

Course Programme:

Day 1: Monday 19th May 2025	
Ammonia Properties, Regulatory Developments and Risk Assessment Methodologies	
09:00 – 09:10 Welcome and Introduction <i>(HYDRUS and University of Strathclyde)</i>	
Introduction to the course, objectives and intended outcomes.	
09:10 – 10:00 Session 1: Introduction to Ammonia as an Alternative Marine Fuel <i>(University of Strathclyde)</i>	
<p>This session will introduce ammonia as an alternative marine fuel, exploring its properties, uses, and its growing role in the maritime industry. Participants will learn about ammonia's energy density, storage requirements, and its potential in reducing greenhouse gas emissions from shipping.</p> <p>In addition, the session will address the specific hazards related to ammonia in a marine context. These include its toxicity, flammability, and corrosiveness, particularly in enclosed spaces or in the event of leaks or spills. The risks associated with handling ammonia, as well as its impact on crew health and the environment, will also be discussed.</p> <p>By the end of this session, participants will have a clear understanding of ammonia's role as a sustainable marine fuel, the associated hazards, and the safety considerations necessary for its effective and safe use in the maritime industry.</p>	
10:00 – 10:10 Break	
10:10 – 11:00 Session 2: Risks Associated with Ammonia <i>(University of Strathclyde)</i>	
<p>This session is dedicated to exploring the various risks associated with ammonia use, with a focus on its chemical hazards, environmental impacts, and real-world examples of incidents involving ammonia. Participants will gain insight into ammonia's toxicity, reactivity, and potential for causing harm if improperly handled, particularly in fuel applications.</p> <p>Through case studies of past incidents, participants will analyse the causes, consequences, and preventive measures associated with ammonia-related accidents, enhancing their understanding of risk factors and safety protocols.</p> <p>By the end of this session, learners will have a comprehensive understanding of the risks of ammonia and practical strategies for mitigating these hazards in a safety-focused operational setting.</p>	
11:00 – 11:10 Break	
11:10 – 12:00 Session 3: Introduction to Safety Considerations under the IGF Code <i>(University of Strathclyde)</i>	
<p>In this session, participants will be introduced to the essential principles of conducting risk assessments in line with the International Code of Safety for Ships Using Gases or Other Low-Flashpoint Fuels (IGF Code). A key focus will be on understanding the primary approaches to risk assessment: qualitative, semi-qualitative, and quantitative methods.</p> <p>Participants will learn how to differentiate between these methods, including when and how each should be applied. The session will cover the strengths and limitations of these approaches, demonstrating how qualitative assessments can provide a broad overview of potential hazards, while quantitative assessments offer a more detailed analysis using statistical and numerical data. Through practical examples and discussions, learners will gain insights into selecting the appropriate method based on specific risk scenarios for ammonia fuel applications.</p>	

By the end of this session, participants will be equipped with the knowledge to effectively identify which risk assessment technique is more suited to their case study, ensuring comprehensive risk management in alignment with IGF Code standards.

12:00 – 13:00 | Lunch break

13:00 – 13:50 | Session 4: *Safety Procedures, Rules and Regulations Under Development (RINA/ABS)*

Currently, alternative fuels and marine engineering technologies pertaining to those are addressed by the International Code of the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code). However, the use of toxic cargoes such as ammonia (NH₃) is not permitted under this framework and consequently an amendment to align with what is already permitted under the International Code of Safety for Ships Using Gases or other Low-Flashpoint Fuels (IGF Code) should be achieved over the long term. In the short-term, harmonization of requirements between the IMO *Sub-Committee on Carriage of Cargo and Containers (CCC)* and the IMO *Maritime Safety Committee (MSC)* will be necessary while Classification Societies are developing goal-based guidance notes and interim rules, with specific focus on safety aspects.

In this session the participants will be informed on current developments and future directions of rules and regulations for the use of NH₃ as an Alternative Marine Fuel onboard ships. The session will outline key goals, functional requirements and risk analysis methods that can be used for safe ship design, ship systems and life cycle shipping operations. Through discussions, it will be possible to get familiar with the practical role of regulatory instruments and classification rules under development, as well as the role played by Classification Societies as Recognized Organizations of National Flag Administrations.

By the end of this session, participants will have a clearer understanding on the structure, on strategic directions of regulatory and rule development and on the need of risk assessment for regulatory compliance.

13:50 – 14:00 | Break

14:00 – 14:50 | Session 5: *Introduction to Qualitative Risk Assessment (HAZID) (University of Strathclyde)*

This session will focus on applying qualitative risk assessment techniques, using the Hazard Identification Study (HAZID) method. Participants will gain the skills to identify, analyse, and evaluate potential risks associated with ammonia as a fuel.

The session will guide participants through the HAZID process, where they will brainstorm and document possible hazards, determine the likelihood and severity of these risks, and discuss appropriate mitigation strategies. This hands-on approach will help learners understand the practical steps involved in qualitative risk assessment and improve their ability to foresee and address safety concerns proactively.

By the end of this session, participants will have gained significant experience in conducting a qualitative risk assessment, reinforcing their understanding of hazard identification methods and enhancing their skills in collaborative risk management of ammonia-fuelled ships.

14:50 – 15:00 | Break

15:00 – 15:50 | Session 6: *Introduction to Qualitative/Semi-qualitative Risk Assessment (HAZOP/FMEA) (TWI)*

The second session on the risk assessment will focus on applying qualitative risk assessment technique using the Hazard and Operability Study (HAZOP) and semi-qualitative risk assessment technique using the Failure Mode and Effect Analysis (FMEA).

The participants will be guided through the HAZOP and FMEA processes, where they will brainstorm and document possible hazards, determine the likelihood and severity of these risks, and discuss appropriate mitigation strategies. This hands-on approach will help learners understand the practical steps involved in qualitative and semi-qualitative risk assessment and improve their ability to foresee and address safety concerns proactively.

By the end of this session, participants will have gained firsthand experience in conducting the HAZOP and FMEA methodologies, reinforcing their understanding of hazard identification and evaluation methods and enhancing their skills in collaborative risk management.

15:50 – 16:00 |

Day 2: Tuesday, 20th May 2025

Safety Considerations, Implementation and Emergency situations in Ammonia Usage

09:10 – 10:00 | **Session 7: *Developing Safety Measures for Ammonia Fuel Storage and Supply Systems***
(University of Strathclyde)

This session will focus on the development and implementation of safety measures specifically designed to address the unique challenges posed by ammonia, particularly in its use as a fuel. Participants will explore the critical safety considerations that arise from ammonia's toxic, flammable, and corrosive properties, as well as its potential environmental impact.

Through a structured approach, the session will cover the creation of comprehensive safety measures, including hazard mitigation strategies, and safety equipment requirements. Emphasis will be placed on identifying the key risks associated with ammonia fuel and developing targeted solutions to minimize those risks.

By the end of this session, participants will be equipped with the knowledge and practical tools needed to create and implement safety measures that effectively manage the risks associated with ammonia, promoting safer operations in ammonia-powered systems.

10:00 – 10:10 | **Break**

10:10 – 11:00 | **Session 8: *Training Session: Mitigation Practices for Identified Risks (HAZOP/FMEA)***
(TWI)

This training session will focus on practical mitigation strategies for risks identified in Session 6, specifically in the context of ammonia as a fuel. Participants will learn how to apply structured approaches, such as Hazard Identification (HAZID) and Hazard and Operability Study (HAZOP), to assess risks and implement appropriate control measures.

The session will cover key risk mitigation practices, including process modifications, safety barriers, and operational best practices. Special attention will be given to proactive measures such as improved ventilation, leak detection systems, and strict handling protocols to minimize ammonia-related hazards.

Through the case study of a real demonstrator vessel, participants will develop and refine mitigation strategies for real-world scenarios. By the end of this session, they will be equipped with practical tools and knowledge to effectively reduce risks in ammonia-fuelled operations, ensuring compliance with safety regulations and best practices.

11:00 – 11:10 | Break

11:10 – 12:00 | Session 9: Ammonia Fuelled Ship Design – Emergency Situations and Protective Barriers (DNV)

Due to the various properties of ammonia and the behaviour of ammonia vapour, there are several strategies that can be implemented to manipulate and control the spread of ammonia gas in case of an emergency. This is clear if one compares the different class guidelines and class rules for various class societies, in particular pertaining to those items not explicitly covered by the MSC Circ.1687-Interim guidelines for the safety of ships using ammonia as fuel. However, any implemented strategy will have potential detrimental effects and side effects that need to be taken into account qualitatively when evaluating the theoretical effectiveness of the chosen design, as well as evaluating whether the practical application is feasible and can be expected to be reliably implemented in an accident scenario.

This training session will focus on the various measures and methods that can be implemented to handle the ammonia vapours from various leakage cases, focusing on enclosed spaces such as fuel preparation rooms, tank connection spaces and enclosed bunkering stations. The discussion will not focus on the establishment of the leakage scenarios themselves, but focus on the practical measures that may be needed to reduce the spread of ammonia from the space or manage the ammonia inside the space to facilitate escape.

After the session, the participants will have an overview of the various safeguards and mitigating actions that may be arranged for by design, and have an understanding of the advantages and drawbacks that can be expected in an accident scenario which needs consideration.

12:00 – 13:00 | Lunch break

13:00 – 13:50 | Session 10: QRA Methodologies: Tools to Deal with Safety Challenges (University of Strathclyde)

This session will shift the focus from a general exploration of Quantitative Risk Assessment (QRA) to a detailed examination of QRA methodologies as practical tools for dealing with safety challenges, particularly in the context of using ammonia as a fuel. Participants will learn how to apply quantitative methods to identify, measure, and assess risks in a precise, data-driven manner.

The session will delve into the various QRA methodologies, such as Fault Tree Analysis (FTA), Event Tree Analysis (ETA), and Computational Fluid Dynamics (CFD) modelling, highlighting how these tools can be utilized to predict and quantify potential hazards. Special attention will be given to how QRA can effectively address specific safety challenges in ammonia storage and its auxiliary systems, ensuring compliance with safety standards and minimizing the risk of incidents.

By the end of this session, participants will have a clear understanding of how to leverage QRA tools to make informed decisions, manage risks proactively, and enhance the safety and reliability of ammonia as a fuel.

13:50 – 14:00 | Break

14:00 – 14:50 | Session 11: Lessons Learned from Safety and Risk Assessment (Quantitative Risk Assessment) (University of Strathclyde)

This session will present a selection of case studies that highlight innovative solutions to the safety challenges associated with ammonia, particularly in its use as a fuel. Applying a detailed Quantitative Risk Assessment (QRA) study of real-world scenarios, the session will examine how to successfully address the risks and hazards inherent in ammonia applications.

The case studies will focus on incidents where Computational Fluid Dynamics (CFD) tools were utilized alongside innovative engineering solutions, risk management strategies, and safety protocols to mitigate potential dangers, prevent accidents, and improve operational safety. The analysis will explore how advanced modelling techniques help predict and control ammonia-related hazards, demonstrating their effectiveness in enhancing safety measures.

By the end of this session, participants will have a deeper understanding of how innovation, proactive safety measures, and simulation tools can significantly reduce risks when using ammonia as a fuel. The session will provide valuable insights into best practices and real-world applications, helping to enhance knowledge of safety strategies in ammonia-fuelled systems.

14:50 – 15:00 | Break

15:00 – 15:50 | Session 12: *Design & Engineering Before and After Risk Assessment Workshop (HYDRUS)*

This session will focus on the design and engineering aspects critical to the use of ammonia as fuel in ammonia-fuelled vessels. The nature of ammonia, the risks and the key lessons learned, will have already been introduced through qualitative and quantitative aspects in the previous sessions 5, 6 and 11.

Building on this foundation, the session will explore engineering considerations in a time series of events by presenting the amendments and development of the vessel design before and after each risk and safety workshop. Also, some safety aspects will be correlated with the current and yet premature regulatory framework that ammonia as fuel is associated with at a high level.

By the end of the session, participants are expected on the one hand to gain a solid understanding about the design implications and challenges that safety workshops can pose but on the other hand to realise how workshops can imperatively lead to a safer and complete design.

15:50 – 16:00 | Concluding Remarks

***5-min allocated for Q&A at the end of each session**