The Nautical Institute

Training Standard for Handling Alternative Fuels in the Maritime Sector

Ammonia, methanol and hydrogen

A guide for trainers and training managers

Training Standard for Handling Alternative Fuels in the Maritime Sector

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Disclaimer

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1 Foreword

The transition to zero emission shipping is having a considerable impact on maritime operations. The need to switch to alternative fuels puts many shipowners in a catch-up situation, with plans not yet fully in place. They need to comply with new operational and legal requirements while at the same time meeting their stakeholders' commercial expectations and society's 'green' expectations.

The choice of alternative fuel in shipping is a decision with immense consequences, both financial and practical. It is not just capital investment at risk, but also the safety of ships, ports and seafarers.

To help mitigate this risk, the seafarers who handle alternative fuels must be central to the solution. They must be properly trained and fully capable of handling the new fuels as part of a just transition. While alternative fuels such as liquefied natural gas (LNG), ammonia and methanol are already carried as cargo today, safely and largely without incident, this enviable record owes itself to the specialist vessels and highly qualified personnel operating them with decades of collective knowledge and experience. However, when alternative fuels are carried as bunkers on vessels that do not routinely handle them and where crew have no specific training in their safe handling, this presents a new order of risk.

This voluntary standard offers guidance on the training seafarers require to handle these alternative fuels safely and with confidence. There can be no just transition without first ensuring the safety of all seafarers involved, at every level.

2 Introduction

In 2022, The Nautical Institute and its partners agreed that there was a clear need for a 'Green Curriculum' setting out what seafarers needed to know and what skills they would be required to develop to operate safely with alternative fuels.

We aimed to develop a global standard for seafarer training, enabling a harmonised, independent and voluntary training solution. A standard that will be a key resource for employers and training centres seeking to understand the need for effective training and professional development required to ensure the safety of our seafarers and the security of our ships.

In so doing, it was important not to underestimate the challenge that awaited the industry in the transition to zero emission shipping. We understood that the knowledge and skills development would be required at scale and there was a short window in which to put in place training and assessment provision. Moreover, there was and is a need for this to be done to a common standard that ship operators, charterers, ports and terminals could freely share and rely on.

The Nautical Institute standard provides consistency, quality and confidence to maritime educators and wider stakeholders.

3 Objective

This document provides a standard intended to offer guidance to organisations that deliver, or are considering delivering, training to seafarers and others involved in the handling of alternative fuel. This training standard focuses specifically on ammonia, methanol and hydrogen, and seeks to be consistent with international regulations and good practice.

4 Aims

1. To outline the theoretical and practical information and skills needed to be delivered in order to meet the objective in a safe and efficient manner.
2. To promote consistency in the content and design of training courses aligned with the demands of the industry.

5 Target Audience

- Maritime Education and Training (MET) providers;
- shipping company superintendents;
- maritime administrators; and
- maritime auditors, surveyors and others with a vested interest in this training.

6 Learning Objectives

On the successful completion of this training programme, delegates will be able to:

1. recognise the dangers inherent in the use of ammonia, methanol and hydrogen as ships' fuel;
2. describe the procedure for the safe loading (bunkering) of ammonia, methanol and hydrogen;
3. explain procedures for the safe storage, and internal transfer, on board ship of ammonia, methanol and hydrogen; and
4. recall the law and international Codes and Conventions pertaining to the loading, carriage and use of ammonia, methanol and hydrogen.

7 Course Outline

This training standard provides the following course outline:

Ref	Topic	Learning Objectives. Delegates will be able to:
1	Introduction to ships' alternative fuels	● recognise and describe the physical and chemical properties of ammonia, methanol, and hydrogen as ships' fuels.
2	Equipment and systems	● appreciate the design and specifications of fuel systems including ventilation, and gas detection systems.
3	Personal, ship and environmental safety	● describe the protocols for loading and unloading of bunkers; transfer procedures, precautions, monitoring and control measures; ● articulate health hazards, PPE and first aid.
4	Emergency response	● specify emergency response and shutdown procedures.
5	Laws and Codes	● demonstrate an awareness of Flag State Law and International Codes and Protocols.

8 Training Centres

Centres providing this training must be staffed by trainers with qualifications and experience commensurate with the level being delivered. Centres must be able to facilitate:

- live demonstrations of fuel handling procedures
- the demonstration of operations using ship simulators and specific seafarer training equipment
- simulation exercises focussed on emergency scenarios

9 Assessment

While it will be up to individual MET providers (and Flag States) to determine assessment and evaluation strategies, the following should be considered:

- direct observation of delegates' behaviours combined with oral questioning
- written and computer-based assessments
- practical assessments to evaluate skills

10 Scheme of Work

10.1 Introduction to alternative ship fuels

<table>
<tr><th colspan="2">Part 1</th></tr>
<tr><td colspan="2">This part provides an overview of the global environmental concern in the context of greenhouse gas (GHG) emissions and the efforts of the IMO to achieve 'net zero' by 2050. Whilst other alternative fuels have been proposed, the fuels listed here are the current preferred options that require a more detailed analysis.</td></tr>
<tr><td>1</td><td>• Seafarers to have awareness of the growing need for alternative ship fuels due to global environmental concerns and regulations
• Explain the role of ammonia, methanol, and hydrogen as promising alternatives in the maritime industry and why these novel fuels have gained traction
<table><tr><td>Ammonia</td><td>Methanol</td><td>Hydrogen</td></tr></table></td></tr>
<tr><td>2</td><td>• Seafarers to recognise the properties of these novel fuels including their chemical composition, physical state, energy content and storage requirement
• Consider and explain the environmental benefits of these novel fuels, this could include a reduction in emissions of GHG, sulphur dioxide and nitrogen oxide
• Seafarers to discuss the specific safety precautions when handling, storing and transporting these novel fuels with considerations on the flammable nature of each fuel
<table><tr><td>Ammonia</td><td>Methanol</td><td>NB: Discuss hydrogen in liquid form</td></tr></table></td></tr>
<tr><td>3</td><td>Seafarers require to have an understanding of the international regulations and standards governing the use of alternative ship fuels, including the IGF Code (International Code of Safety for Ships using Gases or other low-flashpoint fuels) and MARPOL Part VI.
• Emphasise the compliance requirements set by MARPOL Part VI and other relevant maritime regulations</td></tr>
</table>

10.2 Understanding the properties and characteristics of the fuels

Part 2	
Seafarers must be aware and have an understanding of the technical insights into the nominated novel fuels.	
1	• Discuss the properties and characteristics of each fuel in the maritime context Ammonia | Methanol | Hydrogen • Understand the chemical composition of these alternative novel fuels. Include material safety data sheets (MSDS) where relevant, describing their physical state, density and solubility, boiling and freezing points. Highlight the characteristics of flammability along with toxicity hazards

Comparative Analysis	
1	For guidance purposes only, conduct a comparative analysis of the novel fuels along the following lines: • Seafarers to understand the energy content of these energy carriers, ie, ammonia, methanol, and hydrogen. Include detail such as: hydrogen has the highest energy content per unit mass, whilst methanol has a higher energy density by volume • Understand storage considerations: in particular, the physical state and properties of ammonia, methanol and hydrogen and this relation to the design of storage systems, such as: ammonia can be stored as a liquid under pressure, whilst methanol can be stored as a liquid under ambient conditions and hydrogen can be stored as a gas or as a liquid • Seafarers to understand the challenges associated with the transportation of these novel fuels. Include and discuss in terms of flammability, with consideration given to the potential for fire and explosion

	Ammonia	Methanol	Hydrogen
2	Health risks:		
	• Seafarers must understand the significant health risks that exposure to ammonia could present. This should include any specialist training and specific PPE requirements	• Seafarers must understand the significant health risks that exposure to methanol could present. This should include any specialist training and specific PPE requirements	• Seafarers must understand the health risks that exposure to hydrogen could present in way of oxygen displacement. This should include any specialist training and specific PPE requirements
3	Flammability:		
	• Seafarers must understand ammonia in terms of flammability and why it can support combustion	• Seafarers must understand methanol in terms of flammability and why it is considered as a fire and explosion hazard	• Seafarers must understand in terms of flammability and why hydrogen can support combustion
4	Compatibility & corrosive nature:		
	• Seafarers must understand the corrosive nature of ammonia to certain metals, with the importance of proper material selection for equipment used in handling and storage emphasised to mitigate the risk of corrosion	• Seafarers must understand the relationship methanol has with certain materials that can lead to material failure. Explain why seafarers should be aware of material compatibility issues to ensure that equipment used for handling methanol is in compliance with industry guidelines.	• Seafarers must understand the factors involved with hydrogen embrittlement of certain steels
	• Compatibility with materials: Explore any specialist construction requirements in the maritime context		

10.3 Describing the generic equipment and systems

<table>
<tr><th colspan="4">Part 3</th></tr>
<tr><td colspan="4">Seafarers must have an understanding of generic novel fuel systems and emergency procedures along with supporting systems</td></tr>
<tr><td>1</td><td colspan="3">Discuss:
• The generic design and specifications of fuel systems along with their associated emergency shutdown procedures. Supporting systems to include ventilation and gas detection systems
<table><tr><td>Ammonia</td><td>Methanol</td><td>Hydrogen</td></tr></table></td></tr>
<tr><td>2</td><td colspan="3">Storage:</td></tr>
<tr><td></td><td>• Whilst there will always be individual designs, describe the generic design and construction specifications for ammonia bunker tanks. Discuss design factors such as cost, tank material, insulation and safety features.</td><td>• Whilst there will always be individual designs, describe the generic design and construction specifications for methanol bunker tanks. Discuss design factors such as cost, tank material, insulation and safety features. Consider the duration of corrosion resistance and material integrity over time</td><td>• Whilst there will always be individual designs, describe the generic design and construction specifications for hydrogen bunker tanks. Discuss design factors such as cost, tank material, insulation and safety features.</td></tr>
<tr><td>3</td><td colspan="3">Piping systems:</td></tr>
<tr><td></td><td colspan="3">• Seafarers to understand the specifications for piping systems used in these novel fuel systems. Stress the importance of corrosion resistant materials and proper welding techniques, with consideration given for the routing of pipes to minimise potential leaks and hazards</td></tr>
<tr><td>4</td><td colspan="3">Transfer equipment (including bunkers):</td></tr>
<tr><td></td><td colspan="3">• Seafarers to understand the design and specifications of equipment used for fuel transfer from bunker tanks to operational systems, including pumps, compressors, and transfer hoses
• Discuss the specifications for pumps, valves, and injection systems in relation to the unique properties of each fuel, as previously highlighted above
• Emphasise the importance of leak detection systems and emergency shutdown mechanisms and procedures</td></tr>
<tr><td>5</td><td colspan="3">Operational systems:</td></tr>
<tr><td></td><td>• Officers must understand the relevant operational design principles of the systems that use ammonia as a fuel, ie, internal combustion engines or fuel cells, and how these systems integrate with existing ship machinery. Give an overview of how this all integrates with the safety and control measures in operation</td><td>• Officers must understand any engine modifications required for methanol engine systems, including considerations for fuel injectors, combustion chambers, and exhaust systems whilst ensuring safety</td><td>• Officers must understand the relevant operational design principles of the systems that use hydrogen as a fuel, ie, internal combustion engines or fuel cells, and how these systems integrate with existing ship machinery. Give an overview of how this all integrates with the safety and control measures in operation</td></tr>
</table>

6	Common considerations:
	• Personnel to understand safety features: Discuss the inclusion of safety features for ammonia, methanol, and hydrogen fuel systems. This may include emergency shutdown systems, pressure relief devices and continuous monitoring for leaks • Personnel to understand material selection: Highlight the importance of compatible material selection for fuel systems for the specific fuel, highlighting corrosion resistance along with durability and reliability • Personnel to understand compliance with regulations: Highlight the necessity of designing fuel systems in strict accordance with international regulations and standards, including the IGF Code. Understand that compliance ensures the systems meet safety requirements and contribute to a secure maritime environment • Personnel to understand maintenance protocols: Discuss the importance of adherence with the recommended maintenance protocols for fuel systems to ensure their continued reliability, this to include regular inspections, testing, and preventative maintenance
7	Emergency shutdown procedures:

	• Immediate response protocols:
	  ○ Personnel to be familiar with emergency scenarios concerning leaks and/or loss of containment. This is to include crew response and appropriate contingency training
	  ○ Personnel to be familiar with clear communication protocols to ensure prompt reporting of abnormalities and/or incidents related to specific fuel handling
	• Rapid detection and identification:
	  ○ Personnel to understand the importance of rapid detection and identification of fuel leaks and/or loss of containment. This is to include crew response and appropriate contingency
	• Activation of emergency shutdown systems:
	  ○ Seafarers to be familiar with emergency shutdown systems relevant to specific fuel handling. This may include automated systems triggered by gas detection sensors or manual shutdown procedure and/or specific safety management systems
	  ○ Personnel to be familiar with the steps for crew members to manually activate the emergency shutdown systems, highlighting the need for a rapid response to contain and mitigate the loss of containment. This is to include the importance of crew members being familiar with this process and their individual on board function
	• Isolation of fuel sources:
	  ○ Discuss the guidance procedures on isolating and shutting off the source of the fuel release and why it is important for seafarers to familiarise with their on board systems
	  ○ Highlight the importance of crew members familiarisation with the location and operation of the isolation point
	• Communication and evacuation protocols:
	  ○ Emphasis to be given on communication channels and procedures for alerting all personnel on board about emergency shutdown with specific on board familiarisation and SMS compliance
	  ○ Seafarers to familiarise and receive training on evacuation routes and assembly points in designated safe areas
	• Emergency response teams:
	  ○ Explore roles and specific responsibilities of emergency response teams during a fuel emergency. This is to include designating individuals for specific tasks of responsibility that they may be likely to encounter

8	General considerations:

	• Training and drills:
	  ○ Highlight the importance of regular on board training sessions and drills to ensure that all crew members are familiar with emergency shutdown procedures
	• Documentation and reporting:
	  ○ Officers must understand the need for thorough documentation of any emergency shutdown event. This is to include the cause, actions taken and lessons learned
	• Continuous improvement:
	  ○ Personnel must understand that a culture of continuous improvement in emergency response procedures coupled with regular reviews and updates in emergency shutdown protocols will enhance their ability to respond to emergencies
	• Integration with onshore authorities:
	  ○ Officers require to understand the need for communication protocols with onshore authorities, emergency services and relevant agencies
	  ○ By providing comprehensive and well-documented emergency shutdown procedures for these fuels, seafarers can respond effectively to potential incidents, mitigate risks and ensure the safety of the vessel and its crew

10.4 Recommended safe handling procedures for seafarers

Part 4	
Seafarers must have an overview of fuel handling procedures. It is important to note that specific familiarisation will be required by the seafarer tailored to an individual vessel. Training centres should not be constrained by these lists and may include content relevant to their participants	
1	When considering educational content for seafarers, maritime training providers may be guided by discussions surrounding the following technical competencies. Whilst this advice is not exhaustive, it can be regarded as relevant to required knowledge by those tasked with specific responsibilities: Ammonia | Methanol | Hydrogen
2	Loading and unloading protocols for alternative fuels:
	• Pre-loading inspection: ○ Seafarers to understand the loading process and associated tasks such as, conducting a thorough inspection of the vessel's fuel handling equipment, bunker tanks, piping, and transfer systems

	• Ventilation procedures:
	  ○ Seafarers to understand proper ventilation procedures that will remove any residual gases from bunker spaces
	• Personal protective equipment (PPE):
	  ○ Seafarers to understand the use of appropriate PPE specific to ammonia. This should include gas masks, eye protection, and chemical-resistant clothing, with emphasis on well maintained and appropriate PPE
	• Bunker transfer procedures:
	  ○ Officers must understand the loading sequence, this to include any valve order and transfer rates
		• Cargo compatibility checks:
		  ○ Officers to understand the importance of bunker tank compatibility with methanol, and the possibility of the risk of contamination
		• Tank inspection and cleaning:
		  ○ Officers to understand procedures for inspecting and cleaning methanol bunker tanks prior to loading
		• Vapour recovery systems:
		  ○ Officers to understand the use of vapour recovery systems during loading, in order to capture and control methanol vapours
		• Inert gas systems:
		  ○ Seafarers to understand the relevance of inert gas systems
		• Bunker loading rates and temperatures:
		  ○ Officers to understand the loading sequence. This is to include valve order, transfer rates and temperatures
		• Grounding and bonding:
		  ○ Officers to understand the importance of proper grounding and bonding during the loading process
		• Emergency response drills:
		  ○ Personnel to understand the importance of regular emergency response drills specific to methanol loading and transfer scenarios. This is to include crew familiarisation with emergency shutdown procedures, evacuation routes and communication protocols
		• Documentation and certification:
		  ○ Officers require to understand the need for maintaining certificates and documentation verifying the quality and compliance of bunkers. They should ensure the vessel complies with international regulations and standards for the transportation of hazardous materials
			• Hydrogen pre-loading inspection:
			• Ventilation procedures:
			  ○ Seafarers must understand proper ventilation procedures that are required in order to remove any residual gases from bunker spaces
			• Inert gas systems:
			  ○ Seafarers must understand the relevance of inert gas systems
			• Personal protective equipment (PPE):
			  ○ Seafarers to understand the use of appropriate PPE specific to hydrogen. This should include gas masks, eye protection, and chemical-resistant clothing, with emphasis on well maintained and appropriate PPE
			• Bunker transfer procedures:
			  ○ Officers must understand the loading sequence, this is to include valve order and transfer rates

3	Common considerations:
	• Crew training:
	  ○ There should be comprehensive training for all personnel involved in the loading, transfer and operational processes of novel fuels
	• Post-operation checks:
	  ○ Officers should understand the post-operation checks following the loading or transfer process
	• Continuous improvement:
	  ○ Seafarers should understand the advantages of a culture of continuous improvement by conducting regular reviews of loading and transfer procedures. This is to include feedback and analysis of incidents and near-misses
	  ○ Seafarers should understand the importance of adequate ventilation in enclosed spaces that prevents a build-up of vapours. This is to include gas detection systems that monitor leaks

10.5 Seafarer training for emergency response when handling novel fuels

Part 5			
Emergency response procedures will be company specific, ship specific and fuel specific. Further, they may also be tailored to an individual's onboard function. Training centres should not be constrained by these lists and may include content relevant to their participants			
1	About emergency response: It is important that crews are trained in specific firefighting and abandon ship techniques relevant to the specific fuels as these techniques are not generic. There will also be a requirement for continuous onboard training and familiarisation		
	Ammonia	Methanol	Hydrogen
2	Emergency response: • Personnel should be familiar with specific training requirements for emergency response procedures. This is to include the use of emergency shutdown systems, evacuation protocols and first aid measures		
3	Emergency shutdown procedure: • Seafarers to be familiar and trained in emergency shutdown procedures specific to the loading phase. This is to include details for isolating the fuel source, activating emergency shutdown systems and communicating with all relevant personnel		
4	• Explore communication protocols and coordination with relevant authorities. This is to include the establishment of clear communication protocols between onboard personnel, port authorities and terminal operators during the transfer operations		

10.6 Alternative fuel health and safety learnings for seafarers

Part 6			
It is important to note that health and safety requirements will vary according to individual company safety management systems (SMS)			
1	There is much written and discussed concerning health and safety surrounding alternative fuels. What is apparent is that these fuels possess an elevated environmental and operational risk. The advice given below is neither exhaustive nor prescriptive but offers guidance to good industry practice.		
	Ammonia	Methanol	Hydrogen
2	Health hazards of ammonia exposure: • Respiratory hazards: ○ Personnel to be made aware of the physical effects exposure to ammonia may cause. Suggested information includes respiratory issues and irritation of the nose, throat and lungs. Prolonged exposure to high concentrations of ammonia may lead to respiratory distress ○ Symptoms may include coughing, difficulty in breathing and chest pain • Visual hazards: ○ Personnel to be made aware that ammonia exposure to the eyes can result in irritation, tearing and, in severe cases, damage to the cornea ○ Seafarers must understand precautionary measures and injury mitigation. This is to include the importance of eye protection and immediate eye flushing in case of exposure • Skin hazards: ○ Seafarers must understand the effects of contact with liquid ammonia. This is to include skin irritation, burns, and frostbite ○ Emphasise the importance of personal protective equipment (PPE). This is to include any specific PPE such as splash suits and respiratory equipment	Health hazards of methanol exposure: • Central nervous system effects: ○ Personnel to be made aware of the toxicity of methanol to the central nervous system. Suggested information includes symptoms of exposure such as headache, dizziness, confusion and loss of consciousness • Visual hazards: ○ Personnel to be made aware that methanol exposure to the eyes can cause blurred vision, pain and, in severe cases, irreversible damage leading to blindness. Explain medical mitigation measures and the importance of the provision of immediate medical attention • Ingestion hazards: ○ Seafarers must understand the effects of methanol ingestion and its toxicity. Explain medical mitigation measures and the provision of immediate medical attention	Health hazards of hydrogen exposure: • Respiratory hazards: ○ Personnel to be made aware of the limited physical effects exposure to hydrogen may cause. Suggested information may include oxygen displacement and thermal injuries • Skin hazards: ○ Seafarers must understand the effects of contact with cryogenic hydrogen. ○ Emphasise the importance of personal protective equipment (PPE). This is to include any specific PPE such as splash suits and respiratory equipment

<table>
<tr><td>3</td><td>First aid measures for ammonia exposure:

For many seafarers, these fuels will present injuries previously not encountered. Therefore, it may be prudent to include specific first aid knowledge such as:
• Inhalation exposure:
○ Seafarers to be made aware of immediate mitigation measures. Suggested information includes moving the affected person into safe clean air and the possibility of using artificial respiration
○ Consider seeking immediate medical attention
• Eye exposure:
○ Seafarers to be made aware of immediate mitigation measures. This is to include flushing the eyes with water or the use of a neutralising agent.
○ Consider seeking immediate medical attention
• Skin exposure:
○ Seafarers to be aware of immediate mitigation measures and consider seeking immediate medical advice</td><td>First aid measures for methanol exposure:

For many seafarers, these fuels will present injuries previously not encountered. Therefore, it may be prudent to include specific first aid knowledge such as:
• Inhalation or ingestion exposure:
○ Seafarers to be made aware of immediate mitigation measures. This is to include moving the affected person into safe clean air and the possibility of using artificial respiration.
○ Consider seeking immediate medical attention
• Eye exposure:
○ Seafarers to be made aware of immediate mitigation measures. This is to include flushing the eyes with water or the use of a neutralising agent
○ Consider seeking immediate medical attention
• Skin exposure:
○ Seafarers to be made aware of immediate mitigation measures and consider seeking immediate medical advice</td><td>First aid measures for hydrogen exposure:

For many seafarers, these fuels will present injuries previously not encountered. Therefore, it may be prudent to include specific first aid knowledge such as:
• Assess breathing and circulation:
○ Seafarers to be made aware of immediate mitigation measures. This is to include moving the affected person into safe clean air and the possibility of using artificial respiration
○ Consider seeking immediate medical attention
• Skin Exposure:
○ Seafarers to be made aware of how to treat frostbite and cold burns. Consider immediate mitigation measures and seeking immediate medical advice</td></tr>
<tr><td>4</td><td colspan="3">Common first aid considerations:
• Communication and reporting:
○ Seafarers should understand clear communication protocols for prompt reporting of any exposure incidents and should encourage crew members to report any symptoms or signs of exposure
• Medical response team:
○ The SMS should consider the provision of an onboard designated medical response team
○ Crew members should be made aware of the availability of onboard first aid supplies, eye wash stations and emergency medical equipment
• Regular training:
○ The necessity of regular onboard training sessions with emphasis on the medical provision and PPE requirements for these fuels should be understood by all crew members
• Documentation and post-incident review:
○ Officers should be made aware of the necessity to maintain detailed records of exposure incidents, first aid administered and any medical follow-up
○ Personnel should understand the requirement for post-incident reviews that would identify areas for improvement in relation to identifying health hazards and first aid response</td></tr>
<tr><td>5</td><td colspan="3">Occupational health and safety considerations:
Officers require to have an understanding of international regulations, such as the IGF Code, and the relevance of the code to safe handling and storage of novel fuels. Seafarers should be made familiar with these regulations and ensure compliance in all operations</td></tr>
</table>

10.7 Seafarer practical training in relation to novel fuel handling

<table>
<tr><th colspan="4">Part 7</th></tr>
<tr><td colspan="4">Whilst it is accepted that not all training establishments may be able to provide a 'real' experience, significant learning outcomes can be achieved by such a facility. Training centres should not be constrained by these lists and may include content relevant to their participants.</td></tr>
<tr><td>1</td><td colspan="3">Ideally, Maritime Educators and Technology institutes (MET) should aim to provide 'live' demonstrations of fuel handling procedures – this will enhance the learning experience and add a practical 'hands-on' element. This may be facilitated through practical instruction with equipment such as simulators, augmented and virtual reality and/or video tools.</td></tr>
<tr><td></td><td>Ammonia</td><td>Methanol</td><td>Hydrogen</td></tr>
<tr><td rowspan="4">2</td><td colspan="3">Fuel handling demonstrations:
• PPE application:
○ Training for seafarers should include the correct application of personal protective equipment (PPE). This is to include gas masks, eye protection and chemical-resistant clothing with emphasis on the importance of a proper fit and adherence to safety protocols</td></tr>
<tr><td></td><td>• Cargo compatibility checks:
○ Seafarers should understand the procedures for cargo compatibility checks before loading methanol. This is to include the importance of inspecting and cleaning bunker tanks</td><td></td></tr>
<tr><td>• Loading procedures:
○ Seafarers will require practical training in the step-by-step process for loading ammonia, from the pre-loading inspection to the activation of emergency shutdown systems.
○ Personnel to have a practical understanding of safety measures such as ventilation procedures, monitoring parameters, and the use of gas detection equipment</td><td>• Loading and transfer processes:
○ Seafarers will require practical training in the loading and transfer processes for methanol, including the use of vapour recovery systems and adherence to loading rates and temperatures</td><td>• Loading procedures:
○ Seafarers will require practical training in the step-by-step process for loading hydrogen, from the pre-loading inspection to the activation of emergency shutdown systems
○ Personnel to have a practical understanding of safety measures such as ventilation procedures, monitoring parameters, and the use of gas detection equipment</td></tr>
<tr><td></td><td>• Grounding and bonding
○ Crew members must have training in grounding and bonding procedures for the loading process to prevent static electricity build-up and to mitigate fire hazards associated with methanol</td><td></td></tr>
</table>

	• Emergency shutdown:
	  ○ Seafarer training must include a simulated emergency shutdown scenario. This is to include isolations of the fuel source and the activation of emergency shutdown systems along with communication protocols
	• Utilisation of system operation:
	  ○ Personnel should experience the provision of a live demonstration of the operation of the fuel systems whilst emphasising safety features and the integration with existing ship machinery
	• Leak response:
	  ○ Seafarer training must be given in the correct response to a simulated fuel leak. This is to include the use of leak detection equipment and the isolation of affected areas along with the implementation of emergency response measures. Simulate emergency response drills specific to the novel fuels and cover scenarios such as leaks, spills or exposure incidents. Seafarer training must include the coordination of crew members and the implementation of emergency shutdown procedures

3	Common considerations:
	• Interactive learning:
	  ○ Seafarers should be encouraged to participate in an interactive learning environment during live demonstrations by encouraging questions, discussions and hands-on participation
	• Realistic scenarios:
	  ○ For practical training purposes, explore realistic scenarios introduced in to the demonstrations to simulate the challenges and decision-making processes that seafarers may encounter in actual fuel handling situations
	• Simulation technology:
	  ○ Training technology may include simulators that can enhance the realism of the demonstrations. Virtual reality or augmented reality tools can provide immersive experiences for seafarers
	• Safety observations:
	  ○ Part of the learnings could emphasise the importance of safety observations, including identifying potential hazards, effective communications and responding promptly to unexpected situations
	• Debriefing sessions:
	  ○ Seafarers should be encouraged to participate in debriefing sessions after each live demonstration to determine key takeaways, address questions or concerns and reinforce learning objectives
	• Feedback processes:
	  ○ Promote feedback processes that allow seafarers to input on the effectiveness of the practical training

10.8 Seafarer learning outcomes and assessment

Part 8	
Assessment is conducted by the trainer as part of the process and therefore the recommended mode of delivery is face to face. However, a blended-learning strategy may be effective, using online or off-line apps and computer-based training programmes. These methods may be particularly welcome to participants who are at sea or are unable to attend a shore establishment. In this event, the authenticity of participants must be validated, and effective learning demonstrated.	
1	Examinations to assess theoretical knowledge: Comprehensive coverage: • Explore the provision and delivery of examinations that comprehensively cover the theoretical aspects of handling alternative ship fuels, with a focus on ammonia, methanol, and hydrogen. Exam topics to include properties of the fuels, regulatory compliance, safety protocols, and emergency procedures Multiple choice and scenario-based questions: • Consider including a mix of multiple-choice questions to test knowledge recall and scenario-based questions to assess the application of theoretical concepts in practical situations. This will ensure a well-rounded evaluation of seafarers' understanding Regulatory compliance assessment: • Consider a dedicated section of the examination to assess the seafarer's knowledge of international regulations and codes related to alternative ship fuels, such as the IGF Code. Ensure that participants demonstrate an understanding of compliance requirements Time-bound assessment: • Set a reasonable time limit for the examination
2	Practical assessments to evaluate hands-on skills: Live demonstrations and simulations: • It may be beneficial to the assessment process to integrate practical assessments during the live training demonstrations. Seafarers must be evaluated on their ability to apply theoretical knowledge to real-life scenarios, including emergency response drills and fuel handling procedures Hands-on tasks: • Trainers to design hands-on tasks that require seafarers to demonstrate their proficiency in handling ammonia, methanol and hydrogen safely. This may include tasks such as connecting transfer equipment, implementing emergency shutdown procedures, and responding to simulated leaks or spills Safety protocols: • Trainers should emphasise the importance of following safety protocols during practical assessments. Seafarers must be evaluated on their use of personal protective equipment, their awareness of potential hazards and their ability to respond appropriately to unforeseen challenges Scenario-based assessments: • Trainers should create scenario-based assessments that replicate real-world situations. Seafarers must be assessed on their decision-making skills, communication under pressure, and effective collaboration in a team setting

3	Issuance of a certificate upon successful completion of the training course: Guidelines for certification: • Clearly define the standard for successful completion of the training programme. This may include achieving a minimum pass score on written examinations and demonstrating competence in practical assessments • Full attendance at every session is a pre-requisite for successful completion of the course Certification levels: • Consider different certification levels based on the complexity of the training programme. For example, distinguish between basic and advanced certifications to reflect varying levels of proficiency and responsibility Documented achievements: • It may be beneficial to provide a detailed certificate that documents the achievements of each participant. Information may include subject areas, examination scores, and a summary of practical assessments Validity period and renewal requirements: • If relevant, specify the validity period of the certificate. Recognition and compliance: • Ensure that the issued certificates are recognised by relevant maritime authorities and comply with international regulations. This will enhance the credibility and transferability of the certification within the maritime industry Continuous professional development (CPD): • Encourage seafarers to engage in continuous professional development by offering opportunities for further training and upskilling

10.9 Seafarer training facilities and learning resources

Part 9	
1	Training facilities can vary significantly, not only from country to country but also nationally. Facilities and equipment must be maintained, and where appropriate, inspected and tested in accordance with applicable regulations, current standards and manufacturers' recommendations. Training centres are responsible for drawing up their own safe working policies and guidelines. Training centres shall assess health and safety risks to trainer and participants. They shall identify, implement, monitor and review measures that are effective in minimising, controlling or eradicating such risks. They shall also have arrangements that are effective in dealing with physical emergencies and accidents in accordance with law. The following advice is not prescriptive and is intended as guidance: Dedicated training spaces: • Training centres should ensure the availability of dedicated training spaces equipped for both theoretical and practical training related to alternative ship fuels. These spaces should accommodate lectures, discussions and hands-on exercises Classrooms and lecture halls: • Training centres should provide well-equipped classrooms and lecture halls with audio-visual aids to enable effective theoretical instruction. These spaces should be conducive to interactive learning and discussions Practical training areas: • Training centres should designate specific areas for practical training, including facilities for live demonstrations, simulations and hands-on exercises. These areas should replicate real-world scenarios for a realistic learning experience • Practical exercises should be designed and delivered solely to meet the course criteria Laboratories: • Training centres should establish laboratories or workshops equipped with necessary tools and equipment for conducting experiments related to alternative fuel properties, handling procedures and safety protocols. Laboratories allow seafarers to engage in practical applications of theoretical knowledge Emergency response zones: • Training centres should consider creating dedicated emergency response zones within the training facilities to simulate incidents such as leaks or spills. These zones should be equipped with safety equipment and resources to facilitate realistic emergency response drills

2	Availability of simulators and training equipment: Fuel handling systems: • Training centres should invest in state-of-the-art simulators that replicate the handling and utilisation of ships alternative fuels such as ammonia and methanol. These simulators provide a virtual environment for seafarers to practice procedures in a controlled setting Emergency response simulations: • Seafarer training should aim to integrate emergency response simulations using specialised training equipment. This may include simulating leaks, fires or other emergencies to ensure that seafarers are well-prepared to respond effectively in real-life situations. Fuel transfer equipment: • Practical seafarer training should ensure the availability of actual fuel transfer equipment for hands-on training. Seafarers should have access to the tools and machinery used in the loading, unloading and transfer of alternative ships fuels Gas detection systems: • Practical seafarer training should ensure the provision of gas detection systems for hands-on monitoring and responding to gas leaks. Seafarers should be familiarised with the operation of these systems and trained on interpreting and responding to gas concentration readings Safety gear and personal protective equipment (PPE) • Training centres should supply a range of specific safety gear and PPE for seafarers to use during practical training sessions. This includes gas masks, chemical-resistant clothing, eye protection and other equipment essential for safe fuel handling
3	Qualified trainers with relevant experience: Teaching and training qualifications: Trainers must be qualified in accordance with Section A 1/6 STCW or to the standards stipulated by the training centres, whichever is higher. In order to enhance empathic understanding, it is strongly recommended that trainers have a seagoing background with an STCW (or equivalent) qualification or have worked within the maritime sector and can demonstrate an awareness of the issues faced by seafarers Expertise in alternative ship fuels: • Training centres should ensure that trainers possess in-depth knowledge and expertise in the handling, storage and utilisation of alternative ship fuels, with a focus on ammonia, methanol and hydrogen. This expertise ensures the delivery of accurate and relevant training Maritime industry experience: • Training centres should verify that trainers hold teaching and training qualifications, ensuring their ability to effectively convey information and engage with diverse groups of learners. Teaching skills are crucial for delivering engaging and impactful training sessions Up-to-date knowledge: • Such a training provision for seafarers requires trainers to stay abreast of the latest developments, regulations and technologies related to alternative ship fuels. Continuous learning ensures that the training content remains current and aligned with industry standards Communication and interpersonal skills: • There is a requirement for effective communication and interpersonal skills in trainers. The ability to convey complex information clearly and engage with trainees fosters a positive and productive learning environment Practical experience in emergency response: • Training centres should prioritise trainers with practical experience in emergency response scenarios. This first-hand knowledge enhances their ability to train seafarers on emergency procedures and fosters confidence in the training programme
	Feedback process: • Implement a feedback process that allows seafarers to provide input on the effectiveness of trainers. Regular evaluations ensure that trainers are meeting the needs of the seafarers and continuously improving their training delivery

4	By establishing well-equipped training facilities, incorporating advanced simulators and equipment, and ensuring trainers possess the necessary expertise and qualifications, the training programme for alternative fuels becomes a comprehensive and effective learning experience for seafarers. This approach contributes to enhanced safety, preparedness and proficiency in the maritime industry

10.10 Alternative fuel course evaluation and continuous improvement for seafarers

Part 10	
1	Participant feedback process: • Surveys and questionnaires: ○ Training centres should implement post-training surveys and questionnaires to gather feedback from seafarers. This is to include the effectiveness of the training, the clarity of content and the relevance of practical exercises • Anonymous feedback: ○ Training centres should encourage anonymous feedback to create an open and honest communication channel. Seafarers may be more likely to express their opinions and provide valuable insights that contribute to improvement • Specific areas of evaluation: ○ Training centres should structure the feedback forms to evaluate specific aspects such as trainer effectiveness, clarity of course materials, practical training experiences and the overall perceived value of the training
2	Trainer self-assessment: • Reflection and self-evaluation: ○ Training centres should encourage their trainers to reflect on their teaching methods and overall course delivery. Self-assessment allows trainers to identify areas for improvement and refine their approach to meet the evolving needs of participants • Peer review: ○ Training centres should facilitate peer reviews among trainers, where colleagues provide constructive feedback on teaching methods, content delivery, and engagement strategies. This collaborative approach enhances the overall quality of instruction
3	Post-incident analysis: • Review of emergency drills: ○ Training centres should analyse the effectiveness of emergency response drills conducted as part of the training and assess how well seafarers applied their knowledge in simulated scenarios and identified areas for improvement in emergency procedures • Documentation of incidents: ○ Training centres should document any incidents or challenges encountered during the training programme. These incidents can then be analysed to understand their root causes and corrective measures implemented to prevent similar issues in future sessions

4	Regulatory compliance evaluation: • Regular compliance audits: ○ Training centres should conduct regular audits to ensure that their training programme remains in compliance with international regulations and standards. This includes verifying that the course content reflects the latest updates in industry guidelines • Alignment with IGF Code: ○ Training centres should specifically assess the alignment of the training programme with the International Code of Safety for Ships using Gases or Other Low-Flashpoint Fuels (IGF Code) to ensure that seafarers are adequately prepared to meet regulatory requirements
5	Continuous improvement strategies: • Actionable recommendations: ○ Training centres should convert feedback and evaluation results into actionable recommendations. They can then identify specific areas that require improvement and develop strategies to address these aspects in subsequent training sessions • Regular curriculum reviews: ○ Training centres should schedule regular reviews of the training curriculum to incorporate updates based on industry developments, technological advancements and changes in regulations. This ensures that the training remains current and relevant • Incorporation of good practices: ○ Training centres require to stay informed about good practices in maritime training and incorporate them into the programme. They should benchmark against industry standards and adopt innovative approaches to enhance the overall quality of the training
6	Adaptability to technological advances: • Integration of technology: ○ Training centres should explore the opportunities to integrate emerging technologies, such as virtual reality or augmented reality, into the training programme. Technology can provide realistic simulations and enhance the overall learning experience • E-Learning platforms: ○ Training centres should consider the implementation of e-learning platforms for certain aspects of theoretical training. These platforms can offer flexibility for participants and provide additional resources for self-paced learning
7	Regular stakeholder meetings: • Collaborative feedback sessions: ○ Training centres should schedule regular meetings with stakeholders, including trainers, participants and industry experts, to discuss the training programme. Collaborative feedback sessions foster a sense of shared responsibility for continuous improvement • Identification of industry trends: ○ Any seafarer training should maintain relevance to industry trends and emerging challenges by actively engaging with stakeholders. Their insights can inform adjustments to the training programme to address evolving needs in the maritime sector
8	Documentation of improvement initiatives: • Maintain improvement records: ○ MET Trainers should maintain records of improvement initiatives undertaken based on evaluations and feedback. This documentation serves as a reference for tracking progress over time and provides transparency in the commitment to continuous improvement • Communication of changes: ○ MET Trainers should clearly communicate any changes or enhancements made to their training programme to both current and future seafarer participants. Transparent communication fosters trust and reinforces the commitment to providing high-quality training
9	By systematically evaluating the training programme and implementing continuous improvement strategies, the course can evolve to meet the dynamic challenges of the maritime industry. This commitment to refinement ensures that seafarers receive training that is not only compliant with regulations but also aligned with good practices and industry advancements

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