships.

### **Experience from operating with alternative fuels will initially be limited.**

MTF recognises that the prospective alternative fuels considered in the maritime industry possess elevated operational and environmental risks relative to fossil fuels. The inherent risks of a specific alternative fuel are a function of its characteristics, while additional risks can emerge with the interactions of the fuel with the operational environment. It should be recognised that the lack of data from the operational experience of equipment operating with alternative fuels will be a gap that will exist in the initial stages of deployment of alternative fuels.

### **SMS should learn from hazardous occurrences and accidents with alternative fuels.**

The application of a structured risk management within the SMS would be beneficial to strengthen the system in managing anticipated risks including risks from the deployment of alternative fuels. The strength of the company's SMS should 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 alternative fuels and facilitate the closing of the gaps. Furthermore, and until operational experience is gained within each organisation, the SMS can be improved based on learnings from additional sources of information, including risk evaluations from the design or retrofit stage, and learnings from other companies or pilots.

### **SMS should be versatile to accommodate mixed fuel operations.**

In the initial stages, with the fuel-mix on board still including fossil fuels along with alternative fuels, the SMS should be versatile enough to meet the fuel scenarios as alternative fuels are progressively scaled and eventually becoming mainstream.

### **Training and familiarisation are critical to ensure safe operations with alternative fuels.**

The safe operations with alternative fuels will require an assessment of the competency, training, familiarisation and resources relevant to the specific alternative fuels. The human element in the operations associated with the handling, storage and utilisation of alternative fuels is critical, and should be considered to ensure safe operations.



## Background and Objective

MTF has been established to provide technical and regulatory expertise for the maritime industry. MTF's role is to publish research based on its members' expertise and offer unbiased advice to the maritime industry. The current research focuses on the common challenges that are faced by the maritime industry such as decarbonisation, alternative fuels and increased levels of automation therefore allowing safe adoption of new technologies. MTF's work can be found on our website: [www.maritimetechnologiesforum.com](http://www.maritimetechnologiesforum.com).

One relevant recent study identified potential gaps within the implementation of three existing Conventions/Codes: The international safety management code [Ref 1], The international convention on standards of training, Certification and Watchkeeping for Seafarers (STCW), 1978 [Ref 2] and the maritime labour convention (MLC), 2006 [Ref 3]; and made suitable recommendations to close these gaps for future safe use of alternative fuels on board ships. This work on "Operational Management to Accelerate Safe Maritime Decarbonisation" can be downloaded from the MTF website. After this review, MTF focused on three gaps from ISM Code's implementation, and these are:

- "Uncertainty related to Safety Management System requirements development and implementation";
- "Uncertainty related to emergency procedure development"; and
- "Uncertainty related to maintenance measures"

MTF believed that the development of a guidance document which can be produced by the industry may help close these gaps. Therefore, MTF members developed these guidelines document to accelerate the maritime industry's safe decarbonisation.

In these guidelines, MTF members followed a meticulous approach to assess these gaps by undertaking a review of ISM Code's Part A implementation for each section, and identifying areas that may be relevant to alternative fuel implementation onboard. MTF members believe that this approach will help the relevant stakeholders to understand the guidelines easily; and use it within their organisations.

A number of 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. MTF members believe that their point of views representing different sectors strengthens 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.

## Introduction to the Guidelines

These guidelines are developed following a review of each section of the ISM Code's Part A. The section numbers within these guidelines therefore mirrors the same layout to help the reader. The structure of these guidelines can be summarised as follows:

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. Reports and Analysis of Non-conformities, Accidents and Hazardous Occurrences
10. Maintenance of the Ship and Equipment
11. Documentation
12. Company Verification, Review and Evaluation

Each section provides assessments and recommendations into SMS implementation when considering alternative fuels on board ships. The reader should appreciate that some sections provide more detailed content than others (high level content) due to the relevance of alternative fuel application on board ships and the size of gap that exists within its implementation via SMS.

While some content within these guidelines may be considered generic and business as usual, MTF believes that these should still be highlighted and interpreted with a focus on alternative fuels on board ships.

The format change in the document between Section 1 to 12 is intentional to provide the reader with a clear difference between the guidelines and the document.

## 1. General

In an operational environment, it is difficult to achieve a process devoid of risks, especially when dealing with operations that may have inherent elevated risks due to several uncertainties.

The consideration of prospective alternative fuels in the maritime industry involves addressing safety and environmental risks that differ from those associated with fossil fuels, and in general, can be considered to be more severe due to uncertainties. These risks may be perceived and mitigated when operational procedures and contingencies are planned, but there may be some adverse outcomes as the systems become functional on ships. The lack of operational data regarding systems operating with alternative fuels creates an initial gap in understanding and experience.

The deployment of alternative fuels creates variability in the equipment and operational aspects:

- **Equipment** – The equipment associated with alternative fuels in some cases will bring variability as they will be novel technologies, and will be tested to go through iterations of improvements.
- **Operational** – The variability brought in by the alternative fuels to the operational environment is certain, but the extent and intensity will be dependent on the characteristics of the alternative fuel.

The practical and pragmatic approach of managing risk in an operational environment can be achieved through risk management i.e. proactive risk assessment, risk mitigation and continual improvement of the operational processes. The measures that would be beneficial for safe operations with alternative fuels could include:

- Identification of potential safety and environmental risks associated with the use of alternative fuels.
- Development of operational procedures for operations involving alternative fuels based on assessment of known and anticipated risks.
- Development of contingency plans to deal with unwanted outcomes of operations.
- Proactive risk assessment and appropriate control measures to mitigate the assessed risks prior to operations.
- Diligent reporting of non-conformities, accidents, and hazardous occurrences (including near-misses) noted by personnel in the operational procedures.
- Assessment of reported gaps in operational procedures and incorporation of the outcomes in the operational procedures and contingency plans, as appropriate.

One key objective of the ISM Code [Ref 1] is that all identified risks shall be assessed and mitigated with control measures put in place. The ISM Code is not applicable at a vessel's design stage, however, risk assessment/analysis shall be conducted, including the vessel's design/retrofit phase. Although design measures take precedence over operational and procedural measures, the risk and control measures identified during this phase, should continue to be implemented into its operational phase and it may be necessary to implement such measures in the SMS.

These assessments and analysis carried out in the design/retrofit phase will accordingly contain valuable information and should follow the vessel through its lifecycle. These should be made available on board the ship upon transfer to the operational phase and whenever the ship changes ownership or company.

Based on the review of risks already identified, development of procedures can be started, followed by considering any additional operational risks not addressed at design/retrofit stage. New technology requires new/changed set of operational criteria as well as changes to mindset and management thereof.

The strength of the company's SMS shall be in the ability to continuously improve the operational processes by proactively identifying any gaps through learning from non-conformities, accidents, and hazardous occurrences (including near-misses). The agility in amending the processes and maintaining a strong safety culture throughout the organisation would show the strength of the SMS in preventing the recurrence of unintended outcomes. Until operational experience is gained within each organisation, the SMS can also consider learnings from additional sources of information, including risk evaluations from the design or retrofit stage, learnings from other companies or pilots.

The deployment of alternative fuels is expected on newbuilds as well as existing assets through suitable retrofits. The initial stages, in both cases may involve a fuel-mix that may still include fossil fuels alongside alternative fuels, while the latter is progressively scaled and becoming mainstream. This understanding is important for the industry in developing and updating the SMS that is responsive to adapt to changes rapidly at all levels of management. The electronic form of document control of the SMS has been widely accepted and implemented but will be a necessity to proactively manage the changes that will be required in a company with one or more vessels operating on alternative fuels.

The International Code of Safety for Ship Using Gases or Other Low-flashpoint Fuels (IGF Code) [Ref 4] in being the guiding standard for alternative fuels provides, the regulation to ensure that operational procedures for loading, storage, operation, maintenance, and inspection of low-flashpoint fuels minimise the risk to the ship, personnel and the environment. The IGF Code in its current form specifies requirements primarily for natural gas fuel.

The International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code) [Ref 5] primarily intended to provide regulations for ships carrying gas as cargo, also outlines the rules for using liquefied gas cargo as fuel. The current version of the code applies these regulations mainly to liquefied natural gas (LNG) and other alternative fuels that are non-toxic and offer the same level of safety as natural gas.

While methyl/ethyl alcohol is not yet included in the IGF Code, MSC.1/Circ.1621 - Interim guidelines for the safety of ships using methyl/ethyl alcohol as fuel [Ref 6] and MSC.1/Circ.1666 - Interim guidelines for the Safety of Ships using LPG fuels [Ref 7] provides the requirements for facilitating the deployment of methyl/ethyl alcohol and LPG as fuel.

For alternative fuels, other than natural gas, it is necessary to prove compliance with the requirements of the IGF Code through a separate design approval process outlined in the IMO guideline MSC.1/Circular.1455 - Guidelines for the Approval of Alternatives and Equivalents [Ref 8]. The approval process is predicated on demonstrating that the alternative design has operational and procedural measures that are equivalent in reducing the risk to the levels of the design being substituted. These measures are required and expected to be included within the SMS as part of the approval process and can form the base for further development of procedures as new information becomes available in operation.

As present, the STCW training requirement is not sufficiently covering gases and all low-flashpoint fuels. As an interim measure the crew may undergo IGF Code training as per the STCW requirements (section V/3) supplemented by fuel specific training.

## 2. Safety and Environmental Protection Policy

The Safety and Environmental Protection (SEP) policy embodies the objectives of the ISM Code and is seen as the reflection of the company's commitment to safety at sea and environmental protection from the highest level of management.

The SEP policy sets the tone for the safety and environmental protection culture in the organisation. In ensuring that the SMS is fit for purpose for the individual company, the SEP policy will need to assimilate and reflect the commitment to manage the elevated operational risk environment that will be brought about by alternative fuels.

It is recommended that as a minimum, the SEP policy should include an additional statement which reflects on the aspects and impacts of the alternative fuels which are considered in mitigating the adverse effects on the safety of life and environment. This will strengthen the company's commitment towards continued operational safety.

Recommended actions that may be considered relevant to section 2 of the ISM Code are listed below:

No.	Recommended Actions
1.	The SEP policy should include aspects and impacts of using alternative fuels to ensure continued operational safety.

### 3. Company Responsibilities and Authority

The ISM Code requires that companies develop, implement and maintain an SMS that includes the functional requirements listed in section 1.4 of the ISM Code. The company's shore based senior management's involvement in the development, implementation, and maintenance of the SMS is paramount. Given the potentially increased operational risk, senior management has a crucial role to play in the safe deployment of alternative fuels in the fleet.

The company has the overarching responsibility to ensure that processes and procedures within the system are fit for purpose in covering the range of ships and their operations. While maintaining and implementing the existing SMS, the company should develop appropriate procedures in anticipation of deployment of alternative fuels. A company should look into the wide-ranging risk potential to the safety of ship, the crew and the environment by actively engaging in the monitoring and updating of safety protocols, staying abreast of industry developments and fostering a culture of continuous improvement. The SMS of the company should be robust to ensure that the processes and procedures are streamlined to ensure the safe operation of all vessels' fuel scenarios in the company fleet.

The company should ensure that the SMS has a description of roles and a clear allocation of their responsibilities to avoid ambiguity in process execution, accountability, authority levels, and interrelations among personnel.

In deploying alternative fuels to their fleet, the company's senior management should understand that managing the elevated operational risks through competence, training and awareness of personnel, and vetted processes is essential.

The company should reassess applicable existing requirements (which may not be apparent at first glance) with the application of alternative fuels. In this particular case, MSC-MEPC.7/Circular.8 [Ref 9] which provides basic principles for companies in developing and maintaining the SMS to the requirements outlined in the ISM Code, may be revisited.

Recommended actions that need to be taken by the company to ensure the adequacy of the SMS (under section 3 of the ISM Code) in general and with a focus on alternative fuels are listed below:

No.	Recommended Actions
2.	A fit for purpose SMS should be developed in addressing the elevated operational risk of alternative fuels.
3.	Adequate resources, which may be more or different with alternative fuels application, should be provided to ensure safe operations and to execute contingency plans. This may also include shore-based resources.
4.	The SMS should be reviewed and evaluated in accordance with the procedures established for processes involving alternative fuels.
5.	Procedures should be developed to analyse reports of non-conformities, observations, accidents and hazardous occurrences (including near-misses) in operation with alternative fuels, and implement corrective and preventive actions.
6.	Procedures should be developed for carrying out internal audits ensuring that the audit process captures the processes involving alternative fuels adequately.

## 4. Designated Person(s)

The Designated Person (DP) plays a pivotal role in the facilitation of the development, implementation, maintenance, and continual improvement of a company's SMS. Establishing a safety culture through SMS will be critical in minimising the period of increased operational risk with alternative fuels being novel technologies with a lack of operational data.

To fulfil the expected outcome from the role of DP, the individual taking on this role should meet certain suitability criteria in relation to qualification, training and experience. The company should assess the suitability criteria within the operational context of the company. MSC-MEPC.7/Circ.6 [Ref 10] provides guidance to industry on the suitability criteria in the appointment of DP under the provision of the ISM Code. Some of these are summarised below in light of application of alternative fuels on board ships:

- **Qualifications** – It is recommended that the DP meet the minimum criteria to have the ability to effectively verify and monitor the implementation of the SMS with refreshed focus on alternative fuels being deployed in their fleet.
- **Training** – It is recommended that the DP have undergone training relating to the elements of the SMS, and additionally in aspects that the company finds relevant during the assessment of the alternative fuels. The training requirements for the DP should be periodically assessed considering learnings from new experiences with the application of alternative fuels on board their fleet.
- **Experience** – The experience of the person in the role of DP cannot be understated and with the application of alternative fuels, this will be even more significant. This experience when augmented with the understanding of the anticipated changes in vessel operations, safety and environmental risks as well as consideration of human element will be the competence that will help the DP to facilitate the safe transition of the fleet to alternative fuels.

It is recommended that the DP should have the understanding of the risks associated with operations involving alternative fuels. This may be achieved through practical experience and training as identified by the company.

Recommended actions that may be considered relevant to section 4 of the ISM Code are listed below:

No.	Recommended Actions
7.	The SMS should establish suitability criteria for the role of DP giving due consideration to the qualifications, training and experience within the assessed operational context with alternative fuels.
8.	Clear lines of communication to the DP for onboard personnel, and from the DP to the highest level of management should be developed.

## 5. Master's Responsibility and Authority

The ISM Code clearly sets out the overriding authority and responsibility of the ship's Master. In addition, the Master has the responsibility for promoting the safety culture on board; and implementing the policies and procedures within the company.

STCW Code section B-V/3 defines the term "person with immediate responsibility" as a person being in a decision-making capacity for handling of fuel addressed by the IGF Code or other fuel-related operations. It places the responsibility on the Master to ensure that the person with immediate responsibility for the fuel on board has the appropriate certification and adequate practical experience. The Master while retaining the overall responsibility of the vessel, delegates the management of the alternative fuels to the role documented in the SMS as the "person with immediate responsibility".

The proactive and diligent review of the SMS and reporting of non-conformities, accidents and hazardous occurrences from the ship-to-shore management with the deployment of alternative fuels will be beneficial to strengthen the SMS.

Recommended actions that may be considered in re-evaluating the role of the Master within the SMS in the context of alternative fuels on board are listed below:

No.	Recommended Actions
9.	The SMS should define the role on board the ship assigned as the "person with immediate responsibility" for the management of alternative fuels.
10.	The SMS should define the responsibility and authority of the Master in relation to the management of alternative fuels on board.

## 6. Resources and Personnel

The fossil fuel grades used on board ships have evolved over the years and the challenge with these fuel grades was their inter-compatibility and operational compatibility with the equipment on board. Although the operational processes may have evolved, the human and environmental risks associated with these fuels have not changed greatly.

In contrast, the alternative fuel candidates possess differing but certainly elevated operational, and environmental risk elements associated with them when compared to fossil fuel grades. This change highlights the increased importance of competence, training, and awareness of ship's personnel in the new operational environment. It is the responsibility of the company to ensure that ships in their fleet are manned with competent and trained personnel commensurate with the responsibility of the individual roles.

The IGF Code (Part D) and STCW Code (Part A-V/3) complement each other in providing the requirements for personnel using gases and low-flashpoint fuels. While the IGF Code (Part D) outlines the requirements for companies to ensure that personnel on board using gases or low-flashpoint fuels are adequately qualified, trained, and experienced; the STCW Code (Part A-V/3) provides mandatory minimum requirements for the training and qualification of personnel on board subject to the IGF Code.

In the interim and until such regulations are developed for other alternative fuel candidates, the deployment of these fuels will need to follow alternative and/or equivalency design approval process. MSC.1/Circular.1455 [Ref 8] as part of the design approval process addresses the requirements for key personnel involved in the different stages of the alternative and/or equivalent design approval process including the ship crew, and will have to adhere to flag requirements, if any.

All ship personnel will need familiarisation specific to the ship and equipment in line with ISM and STCW requirements. Additionally, all ship's personnel should have awareness of the risks associated with specific alternative fuel on board. This could be delivered in a way that is suitable for the size and risk associated with the fuel as identified by the company.

Considering the novel nature of the technologies that may be involved with deployment of alternative fuels, the company may consider consulting all relevant stakeholders such as the original equipment manufacturer (OEM) in providing specific training to personnel.

The ship crew should have the competence, training and familiarisation to:

- Understand the nature of operations associated with equipment specific to alternative fuels and the differences from traditional fossil fuel-operated equipment.
- Understand the operational risks in terms of damage to equipment and hazards to humans and the environment from equipment operated on specific alternative fuels.
- Perform operational tasks, maintenance and inspection of equipment operated on specific alternative fuels.

Recommended actions for appropriate resources and planning to safely manage the operations on board ships with alternative fuels are listed below:

No.	Recommended Actions
11.	List of competencies should be developed in a suitability matrix for personnel based on certification, training and experience.
12.	<p>Training procedures should be identified and implemented for personnel on hazards and risks associated with specific alternative fuels, and contingency plans for dealing with hazardous situations.</p> <p>Training procedures should be simulated for training of personnel in dealing with anticipated hazardous situations with specific alternative fuels.</p> <p>Basic or advanced training certification should be provided based on the role and responsibilities related to alternative fuels.</p>
13.	Procedures for familiarisation of personnel on risks associated with the relevant alternative fuels and equipment should be developed.
14.	<p>Assessment should be able to identify any additional personnel that may be needed with alternative fuels operations.</p> <p>Personal protective equipment appropriate for the hazardous area zones classified as 0, 1 and 2 should be provided.</p>

## 7. Shipboard Operations

The shipboard operations that are directly related to alternative fuels will need to have documented procedures for the transfer, storage, operation, and maintenance to minimise the risk to ship, personnel and the environment. These procedures will consider the regulations on requirements for the fuel in the IGF Code, and in the absence of such regulations for that fuel, the procedures will need to be guided by the requirements in the IMO guideline MSC.1/Circular.1455 [Ref 8]. The approval process in the guideline is predicated on demonstrating that the alternative design has measures that are equivalent in reducing the risk to the levels of the design being substituted. These measures are expected to be included within the SMS as part of the approval process and can form the base for further development of procedures as new information becomes available.

Being novel fuel technologies, there may be a lack of operational data to develop robust operational procedures for alternative fuel candidates. Whilst understanding the characteristics of alternative fuels may help reduce the operational risks, it can be beneficial to be guided by established fuels such as LNG in developing operational procedures and contingency plans.

Some of the existing standards and industry guidelines in place for handling of chemicals and liquified gases as fuel or cargo are listed below. These can inform the development of operational procedures for gas and low-flashpoint alternative fuels.

- *ISO 20519:2021- Ships and marine technology — Specification for bunkering of liquefied natural gas fuelled vessels* [Ref 11]: The document specifies requirements for LNG bunkering transfer systems and equipment used in LNG-fuelled vessels, which are not covered by the IGC Code.
- *ICS -Tanker Safety Guide (Liquefied Gas) 4th Edition* [Ref 12]: The guide provides industry guide to support gas carrier operators conduct safe and efficient operations.
- *SIGTTO - Guidelines for the Alleviation of Excessive Surge Pressures on ESD for Liquefied Gas Transfer Systems* [Ref 13]: This guideline explains the concept of surge pressure and provides practical advice on its associated hazards and risk management.
- *SIGTTO - Ship/Shore Interface for LPG/Chemical Gas Carriers and Terminals* [Ref 14]: This publication describes risk assessment and hazard identification techniques that can be applied by LPG/chemical gas shipping staff and terminal operators.
- *SIGTTO - Recommendations for Liquefied Gas Carrier Manifolds* [Ref 15]: This document provides recommendations on the layout, strength, and fittings for gas carrier manifolds.
- *SIGTTO - Liquefied Gas Handling Principles on Ships and in Terminals, (LGHP4)* [Ref 16]: This reference book covers aspects of safe handling of bulk liquid gases (LNG, LPG and chemical gases) on board ships and at the ship/shore interface at terminals.
- *SGMF – Ammonia as a Marine Fuel* [Ref 17]: The document provides insights into technical considerations, safety aspects, and personnel training on ships using ammonia as a fuel.
- *SGMF – Hydrogen as a Marine Fuel* [Ref 18]: The document provides insights into technical considerations, safety aspects, and personnel training on ships using hydrogen as a fuel.
- *OCIMF/MSF – The Carriage of Methanol in Bulk Onboard Offshore Vessels* [Ref 19]: The document provides guidance for the safe loading, carriage and discharge of methanol on offshore vessels.

While the ISM Code does not specify any specific approach in managing risks on board ships, it is for the company to decide on the methods that are most suitable in assessing risks within the context of the company. ISO 31000:2019 [Ref 20] can prove beneficial in carrying out a structured identification, analysis and evaluation of the risks associated with alternative fuels. The standard provides generic guidelines that can help structure the risk management into the SMS and thereby strengthen the system in managing anticipated risks including risks from the deployment of alternative fuels on existing assets as well as new builds.

The procedures developed for shipboard processes that involve handling, storage and utilisation of alternative fuels should be ship-specific and set out to manage the assessed risks to a level as low as reasonably practicable.

The inherent risks of a specific alternative fuel are a function of its characteristics, while additional risks can emerge with the interactions of the fuel with the operational environment. The identification of the sources of risk associated with any specific alternative fuel may go beyond those inherent to its characteristics. The additional sources of risk generated by the interaction of these fuels in the operational environment could include:

- The risks anticipated to develop due to possible mixing of the alternative fuel with other fuels, if applicable.
- The risks anticipated to develop due to the interaction of the alternative fuel with the specific operational environment.

Recommended actions that may ensure safe shipboard operations for ships with alternative fuels are listed below:

No.	Recommended Actions
15.	A ship-specific fuel handling manual should be developed detailing the system layout, fuel characteristics, storage conditions, bunkering procedures, checklists, simultaneous operations and contingency plans.
16.	Management of Change (MOC) should be integral to the development of shipboard procedures to address changes resulting in the deployment of alternative fuels. The MOC should be guided by the assessment of the impact on personnel safety, training requirements, and documentation.
17.	The company should establish procedures for risk assessment of the shipboard operations. This should be carried out by placing the prospective alternative fuels in context, and the process would include risk identification, risk analysis, and risk evaluation.
18.	The risk identification should be carried out by persons with appropriate knowledge of the alternative fuels and the operational environment.
19.	The analysis of the identified risks should be carried out specifically to the operational environment in which the alternative fuel is being deployed. In addition, and if applicable the analysis should consider the effects of the interactions with other fuels that may be part of the fuel mix on board.
20.	The evaluation of the risk should be able to determine the level of risk and the mitigation measures that will be required to lower the risk to an acceptable level.

To complement the above recommended actions, an analysis of how the deployment of alternative fuels on board ships can be addressed through the principles of risk management are listed as below:

- Risk management creates and protects value: The inherent hazards due to characteristics of alternative fuels, compounded by the elevated operational risk and a lack of experience leading to uncertainty, emphasises the importance of robust risk management. Such measures are essential to minimise risk to ship, personnel and the environment.
- Risk management is an integral part of all organisational processes: The integration of risk management in all processes in an organisation demonstrates the safety culture in an organisation, and these processes will need to be analysed within the context of relevant alternative fuels.
- Risk management is part of decision-making: The operational landscape on board the ship as well as the ship-shore interface is expected to shift drastically with alternative fuels, and understanding the associated risks will help the decision makers make informed choices.
- Risk management explicitly addresses uncertainty: When alternative fuels are deployed on board ships, there is expected to be some degree of uncertainty in the operational environment, and this can be minimised by well-conceived plans to manage the perceived risks.
- Risk management is systematic, structured, and timely: A risk management process set out in the SMS that is systematic, structured and that provides the tools to identify risks associated with alternative fuels, analyse them, and put mitigations in place promptly will ensure that the risks that arise with the deployment of alternative fuels are addressed at the earliest.

- Risk management is based on best available information: The management of risks with alternative fuels initially will be reliant on its characteristics and perceived behaviour in operation, and would be based on the best information at that time. This information will be augmented by operational data and will have to be assessed based on the information that will be continually updated once systems are functional.
- Risk management is tailored: The management of operational risk with alternative fuels within the SMS will have to be versatile and agile to be tailored to meet different scenarios that may come into existence.
- Risk management takes human and cultural factors into account: The inclusion of human and cultural factors in assessing the operational risks with alternative fuels will be paramount can influence the outcome of the operations.
- Risk management is transparent and inclusive: The safety culture of a company driven from the top and that provides visibility at all levels is essential for proactiveness in managing the operational risks.
- Risk management is dynamic, iterative, and responsive to change: The process laid out in the company SMS towards risk management will need to be adaptive to changes that will be required as non-conformities, accidents and hazardous occurrences (including near-misses) can be expected to come fast once alternative fuels are deployed and will need to be addressed promptly within the SMS.
- Risk management facilitates continual improvement of the organisation: The transition of ships on to alternative fuels is expected to change the operational risk, but proactive risk management that takes learnings within the fleet and the industry in progressively strengthening the SMS will be the key in reaching a state of safe operational environment.

## 8. Emergency Preparedness

The ISM Code requires the company to identify potential emergency shipboard situations and establish procedures to respond to them. The company SMS should be versatile through its procedures to manage the risks associated with these fuels. Understanding that certain processes cannot be entirely controlled, either through design or through normal operational procedures, requires emergency preparedness to minimise the damage to the ship, personnel and the environment.

The IGF Code (Part C-1/17) requires gas-related drills and emergency exercises on board to be conducted at regular intervals and related safety systems to be regularly tested as part of emergency preparedness. Emergency preparedness planning has two components:

- Contingency plans – Development of plans that are conceptualised as the best course of action in an emergency to protect the ship, personnel and the environment.
- Emergency training – Training of crew on action to be taken in the event of an emergency.

IMO Resolution A.1072(28) [Ref 21] provides guidelines to assist in the preparation of an integrated system of contingency planning for shipboard emergencies and will be particularly beneficial in integrating the assessed emergency preparedness with alternative fuels with other existing contingency plans.

Recommended actions that may ensure safe emergency preparedness for ships with alternative fuels are listed below:

No.	Recommended Actions
21.	The company should identify concerns and provide advice on remedial actions by initiating assistance from flag and coastal states as part of company response plan.
22.	The emergency preparedness of the ship with alternative fuels should implement an integrated system of contingency planning for shipboard emergencies. This will provide a structured framework that tailors individual contingency plans to potential emergencies.

To complement the above recommended actions, some elements of emergency preparedness that may be addressed in the development of contingency plans and emergency training are listed below:

- Contingency plans:
  - procedures to be followed when reporting an emergency,
  - procedures for identifying, describing, and responding to potential emergency shipboard situations, and
  - procedures for the maintenance of the system and associated plans.
- Emergency training:
  - onboard familiarisation of shipboard personnel with the system and plans,
  - providing training for shipboard personnel about the system and plans,
  - scheduling of regular drills and exercises,
  - effective coordination of crew and the company's actions, and
  - developing an effective, transparent, and workable feedback system.

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

The ISM Code requires the SMS to include procedures ensuring that non-conformities, accidents and hazardous occurrences (including near-misses) are reported to the company and are investigated, analysed, and corrective actions implemented to prevent recurrence.

The SMS that has been developed through utmost diligence including the operational context of the company and further strengthened over a period of time by assimilating the learnings from non-conformities, accidents and hazardous occurrences (including near-misses) is expected to be robust in managing operational risks.

With the novel nature of the alternative fuels, development of new operational procedures or amendment of existing ones will be based on inherent characteristics of the specific fuel and assessment of perceived operational risks, but may lack the operational data. The effectiveness of the procedures within the SMS that provide practical feedback on non-conformities, accidents and hazardous occurrences (including near-misses) related to alternative fuels is crucial. This can be the differentiator that impacts the time span in closing the gaps that may exist and operational processes reach a place that minimise the risk to the ship, personnel and the environment.

MSC-MEPC.7/Circ.7 [Ref 22] provides guidance on developing the process of reporting of near-misses within the SMS. The effectiveness of this feedback from the ship to the company will be crucial in the SMS in achieving an operational excellence with alternative fuels in the last time frame.

Recommended actions that may be considered relevant to section 9 of the ISM Code are listed below:

No.	Recommended Actions
23.	Effective feedback process within the SMS should be included to report and analyse non-conformities, accidents and hazardous occurrences (including near-misses) related to alternative fuels.
24.	Learning from non-conformities, accidents and hazardous occurrences (including near-misses) should be critical to continuous development of the SMS.
25.	The procedures should be improved once the systems are functional and the operational data becomes available with the alternative fuels.

## 10. Maintenance of the Ship and Equipment

With the adoption of alternative fuels, fundamentally there is no change envisaged with respect to management practices in which the equipment is maintained, however there is expected to be an elevated operational risk due to uncertainties. The effective consideration of the human element in the maintenance of the equipment associated with the handling, storage and utilisation of alternative fuels is thereby highly critical.

The IGF Code (Part C-1/18) provides the regulations to ensure that operational procedures for the transfer, storage, operation, maintenance, and inspection of systems for gas or low-flashpoint fuels minimise the risk to the ship, personnel and the environment. These requirements should be considered and integrated in the Planned Maintenance System (PMS).

Recommended actions that may be considered for the maintenance of the ship and equipment with alternative fuels are listed below:

No.	Recommended Actions
26.	Maintenance procedures should be adapted to include specific requirements related to the maintenance of equipment associated with the handling, storage, and utilisation of alternative fuels. This may involve additional checks and inspections for components that come into direct contact with alternative fuels.

To complement the above recommended actions, aspects that need to be considered in developing maintenance plans and procedures for equipment associated with alternative fuels are listed below:

- Establishment of procedures for the requirements on maintenance and inspection of systems.
- Establishment of procedures in adherence to the OEM's recommendation on maintenance intervals and procedures as well as recommendations from industry guidelines.
- Incorporation of the safety procedures related to handling of the alternative fuels within or linked to the established maintenance procedure.
- Identification and documentation of critical equipment and systems related to alternative fuels.
- Establishment of levels of competence within the PMS required for carrying out maintenance events on equipment associated with alternative fuels, with senior personnel oversight for critical tasks.

## 11. Documentation

A company fleet may have ships operating on alternative fuels and ships operating on fossil fuels. In any of these scenarios, the company SMS should always have the correct procedures and documentation for each ship in the fleet to ensure safe operations and to meet regulatory compliance. The importance of the control of documents, maintaining updated documents, and removal of obsolete documents from the SMS cannot be emphasised enough on ships operating on alternative fuels which have elevated operational risk. The granularity of content and volume of documentation may be the differentiator for a ship operating on alternative fuel.

**Operational Procedures** – The company SMS applies to all ships in the fleet, and there have always been some procedures applicable to all ships while there were others that were applicable to certain ship types and even to particular ships. With the introduction of alternative fuels on some of the ships, there could be updates to existing procedures as well as new procedures included in the SMS. This may lead to further granularity of procedures in the SMS and can get quite complex for the ship crew that has to disseminate the applicability of operational procedures for the individual ship. It is therefore important that the operational procedures are streamlined to an extent that leaves no doubt in the interpretation of their applicability on each ship in the fleet.

**Documented Information** – Vessel operational data is recorded, and these records are retained as documented information for performance monitoring and to evidence “duty of care” and to satisfy compliance obligations. With the introduction of alternative fuels, changes to the documented information that needs to be retained can be anticipated, the extent of which will depend on the specific alternative fuels. Ensure that the related and valid documents are available at all relevant locations on the ship which may include manuals, checklists, and emergency response plans specific to alternative fuels.

**Regulatory Documentation** – All ships are required to carry documentation and certificates on board that are common to all ship types with some ships required to carry additional ship-specific documents. With the deployment of alternative fuels, it is expected that there will be changes in the current documentation as well as additional documentation and certificates may be required to be retained on the ship. The extent of changes in documentation and certificates will depend on the additional documentation required to meet the approval criteria under which the alternative and/or equivalency has been granted.

**IMO Guidelines “MSC.1/Circular.1455** – Guidelines for the Approval of Alternatives and Equivalents” [Ref 8] in section 7.2 “Onboard documentation requirements” provides the anticipated generic list of documentation and additional information that is expected to be retained on ships with equipment approved with alternative and/or equivalency. And, IMO circular “MSC.1/Circular.1646’ [Ref 23]” provides a list of certificates and documents required to be carried on board ships.

Recommended actions that may be considered in the maintenance of documentation relevant to alternative fuels are listed below:

No.	Recommended Actions
27.	Effective document control and updated information should be available, and obsolete documents should be removed.
28.	Operational procedures, checklists, etc., related to alternative fuels should be developed in a manner that can be easily disseminated.
29.	Procedures for the effective retention of required operational records should be developed.
30.	Procedures for effective document control due to higher volumes of documents should be updated regularly.

## 12. Company Verification, Review and Evaluation

The adequacy of the SMS in managing the operational processes on board the ship is evaluated at regular intervals. While the internal audit, evaluation and corrective action process will remain fundamentally the same with alternative fuels, there may be room for inspection on the company verification, review and evaluation processes set in the SMS.

The audit process will need to be amended to include aspects relevant to alternative fuels in ensuring that audits are comprehensive and relevant, and may include:

- Verification of the procedures on handling and storage of alternative fuels, and the retention of required records as documented information.
- Verification of competence, training and familiarisation of personnel relevant to alternative fuels documented in the SMS.

The SMS will need to re-evaluate and document the minimum suitability criteria for auditors eligible to carry out the audits on ships with alternative fuels, and the criteria could include experience on ships with specific alternative fuels or suitable training in lieu.

Recommendations that can be considered relevant to section 12 of the ISM Code are listed below:

No.	Recommended Actions
31.	Develop the audit process to include aspects relevant to alternative fuels.

## Conclusions

As companies look to deploy a diverse range of alternative fuels ahead of national and international regulatory requirements being developed, they can use their SMS to provide an effective tool for managing the associated risks. 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.

MTF believes that these guidelines may be one way of encouraging safe application of alternative fuels for industry wide application; acceptance; and consistent development and implementation. Companies can use these guidelines to develop new SMS and/or strengthen their existing SMS for alternative fuels onboard their fleet.

MTF recommends that these guidelines may be used in addition to other similar existing and/or upcoming guidelines (some of which are already referenced within this document) to ensure a safe application of alternative fuels on board ships.

Based on MTF reviews, some highlights may be drawn from the overall review and are listed below:

- In the initial stages, with the fuel-mix on board still including fossil fuels along with alternative fuels, the SMS should be versatile enough to meet the fuel scenarios as alternative fuels are progressively scaled and becoming mainstream.
- The lack of data from the operational experience of equipment operating with alternative fuels will be a gap that will exist in the initial stages of deployment of alternative fuels.
- 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 alternative fuels, and facilitate the closing of the gaps that would exist initially due to lack of operational data.
- The IGF Code, IGC Code and relevant IMO circulars may be consulted in developing the procedures related to alternative fuels within the SMS.
- The anticipated changes in the ship operation that are expected to be brought about by alternative fuels are set to expand the suitability criteria of the person assuming the role of DP.
- The SMS should identify the role defined in STCW Code section B-V/3 as "person with immediate responsibility" as a person being in a decision-making capacity for handling of fuels addressed by the IGF Code or other fuel-related operations.
- The integration of a structured risk management within the SMS would be beneficial to strengthen the system in managing anticipated risks including risks from the deployment of alternative fuels.
- The effective control of documents within the SMS is important, and this can be emphasised further with alternative fuels given the associated elevated operational risk.

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