UK CHAMBER of SHIPPING

Alternative Fuels: **Building the Safety Evidence Base**

Industry-led risk assessments across fuel pathways

Foreword

Shipping is on a critical pathway to net zero. New fuels and energy sources are moving from pilots to early commercial adoption - but safety, standards and operational readiness must keep pace.

That is why the UK Chamber of Shipping convened the Safety of Alternative Fuels Working Group (SAFWG): to bring together operators, fuel providers, engine and equipment manufacturers, Classification Societies, ports, insurers, legal experts, academia and government stakeholders to build a shared, evidence-led baseline of safety considerations for alternative marine fuels.

As the sector accelerates decarbonisation, this publication and the work of the SAFWG's aim is to provide thought-leadership alongside practical guidance and themes for discussion - clarifying the 'knowns' and 'unknowns', highlighting recurring risk themes across fuels, and creating a platform for collective learning.

The outcome of this work to date, is a set of preliminary, high-level risk assessments across five fuel pathways:

Battery Energy Storage Systems

Biofuels

Methanol

Hydrogen

Ammonia

The full risk assessments, along with a detailed resource library are available via ukchamberofshipping.com.

These risk assessments have been developed through structured expert workshops and cross-sector validation.

These risk matrices are not safety cases; they are a forward-looking foundation to inform project-specific design reviews, operational planning and future regulation.

This first-year work has focussed on stakeholder engagement and mapping, broadening participation across industry, government, academia and supporting organisations.

Together, these insights provide an important foundation for Year 2, helping to focus future collaboration, prioritise gaps, and support the development of more coherent safety frameworks for safe adoption of new fuels and energy sources at scale.

Looking ahead we will build on this foundation to prioritise regulatory and knowledge gaps, develop project-specific case studies, and support the development of coherent safety frameworks that enable safe scaling.

Key Findings

Safety as a pre-requisite
Design and process safety protocols to support the commercial rollout of alternative fuels are needed.

Industry-led evidence base
This work brings together first-hand operational, technical and regulatory perspectives to create a shared baseline.

From baseline risks to actionable priorities
From establishing the hazard baseline, the UK Chamber will work with partners to develop a prioritization matrix and recommendations.

> The SAFWG is an excellent, highly productive and rewarding initiative that has delivered excellent results that are valuable to a wide range of industry stakeholders. This wouldn't have been possible without the UK Chamber of Shipping's leadership, the excellent expert speakers and those that have given up their time to contribute.
>
> I have personally gained an enormous amount from the experience, reconnected with old friends and met new ones. Many thanks to everyone involved. The SAFWG is an excellent example of what is possible when industry stakeholders come together to achieve a common goal.

Stephen Brown
Chair of SAFWG, Technology Manager at Shell Shipping and Maritime

> Significant work has been undertaken by players across the industry to pilot and test alternative fuels. This work is often hard to come by and not publicly available. The SAFWG has made great progress in year 1 in bringing together useful sources on alternative fuels to develop clear and concise risk registers on alternative fuels. This resource provides a strong foundation to those looking to design and build new vessel types.

James Helliwell
Vice chair of SAFWG, Commercial Director for Decarbonisation at V. Group

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The following annexes are available on the UK Chamber of Shipping website or via the links below:

Annex A – Terms of Reference
Annex B – Stakeholder Engagement
Annex C – Resource Library
Annex D – Risk Assessment Template
Annex E – Preliminary Risk Assessments
Annex F – Full Statements by Speakers and Participants

Introduction

In 2023, the IMO adopted the revised Strategy on the Reduction of GHG Emissions from Ships, setting a strengthened ambition for the maritime sector to reach net-zero GHG emissions by, or around, 2050.

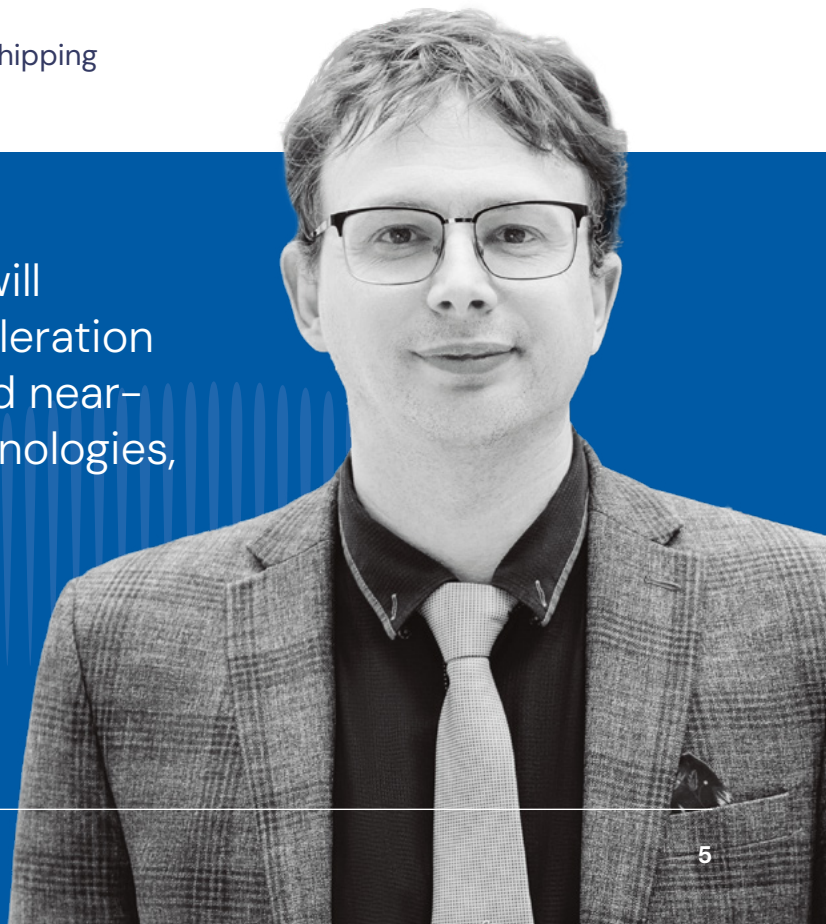
Delivering this ambition will require a significant acceleration in the uptake of zero- and near-zero-emission fuels, technologies, and energy sources.

Recognising the need for industry-led safety guidance on emerging fuel types, the UK Chamber's Safety and Environment Committee endorsed the creation of the Safety of Alternative Fuels Working Group (SAFWG) in November 2023 to bring together industry expertise to identify safety gaps, develop knowledge, and influence future regulation.

An introductory meeting took place in May 2024, followed by formal establishment of the Group – with appointed Chairs and Terms of Reference – in November 2024. This report summarises the Working Group's first full year of activity (2025).

The year focused on building a shared evidence base, jointly developing knowledge and understanding between Members and Stakeholders, establishing strong stakeholder collaboration and developing preliminary safety risk assessments for five priority alternative fuels: Battery Energy Storage Systems, Methanol, Ammonia, Hydrogen, and Biofuels, assisting Members to take informed decisions.

Francesco Sandrelli
Policy Director - Environment, UK Chamber of Shipping



> Delivering this ambition will require a significant acceleration in the uptake of zero- and near-zero-emission fuels, technologies, and energy sources.

About the SAFWG

The Safety of Alternative Fuels Working Group (SAFWG) was established in 2024 to support UK Chamber of Shipping Members and the shipping industry in navigating the transition towards zero- and near-zero-emission fuels.

In alignment with the IMO's revised 2023 Strategy on the Reduction of GHG Emissions from Ships, the SAFWG was tasked with identifying safety, regulatory, and knowledge gaps across emerging fuel types and developing a shared evidence base to support safe commercial adoption.

2025 marked the first full operational year of the SAFWG. The Group focused on building strong industry collaboration, developed a shared understanding among participants, provided expert networking and generate initial technical outputs.

Delivery to date

Establishing a **multi-stakeholder engagement network**

Hosting five technical workshops supported by expert speakers

Producing **preliminary/high-level risk assessments for five fuels**

Developing a **structured Resource Library**

Launch of **Stakeholder Mapping and Engagement Work**

Establishing document control processes and beginning a formal gap identification process

These outputs are **preliminary working documents** and are intended to inform company specific risk assessments and further SAFWG activity; they do not replace project specific safety cases or regulatory approvals.

Initial regulatory and knowledge gap analysis has begun but will require further development and expansion in 2026.

This report summarises the Group's structure, purpose, activities, and early deliverables, and sets out the groundwork for a focused Year 2.

The SAFWG – At a Glance

An industry led evidence base: participation and stakeholder breadth

The Working Group engaged shipowners and operators, Classification Societies, marine consultancies, legal and P&I experts, ports and harbour authorities, government departments and agencies, academic institutions, other shipping associations, and equipment manufacturers and fuel suppliers.

Shipowners & Operators

Shell
V. Group,
AngloEastern
BP
Bibby Marine
CalMac
Carnival
CEMEX
Evergreen
James Fisher
J.P. Morgan
MOD
MOL
MSC
Northern Lighthouse Board
Northern Marine
P&O
Purus
Stena Line
Svitzer
NYK
Fortescue

Classification Societies

ABS
BV
LR
RINA
DNV

Consultancies

Frazer Nash Consultancy

Legal & P&I

Gard
North Standard
Shipowner Club
Thomas Miller
West P&I
International Group of P&I Clubs (Steamship Mutual)

Ports & Harbours

Forth Port
Singapore MPA
Port of Rotterdam

Government Agencies

MCA UK
Singapore MPA
UK Health & Safety Executive

Academia

UK National Clean Maritime Research Hub
University of Southampton (SOTON)
University of Strathclyde

Industry Associations

ICS
IBIA

Equipment Manufacturers and Fuel Suppliers

Corvus
Everllence
Wartsila
Alfa Laval
GiBunkering
Yara

Year 1 – At a Glance

5
Workshops held

52
Organisations involved

30
Hours of Activities with Members

18
Speakers and presenters

206
Total participants

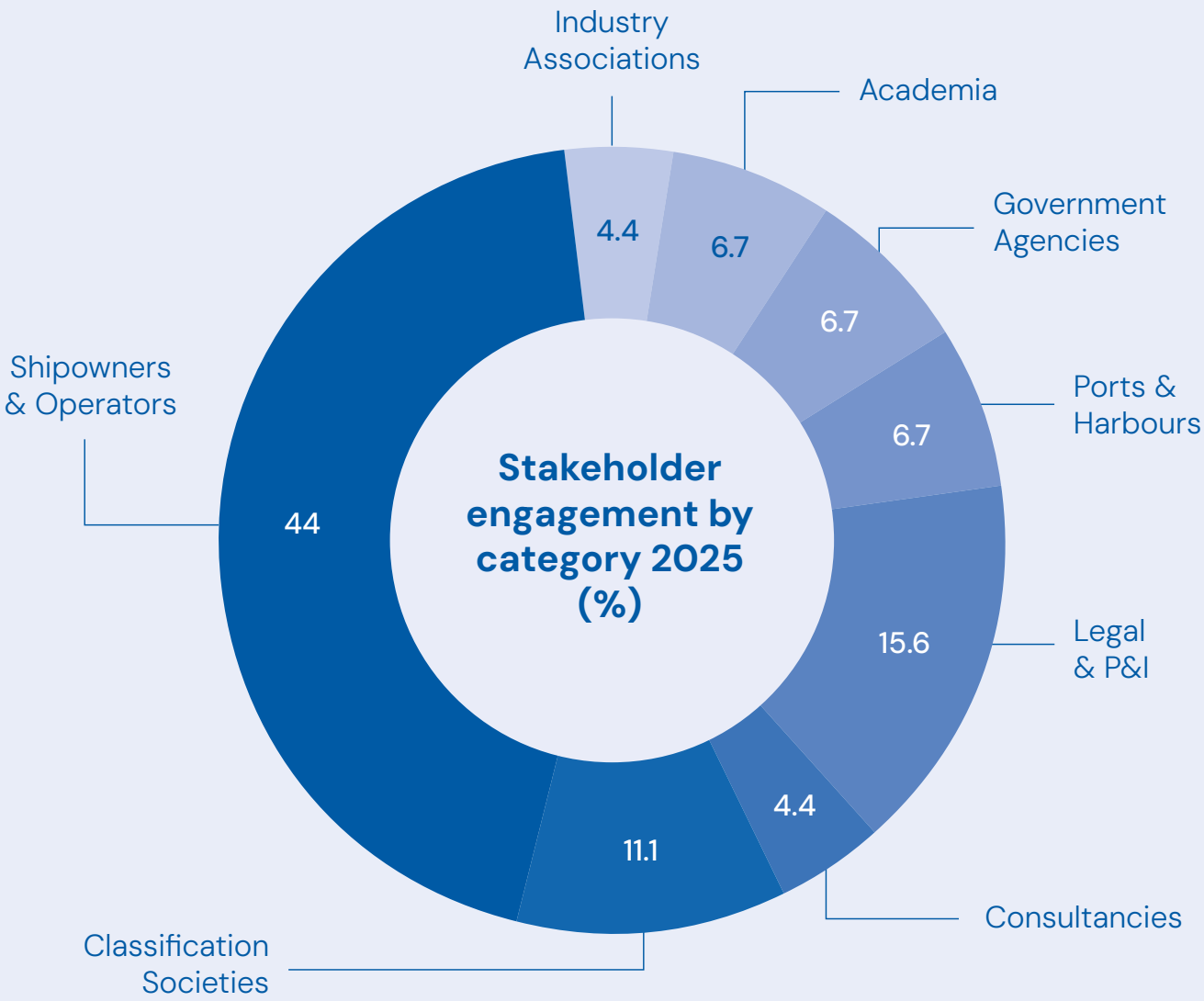
Key Deliverables

- 5 Initial Risk Assessments
- Resource Library
- Stakeholder Map
- Document Control Procedure

> The UK Chamber of Shipping demonstrated outstanding leadership, providing a valuable platform, strengthening understanding of the challenges and identifying the ways to address them.

Professor Osman Turan
University of Strathclyde

A year of collaborative risk assessment building the foundation for future activities.



Value Delivered to Members in 2025

- **Clear baseline understanding** of safety considerations across five alternative fuels
- **Access to expert knowledge** from operators, fuel suppliers, engine manufacturers, Classification Societies and academia
- **Foundation for company-specific risk assessments**
- **Early visibility** on emerging regulatory and knowledge gaps
- **Strengthened connections** across UK Chamber Members and global partners

Legal Disclaimer: Limitation of Year 1 Deliverables

The risk assessments and related materials produced in 2025 are based on information available at the time of preparation and on the professional knowledge, experience, and judgment of participating members and subject-matter contributors.

While reasonable care has been taken in their development, unidentified, emerging, or currently unknown risks may exist and are not necessarily reflected in the findings.

All findings, analyses, and recommendations are preliminary in nature and are intended solely as working documents and developmental inputs for subsequent project phases.

They do not constitute final safety cases, certified risk evaluations, or comprehensive hazard analyses (the list of risks identified is not exhaustive, and impact and likelihood are subject to change).

They must not be relied upon as a substitute for project-specific, detailed risk assessments, design reviews, regulatory compliance evaluations, or operational risk studies conducted by or on behalf of individual organisations.

This report reflects collaborative industry input and member opinion only and does not represent formal regulatory guidance, statutory requirements, or official positions of any authority, classification body, or governmental agency. Reference to any methodology, control measure, or mitigation strategy does not imply approval, endorsement, or certification by any regulator or third party.

Certain deliverables and conclusions remain in draft or developmental form and are expected to evolve through continued research, validation, and stakeholder engagement in 2026 and beyond. Updates, revisions, or corrections may be issued without notice.

No warranty or representation, express or implied, is made as to the accuracy, completeness, fitness for purpose, or applicability of the content. Use of, or reliance on, this material is at the user's sole risk. The authors, contributors, and sponsoring organisations accept no liability for any loss, damage, cost, or consequence arising directly or indirectly from the use or misuse of this report or its contents.

Annex E contains the Working Group's preliminary risk assessment matrices (hazard descriptions and impact/probability ratings). Annex E is subject to the same limitations described above and intentionally excluded mitigations measures because appropriate controls vary by vessel type, operational profile, company practice, regulatory context.

Annex E matrices provide preliminary hazard-descriptions and impact/probability ratings. They are intended to inform, not replace, project-level risk assessments, safety cases and design reviews; see Summary of Workshops (pg.19) for scope and use.

The deployment of alternative fuels on board ships introduces a variability in the operational landscape, requiring the understanding of the characteristics of each fuel type in order to accurately assess and manage operational risks.

With each of these fuels having a distinct risk profile, the lack of operational data during initial deployment periods will require an agile Safety Management System (SMS) designed to effectively absorb operational learnings and adapt to new requirements.

Gilmark D'Mello
International Group of P&I Clubs (Steamship Mutual)

Fuel-by-fuel risk outlook

Battery Energy Storage Systems (BESS)

Risk profile summary

Thermal runaway and fire dominate the risk profile; ventilation, Battery Management Systems (BMS) resilience and emergency power are recurring vulnerabilities.

Indicative top hazards (Examples from the preliminary matrices)

- Thermal runaway due to manufacturing fault/internal cell failure.
- Cooling/ventilation failure leading to overheating and thermal runaway.
- Loss of battery safety monitoring/control systems (e.g., emergency power failure).
- Water ingress/condensation leading to short circuit and electrical fire.
- Dropped objects damaging batteries leading to thermal runaway.

Biofuels

Risk profile summary

Drop-in biofuels are a pragmatic near-term pathway but require strict supply-chain quality assurance and onboard handling controls to avoid contamination and material incompatibility.

Indicative top hazards

- Bunkering unknown biofuel grade risking warranty/insurance invalidation.
- Cross-contamination in supply chain causing fuel system/engine damage.
- Material incompatibility (seals/coatings) leading to component failure and potential loss of containment.
- Hydroscopic properties of blends causing water/bacteria, sludging and corrosion.
- Incorrect or unavailable Proof of Sustainability (PoS) certificates leading to economic impacts.

"The workshop reinforced that while biofuels offer a practical solution for decarbonisation, successful implementation relies on rigorous quality assurance and well managed onboard handling."

Ansuman Ghosh
Director of Engineering, Thomas Miller

Methanol

Risk profile summary

Methanol's operational maturity is growing; primary concerns are loss of containment, non-visible flames and Simultaneous Operations (SimOps) during bunkering.

Indicative top hazards

- Collision/grounding damaging bunker tanks leading to loss of containment.
- Non-visible methanol flame following loss of containment.
- Toxic inhalation exposure following leak/release.
- Inadequate gas detection/ventilation allowing vapour in enclosed spaces.
- SIMOPS (cargo + bunkering) increasing likelihood of high-consequence incidents.

"...while methanol is a mature chemical, it is still growing as a marine fuel; its safe adoption requires a disciplined and systems-based approach. Key risks discussed included toxicity through exposure, low flashpoint behaviour, and the need for robust fuel containment, ventilation, and detection systems."

Rene Laursen, Director
Fuels & Technology, ABS

"While lower energy density and specific handling risks require careful operational planning, fleet experiences and the expanding support from OEMs and Classification Societies indicate that methanol is emerging as a credible long-term decarbonisation pathway... with disciplined procedures and well-trained crews, methanol can be integrated into vessel operations safely and reliably."

Ansuman Ghosh
Director of Engineering, Thomas Miller

Hydrogen

Risk profile summary

Hydrogen presents storage and explosion risks and cryogenic handling challenges (for liquid hydrogen). Early-adopter experience reduces perceived unknowns, but commercial barriers remain.

Indicative top hazards

- Lack of hydrogen design standards leading to unsafe operating conditions.
- Hydrogen embrittlement from unsuitable materials causing loss of containment.
- Leaks during construction/maintenance causing gaseous or liquid hydrogen release.
- Inadequate ventilation design causing accumulation in enclosed spaces.
- Limited trained personnel for operation/repair increasing the likelihood of incidents.

"There is still a significant gap in hydrogen safety awareness among prospective users, contributing to hesitation in adoption. This workshop brought together experienced hydrogen practitioners who demonstrated that many of the earlier uncertainties have now been addressed. The experiences of these first movers demonstrate that hydrogen can be handled safely. Of course there is more work to do, but in parallel we must improve commercial viability."

Arulmani Arunachalam, Senior Marine Engineer, Shell

Ammonia

Risk profile summary

Ammonia's toxicity and potential for high-impact releases make port preparedness, onboard safety, emergency response and material compatibility top priorities.

Indicative top hazards

- Hose rupture during transfer leading to loss of containment and toxic release.
- Incorrect valve alignment during bunkering leading to toxic release.
- Dropped objects damaging storage tanks/fuel systems leading to loss of containment.
- Vessel collision rupturing fuel tank leading to toxic release.
- Unfamiliarity of nearby vessels/ports with emergency response escalating incidents.

"The Ammonia workshop represented one of our most challenging yet critical sessions, reflecting the complexity of introducing ammonia as a new fuel. A key insight emerging from the discussions was that preparedness must extend beyond the vessel, and how important collaborative emergency planning and familiarisation programmes are at a local level."

Francesco Sandrelli, UK Chamber of Shipping

Report from the SAFWG

Structure and Governance of the Working Group

Chairs

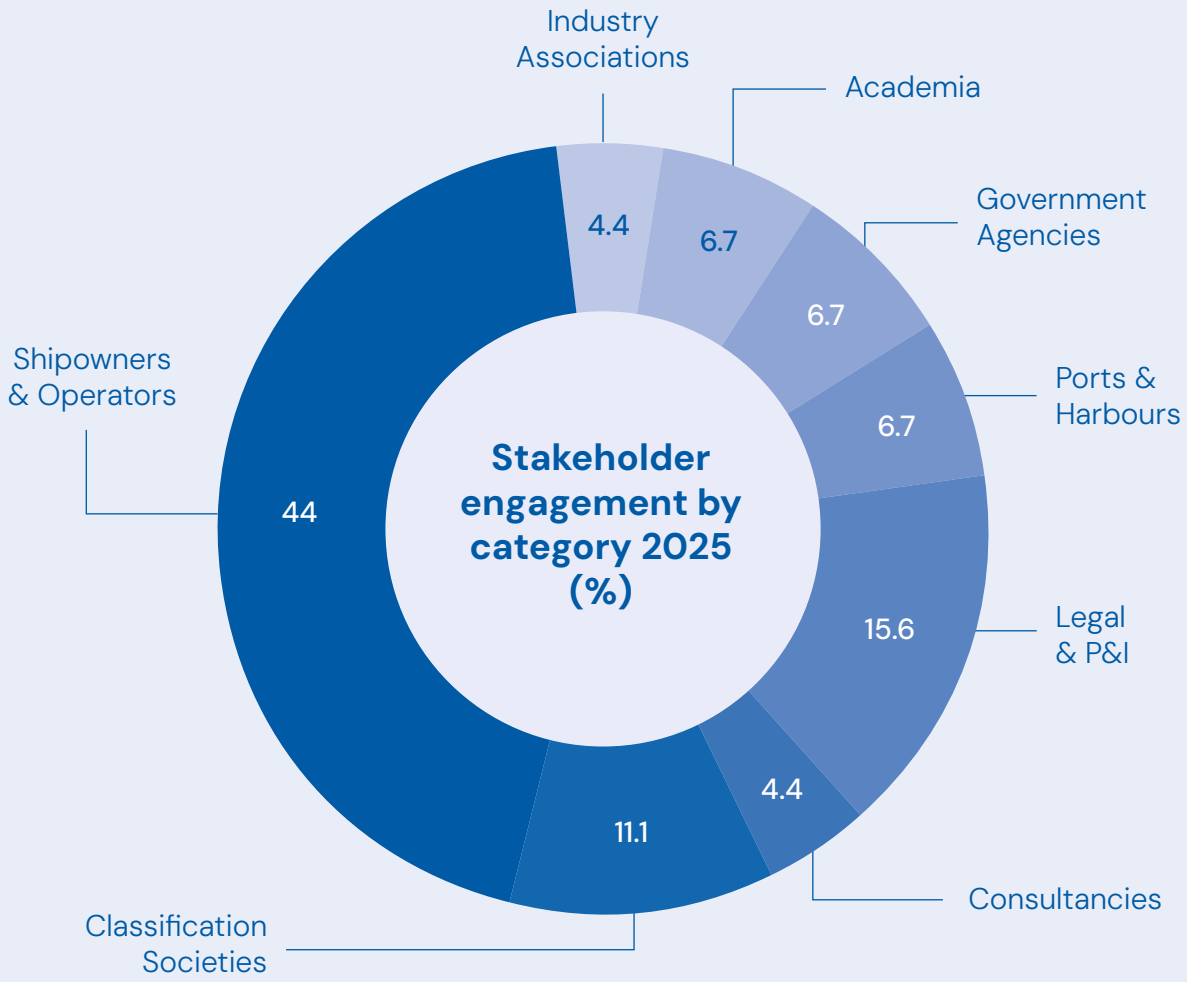
Stephen Brown (Shell) and James Helliwell (V. Group).

Secretariat (UK Chamber)

Francesco Sandrelli, Paul Markides and Robert Merrylees.

The Working Group is open to participation for all UK Chamber Members and selected Non-Member experts. The Group benefits from broad and active engagement with internal and external stakeholders, including: **52 organisations (Full list: Annex B)** – divided as follows:

- **22** Shipowners and operators
- **5** Classification Societies
- **1** Marine consultancy
- **7** Legal and P&I experts
- **3** Port and harbour authorities
- **3** Government departments and agencies
- **3** Academic institutions
- **2** Other shipping associations
- **6** Equipment manufacturers and fuel suppliers

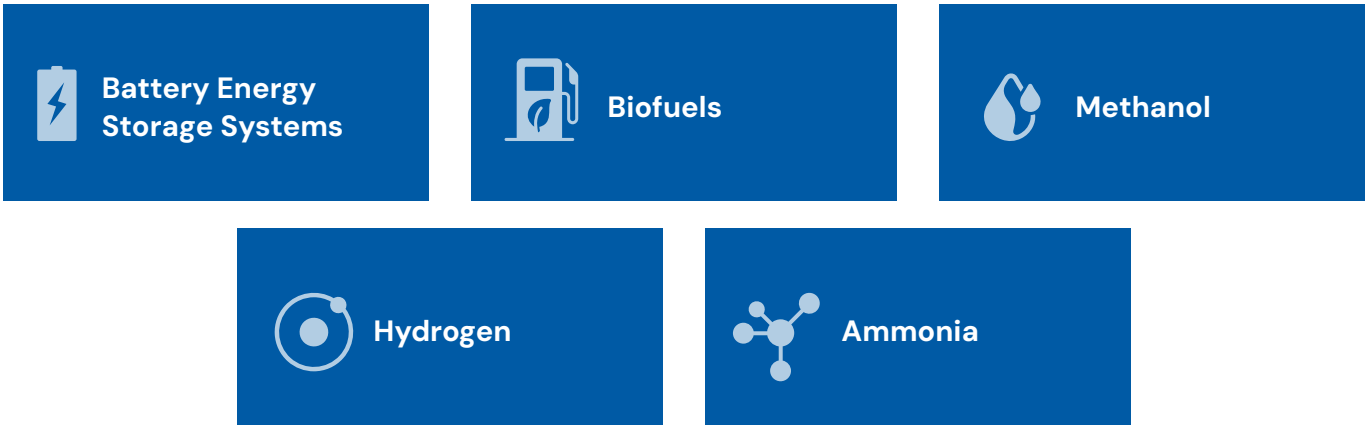


Year 1 Approach & Focus Areas

The SAFWG's Terms of Reference, (Annex A) adopted in November 2024, define the Group's General Purpose as:

> "Bringing together industry expertise to identify, investigate and document existing gaps in regulation and knowledge relating to alternative marine fuels, and to make recommendations to UK Government, European partners, and IMO (via ECSA, ICS, and other channels) on the development of a safety case to support their safe commercial adoption."

The Working Group decided to consider in **scope the following fuels:**



LNG is considered out of scope for the working group due to the well-established safety case and regulatory framework for LNG as a fuel and the significant number of commercial LNG bunkering operations now taking place in the UK.

Nuclear is considered out of scope for the working group as it requires alternative expertise and a standalone scope of work. The Chamber's Futures Forum is looking at this area as an energy system that will need considerable political encouragement as well as strategic alignment. This will be periodically reviewed.

In 2025, the Working Group focused on six core tasks:

- Resource Library Development
- Workshops and Preliminary Risk Assessments
- Stakeholder Engagement and Mapping
- Identification of Gaps
- Document Control and Quality Assurance
- Development of a Communications Plan

Progress against each task is summarised below – with Purpose, Approach/Methodology, Deliverable and Current Status indicated.

Key Deliverables and Progress

Task	Impact
Strong multi-stakeholder collaboration	• Stakeholder engagement map & plan
Expert network	• 53 Organisations and 18 expert speakers
Five technical workshops	• 30+ hours of activities with participants • Risk assesment template • 5 preliminary risk assessments: BESS, Biofuel, Methanol, Hydrogen, Ammonia
Foundation knowledge	• Resource library established

> Having participated in numerous industry working groups… limited engagement from ship operators is often a missing link — something that was notably different at the UKCS workshop… their firsthand operational insight is invaluable.

Dr Muhammad Usman
FOBAS/LR

Foundational Knowledge: The Resource Library

Purpose

To aggregate and synthesise existing research, trials, and regulations to avoid duplication and ensure the Working Group's work is evidence-based.

Approach/Methodology

Development of a live Resource Library hosted by the UK Chamber. Structured into:

- General references (with High level resources and other industry portals).
- Fuel-specific sections: Battery energy storage systems, Biofuels, Methanol, Ammonia, and Hydrogen.

Outputs

- Consolidated library of research, standards, and case studies.
- Mechanism for participants to contribute additional resources.

Status

- A live hub, continuously updated with Members and Expert contributions.

Collaborative Risk Assessment Workshops

Purpose

The workshops were the central activity of the Working Group in 2025. Their purpose was to develop preliminary/high-level risk assessments for each of the five alternative fuels within the Group's scope. The Workshops were essential in building relationships, in finalising all other deliverables and related engagement.

Approach/Methodology

A standardised Risk Assessment Template (Annex D) was used across all workshops to ensure consistency. This tool provides clear guidance on:

- Formulating risk statements
- Scoring impact and probability
- Identifying mitigation measures

Members were briefed on how to apply the template, with expectations set for evidence-based, transparent assessments. The template now serves as the foundation for all fuel-specific evaluations.

Each workshop followed a structured format (see the list below on pg.19) – Summary of Workshops)

1. **Pre-discussion with Experts:** Pre-discussion on Risk Assessment Template, pre-population and briefing on the Workshop.
2. **Pre-Workshop with the SAFWG (BESS and Methanol Only):** Review of pre-populated risk assessments and discussion with Members and experts prior to the Workshop day.
3. **Expert Presentations:** Industry specialists shared insights, case studies, and technical considerations.
4. **Breakout Sessions:** Members collaborated in smaller groups to identify risks, debate mitigation strategies, and prioritise key concerns. Using a Risk Assessment pre-populated by Experts based on the standard Risk Assessment Template (Annex D) to ensure consistency.
5. **Plenary Discussions:** Findings were consolidated, ensuring alignment and agreement on the most critical risk factors.
6. **Follow up:** Further consolidation and circulation with Working Group and Experts of the Risk Assessments.

This approach fostered active participation, encouraged knowledge sharing, and strengthened collaboration among members and external stakeholders. The sessions were designed to build a shared understanding of the safety challenges associated with emerging fuels and to provide a structured framework for evaluating risks across the sector.

Output

The workshops produced five preliminary/high-level risk assessment matrices, forming a critical baseline for future work (during Year 2), which represents a consolidated initial learning by participants (Annex E – Preliminary Risk Assessments).

The five risk assessments presented in Annex E comprise a structured set of hazard descriptions and associated impact and probability ratings. Mitigation measures have been intentionally excluded from the Annexes because appropriate controls vary by vessel type, operational profile, company practice, and regulatory context. These matrices should be used to inform, not replace, project-level safety cases and design reviews. For additional information, please refer to the Legal Disclaimer: Limitation of Year 1 Deliverables (pg.10).

> Overall, the workshop was well run and led to good, open discussion, specifically during the time in our individual breakout rooms. There was a real mix of people in the room from across the marine industry, including class surveyors, battery manufacturers, and vessel owners and operators.

Oliver McKellar
Technical Specialist, CalMac

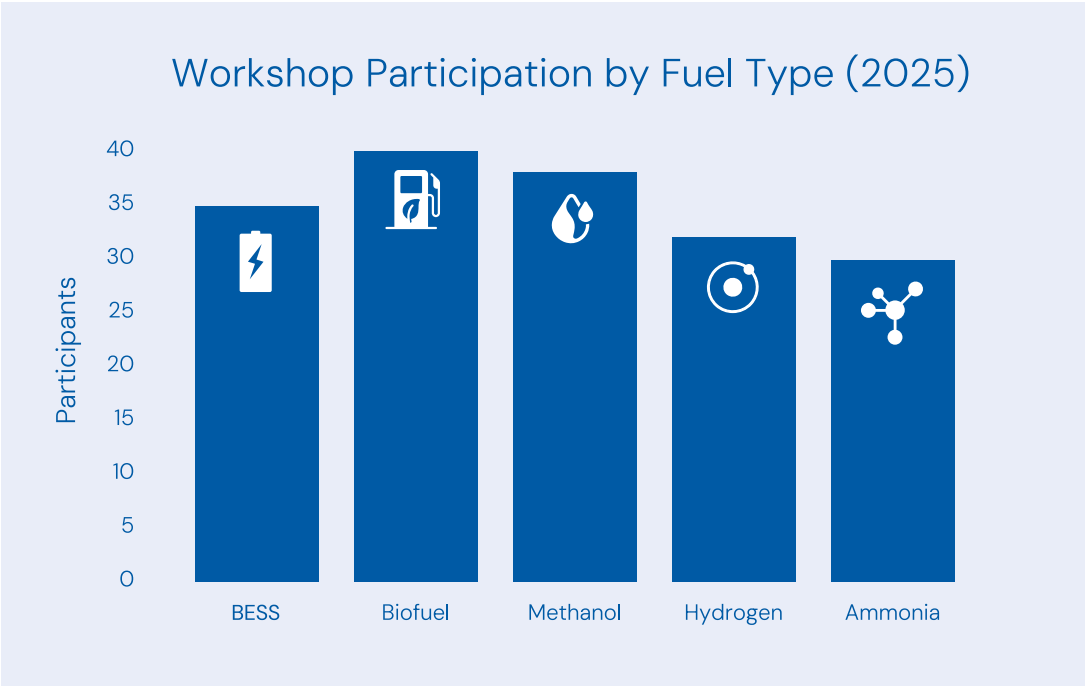
Summary of Workshops

Each workshop combined expert presentations, pre workshop briefings, breakout risk scoring sessions using the standard Risk Assessment Template (Annex D), and plenary validation.

Date	Events/Workshops	Key presenting organisations
30 May 24	Inaugural Meeting	Singapore MPA, West of England, IBIA, RINA (Class)
21 Nov 24	Establishment Meeting	RINA (Class)
11 Mar 25	BESS Workshop	Corvus, Shell, Calmac Ferries
29 Apr 25	Biofuel Workshop	LR/FOBAS, Man Engine, Glander Bunkering, SVITZER
10 Jul 25	Methanol Workshop	ABS, Wartsila, V.Ships
01 Oct 25	Working Group Meeting	ICS, MOL
07 Nov 25	Hydrogen Workshop	DNV, Wartsila, Shell
20 Nov 25	Ammonia Workshop	Yara, Fortescue, Port of Rotterdam

All presentation materials are available to members via the UK Chamber of Shipping resource portal.

The five workshops formed the cornerstone of the Working Group's first year, bringing together over 200 participants from 53 organisations to collaboratively develop preliminary risk assessments for Battery Energy Storage Systems, Biofuels, Methanol, Hydrogen, and Ammonia.



The depth and credibility of the discussions were widely praised. Professor Alan J. Murphy, Head of Maritime Engineering at the University of Southampton, noted the unique value of combining breadth of coverage with authentic, first-hand experience:

> What in particular set this initiative and workshops apart from many others I have been involved in include the breadth of coverage across the multiple fuels, and the depth and veracity of the information and experiences presented.
>
> Speakers with current and direct practical experience with each of the fuels were able to provide detail and candid first-hand experiences – lifting the knowledge generation beyond purely theoretical or speculative.

Professor Alan J. Murphy
Head of Maritime Engineering,
University of Southampton

This practical focus was essential given the distinct risk profiles of each fuel. Gilmark D'Mello, representing The International Group of P&I Clubs (Steamship Mutual) highlighted the operational implications:

> *"The deployment of alternative fuels on board ships introduces a variability in the operational landscape, requiring the understanding of the characteristics of each fuel type in order to accurately assess and manage operational risks. With each of these fuels having a distinct risk profile, the lack of operational data during initial deployment periods will require an agile Safety Management System (SMS) designed to effectively absorb operational learnings and adapt to new requirements."*

The workshops not only built industry consensus but also created a foundation for future research and regulatory development. Professor Osman Turan, Director of the Oldendorff Research Centre for Sustainable Shipping at the University of Strathclyde, emphasised the broader impact:

> *"The UK Chamber of Shipping demonstrated outstanding leadership by organising a series of workshops that brought together a wide range of stakeholders. These workshops provided a valuable platform for participants to openly share their experiences, concerns, and potential solutions, all united by the common goal of improving the safety of alternative fuels. As a result, the UK Chamber of Shipping produced an important document that supports the international maritime community in strengthening its understanding of the challenges posed by alternative fuels and in identifying the ways to address them. Moreover, it serves as a catalyst for the research community, encouraging systematic research activities to close critical knowledge gaps in alternative fuel safety."*

Whereas, Dr Claire Copeland, Policy Lead, UK National Clean Maritime Research Hub emphasised:

> Safety must remain at the heart of the shift towards alternative shipping fuels, and efforts to build a cross sector evidence base are vital. This initiative shows real leadership from industry, and the UK National Clean Maritime Research Hub is pleased to participate in SAFWG.

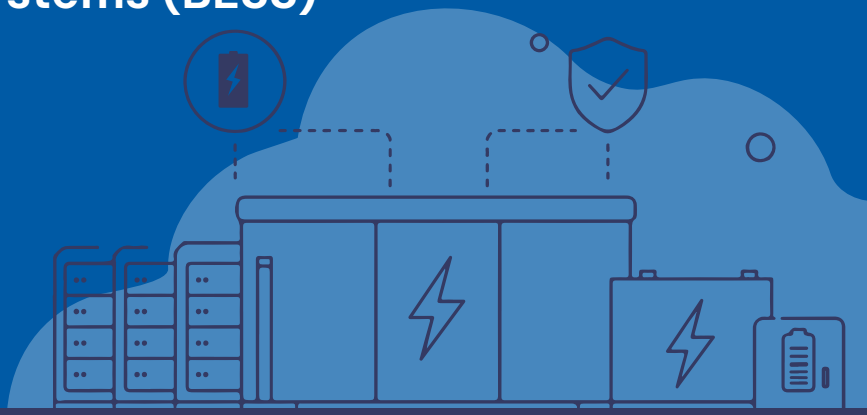
Dr Claire Copeland
Policy Lead, UK National Clean Maritime Research Hub

Together, the workshops delivered a shared evidence base that will inform both company specific risk assessments and the Working Group's future gap analysis. The collaborative spirit and expert input captured in these sessions are reflected in the preliminary risk assessment matrices presented in Annex E.

Battery Energy Storage Systems (BESS)

Workshop date
11 Mar 2025

Workshop presenters
Corvus, CalMac, Shell



Executive summary

Thermal runaway and fire dominate the risk profile; ventilation, BMS resilience and emergency power are recurring vulnerabilities.

Top 5 risks

Risk	Impact	Priority
Thermal runaway (manufacturing defect/cell failure)	Catastrophic	Immediate
Cooling/ventilation failure	Catastrophic	High
Loss of BMS/emergency power	Catastrophic	High
Water ingress/condensation	Catastrophic	High
Inadequate enclosure/electrocution exposure	Severe	Medium

The risk assessment identified thermal runaway as a central threat, driven by various causes including manufacturing faults (Risk 1.0), cooling system failures (Risk 2.0), physical damage from dropped objects (Risk 7.0), and external fires (Risk 15.0).

Discussions also emphasised the critical importance of the Battery Management System (BMS) and the risks associated with its failure (Risk 5.0) or a loss of communication (Risk 6.0).

The significant variability in industry experience levels, underscoring a sector-wide knowledge gap. Oliver McKellar, Technical Specialist at CalMac, observed:

> *"Experience levels varied quite a bit highlighting a current issue with the lack of general awareness and detailed understanding across the sector when it comes to lithium battery technology… The gaps in knowledge were noticeable when discussing fire-fighting arrangements, containment measures, and emergency response procedures for vessels fitted with lithium battery systems. This is mainly because there are still relatively few vessels operating with lithium/hybrid propulsion, so many people simply don't have hands-on experience."*

He noted that this caution is leading to a "wait and see" approach among some operators, slowed by safety concerns, cost, and regulatory uncertainty. CalMac's practical experience—including managing actual thermal runaway incidents—provided the group with a grounded perspective. As McKellar added, "This experience allows us to provide a balanced perspective on the advantages and challenges of lithium based propulsion and power systems based on what we have experienced to date."

The workshop shared learning from Speakers and participants, which is essential to building confidence and operational competence.

Key mitigations recommended:

BMS redundancy | Emergency power segregation | Dedicated ventilation and vent routing | Fire containment design | Crew thermal runaway drills.

Biofuel

Workshop date
29 Apr 2025

Workshop presenters
LR FOBAS, MAN Energy Solutions, Glander Bunkering, Svitzer

Executive summary

Drop in biofuels are a pragmatic near term pathway but require strict supply chain QA (Quality Assurance) and onboard handling controls to avoid contamination and material incompatibility.

Top 5 risks

Risk	Impact	Priority
Fuel contamination/cross contamination	Equipment damage	High
Microbial growth/water formation	Engine failure	High
Material incompatibility (seals, coatings)	System failure	High
Incorrect PoS/regulatory non compliance	Economic	Medium
Sensor/calibration mismatch	Operational	Medium

The risk assessment highlighted that many of the primary concerns are not about catastrophic failure, but about performance, compatibility, and economic risk. Key issues included the risk of invalidating warranties due to unknown fuel grades (Risk 1.0), the incompatibility of FAME blends with existing tank coatings and seals (Risk 5.0, 19.0), and the hydroscopic properties leading to sludge and bacterial growth (Risk 7.0). The importance of correct Proof of Sustainability (PoS) certificates for regulatory compliance was also noted as a significant economic risk (Risk 3.0).

The workshop was praised for bringing together a crucial mix of stakeholders, including the ship operators who are the ultimate end-users. Dr Muhammad Usman, Product Manager at FOBAS/LR, commented on this unique aspect:

> *"Having participated in numerous industry working groups, I often find that limited engagement from ship operators is a missing link – something that was notably different at the UKCS workshop. As end users, ship operators are critical stakeholders; their firsthand operational insight is invaluable for strengthening our collective understanding of renewable fuel deployment."*

Ansuman Ghosh, Director of Engineering at Thomas Miller, reinforced the message that these risks are manageable with the right approach, summarising the workshop's balanced perspective:

> *"The Biofuels Workshop offered a clear and balanced overview of the opportunities and challenges associated with deploying drop in biofuels across the existing fleet. Discussions highlighted the variability in fuel quality, stability, and feedstock origins, as well as operational concerns such as microbial activity, material compatibility, cold flow behaviour, and accelerated wear on fuel system components... the workshop reinforced that while biofuels offer a practical solution for decarbonisation, successful implementation relies on rigorous quality assurance and well managed onboard handling."*

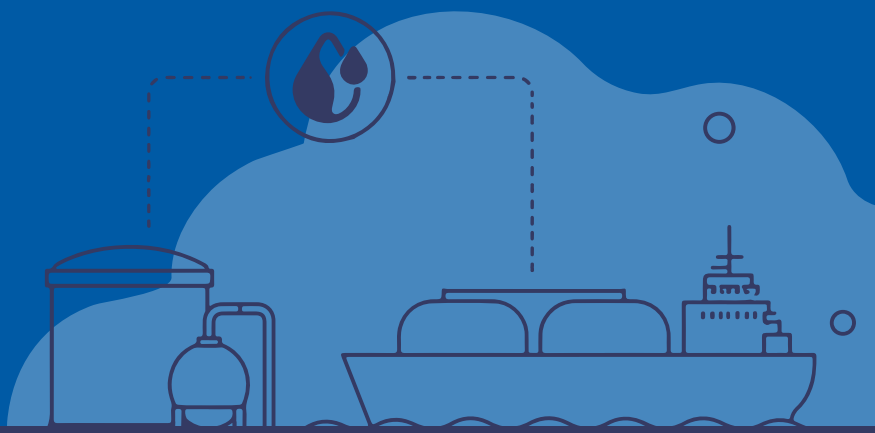
Key mitigations recommended:

Supplier certification | Pre bunkering tank cleaning | Fuel testing protocols | Crew training on handling and water management.

Methanol

Workshop date
10 Jul 2025

Workshop presenters
ABS, Wärtsilä, V.Ships



It should be noted that on 01 October 2025: the Working Group had a presentation from MOL – which shared their experiences using Methanol fuel since 2019. The discussion focused on how they have overcome many of the issues identified during the Workshop and how they were tackling remaining challenges.

Executive summary

Methanol's operational maturity is growing; primary concerns are loss of containment, non visible flames and SimOps during bunkering. Many risks are manageable with disciplined systems and training.

Top 5 risks

Risk	Impact	Priority
Loss of containment during bunkering/ operations	Catastrophic	High
Non visible flame/inhalation toxicity	Severe	High
Inadequate gas detection/ventilation	Severe	High
SIMOPS (Simultaneous Operations) (cargo + bunkering)	Catastrophic	High
Lack of trained crew/shipyard unfamiliarity	Operational	High

The risk assessment highlighted that many risks are well-understood (due to cargo operations on chemical cargoes) but require rigorous operational control and a rethink -High-consequence events, such as loss of containment from collisions (Risk 1.0) or vehicle strikes (Risk 2.0), were scored highly. The workshop also delved into fuel-specific hazards, including the near-invisible flame (Risk 6.0), toxicity (Risk 7.0), and the challenges of detecting methanol vapour (Risk 15.0). Operational risks like "hammering" during bunkering (Risk 20.0) and the potential for stress corrosion cracking from poor fuel quality (Risk 14.0) were also key points of discussion.

The consensus was that the risks, while significant, are manageable using established industrial practices. Rene Laursen, Director of Fuels & Technology at ABS, captured this sentiment:

> *"...the workshop highlighted that while methanol is a mature chemical while it is still growing as a marine fuel, its safe adoption requires a disciplined and systems-based approach. Key risks discussed included toxicity through exposure, low flashpoint behavior, and the need for robust fuel containment, ventilation, and detection systems. The workshop clearly demonstrated that the risks are manageable using established industrial practices including today's guidelines for the use of methanol as fuel."*

Ansuman Ghosh, Director of Engineering, Thomas Miller, added that the growing body of fleet experience and support from OEMs indicates that, with disciplined procedures and well-trained crews, methanol can be integrated safely and reliably. He noted that:

> *"Fleet experiences and the expanding support from OEMs and Classification Societies indicate that methanol is emerging as a credible long term decarbonisation pathway."*

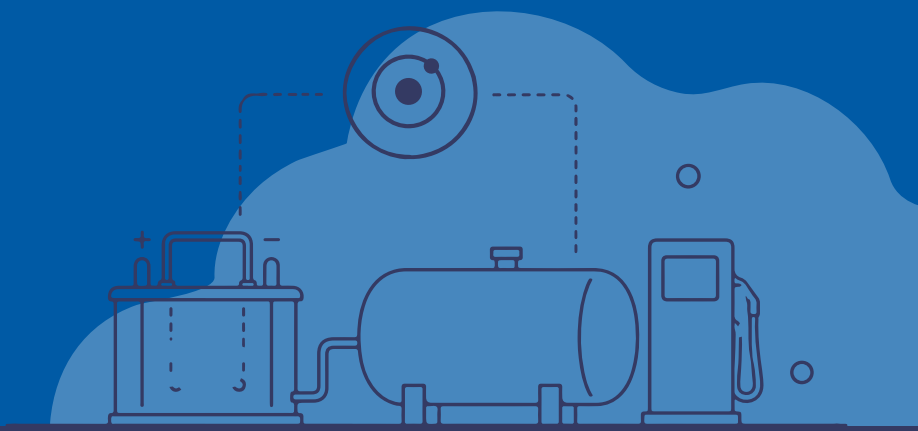
Key mitigations recommended:

Vapour return systems | Exclusion zones | Robust detection & ventilation | Methanol specific SOPs and training | Adoption of Risk-Based Design.

Hydrogen

Workshop date
07 November 2025

Workshop presenters
DNV, Wärtsilä, Shell



Executive summary

Hydrogen presents storage and explosion risks. Liquid Hydrogen (LH2)storage reduces these risks however introduces cryogenic handling risks that require better understanding in Vacuum management and safe vent dispersion. Presentations from early adopters of LH2 have reduced perceived unknowns in this risk assessment.

Learnings from first adopters of LH2 must translate into standards and guidelines on vacuum management, maritime tank/piping designs and safe vent dispersion methods.

Top 5 risks

Risk	Impact	Priority
Storage/leakage/explosion risk	Catastrophic	High
Cryogenic handling (LH2) — brittle fracture, Vacuum or Insulation management	Severe	High
Limited operational experience/awareness gap	Operational	High
Detection & venting inadequacies	Severe	Medium
Commercial affordability/supply constraints	Economic	Medium

A significant outcome of the workshop was the demonstration that many of the perceived “unknowns” around hydrogen are being addressed by early movers. Arulmani Arunachalam, Senior Marine Engineer at Shell, shared his perspective:

> There is a big gap in awareness among users aspiring to adopt hydrogen as fuel. Sometimes there is a fear in adoption of hydrogen due to unknowns. The UK Chamber has set up this workshop to bring together experts with hands on experience managing hydrogen that have demonstrated significant progress. The presentation on experiences of these first movers in handling hydrogen gives clarity to many on hydrogen as a safe zero carbon fuel and what remains to be solved is affordability/commercial competitiveness of Hydrogen as a fuel.

Arulmani Arunachalam
Senior Marine Engineer, Shell

The workshop concluded that while technical solutions for safe handling are emerging these need to be captured as design standards and guidelines for wider industry to catch up. The primary barriers to adoption are now shifting from safety concerns to commercial competitiveness and supply chain maturity. Industry needs to build knowledge and operational experience on Hydrogen to develop better understanding and scaling up this solution.

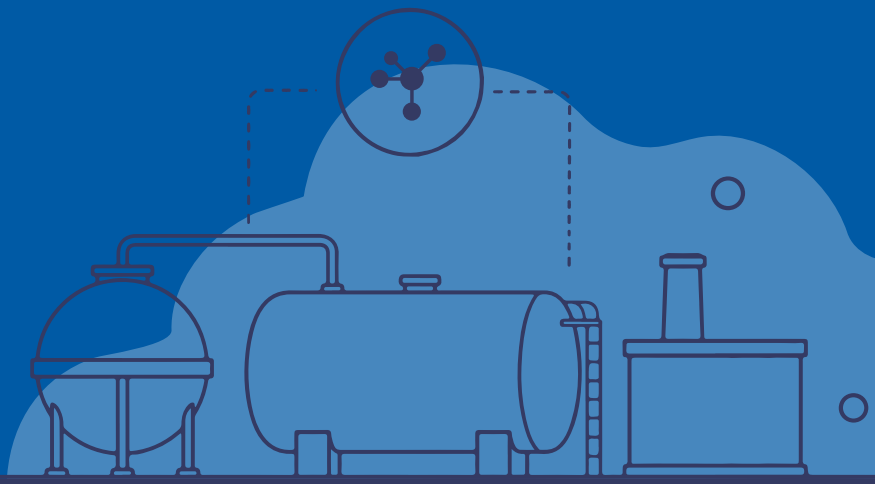
Key mitigations recommended:

Storage design guidance | Venting and dispersion modelling | Leak detection guidance | Hydrogen operator training | Adoption of Risk Based Design.

Ammonia

Workshop date
20 November 2025

Workshop presenters
Yara, Fortescue, Port of Rotterdam



Executive summary

Ammonia's toxicity and potential for high impact releases make port preparedness, onboard safety, emergency response and material compatibility top priorities. Conservative port decisions could restrict access and trade.

Top 5 risks

Risk	Impact	Priority
Loss of containment during bunkering/ hose failure	Toxic	High
Port/adjacent crew unfamiliarity with ammonia response	Escalation	High
Material incompatibility	Structural failure	High
Incorrect purging/maintenance procedures	Fatality	High
Supply/PoS and regulatory uncertainty	Economic	Medium

The preliminary risk assessment is dominated by a single, overarching theme: loss of containment leading to a toxic release. A significant number of risks, from bunkering hose rupture (Risk 1.0) to dropped objects (Risk 8.0), incorrect valve alignment (Risk 10.0), and vessel collision (Risk 16.0), all converge on this same high-consequence scenario.

The assessment also highlighted emerging risks related to the novelty of ammonia, such as the unfamiliarity of shipyards (Risk 2.0) and a general lack of experience in vessel design (Risk 3.0). Specific technical challenges, like the risk of brittle fracture following low-temperature ammonia releases (Risk 22.0) and the need for significant pilot fuel due to poor combustion properties (Risk 20.0), were also central to the discussions.

The workshop underscored that while the challenges are substantial, they are being addressed through rigorous safety engineering and the development of new guidelines. The group acknowledged that managing ammonia's toxicity will require a paradigm shift in onboard safety management and emergency response, extending beyond the vessel to include ports and surrounding communities.

Francesco Sandrelli, Policy Director for Environment, UK Chamber of Shipping:

> *"The Ammonia workshop represented one of our most challenging yet critical sessions, reflecting the complexity of introducing a fuel whose toxicity demands a fundamental rethink of onboard safety management and port emergency response. The risk assessment clearly illustrated that loss of containment leading to toxic release is the overarching concern—whether from bunkering hose failure, dropped objects, incorrect valve alignment, or vessel collision. What made the workshop particularly valuable was the presence of first movers like Yara and Fortescue, alongside port authorities including the Port of Rotterdam, who brought practical perspectives on the operational and infrastructure challenges ahead.*
>
> *A key insight emerging from the discussions was that preparedness must extend beyond the vessel. The unfamiliarity of port workers, local communities living close to port operations, adjacent vessels' crews, and local emergency responders with ammonia's properties could significantly escalate an incident. This highlighted the urgent need for collaborative emergency planning and familiarisation programmes at a local level, before ammonia-fuelled vessels arrive in port."*

Key mitigations recommended:

Port emergency playbook | Ammonia specific PPE and training | Material selection standards | Pilot port acceptance frameworks | Adoption of Risk Based Design.

Stakeholder Engagement & Mapping

Purpose

Engage with external stakeholders to understand their needs, expectations and what they want to achieve in order to build up and foster collaborations and develop a stakeholder map and engagement document.

Approach/Methodology

This engagement task was carried out in a dynamic way and collaboration was built through 2025. This continues with the ongoing expansion of the SAFWG.

The Working Group is engaging with different Internal and external stakeholders which has been divided in the following groups: shipowners and operators, Classification Societies, consultancies, legal and P&I, port and harbour authorities, government agencies and departments, universities/academic partners, other shipping associations, equipment manufacturers, funding organisations and fuel associations/producers.

Activities and Outputs

- A dynamic stakeholder engagement map and plan has been developed, fostering collaborations with a wide range of organisations, through working group meetings and direct outreach (Annex B – Stakeholder Engagement).
- Development of a living stakeholder map and engagement plan.

Status

- Ongoing. Engagement continues to expand as the Group deepens its technical work.

Identification of Gaps

Purpose

To analyse existing regulatory and knowledge gaps relating to alternative fuel safety.

Progress in 2025

- Early-stage identification of gaps embedded within each fuel's risk assessment.
- Cross-cutting gap analysis not yet completed (as planned in 2025).

Status/Next steps 2026

- During the second year to continue develop full Safety Fuel Assessments in order to consolidate experience and knowledge and prioritise gaps identification for engagement with UK Government, MCA, and relevant IMO committee.

Preliminary Findings

The initial risk assessments have already begun to highlight recurring themes and potential gaps, particularly in the areas of material compatibility across multiple fuel types, the need for robust emergency response planning that extends beyond the vessel to ports and local responders, and the critical importance of crew familiarity with novel fuel properties."

2025 was the Working Group's establishment and delivery year.

A detailed analysis and formal gap identification is a primary objective for Year 2.

Key achievements for Year 1 include:

- Solid multi-stakeholder engagement base (diverse stakeholders' engagements)
- Excellent expert basis for the Working Group
- Comprehensive Resource Library
- Five preliminary risk assessments
- Improved knowledge-sharing across Members and non-Member experts
- Identification of future research and regulatory needs
- Deliverables provided in a timely manner and in accordance with the plan

There was a great energy in the Workshops, and it should be noted that first movers within the industry are moving forward despite not having finalised clear rules and regulations by the International Maritime Organization (IMO). Which has set ambitious goals for net-zero emissions by or around 2050, but the adoption of specific mid-term measures, including a global fuel standard and emissions pricing, has been postponed at MEPC 83 in late 2025, delaying their expected entry into force.

Way Forward: Year 2 Priorities (July 2026 – July 2027)

as Set in the Terms of Reference

Task No.1

Expand engagement with External Stakeholders to broad the Stakeholder Map and Engagement document to build up and foster collaborations focusing on Project-Specific activities, supported by Members and participants.

Task No.2

Host Marine Alternative Fuels Events focusing on Specific Projects and their associated Stakeholders (willingly to collaborate and participate in the Working Group, e.g. Ports, Operators, regulators, manufacturers etc..) in order to identify Gaps, controls and mitigations at specific-project level, using the experience and methodology gained during the first year of activities.

Task No.3

Develop further the Year 1 scoping/mapping exercise, incorporating new literature, regulation and experience on Alternative Fuels.

Task No.4

Established an Anonymised Accident/Incident database on Alternative Fuels in collaboration with Internal and External Stakeholders.

Task No.5

Run a webinar to present the outcome of the Working Group's work.

Task No.6

Run a roadshow where we present the outcome to key stakeholders.

Task No.7

Agreed a publication route for publishing the paper.

Task No.8

Additional Activities identified by the Working Group.

With a strong collaborative foundation in place, the SAFWG is now well positioned to deliver meaningful technical outputs, engagement, and recommendations.

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To get involved with the Safety of Alternative Fuels Working Group, please contact Francesco Sandrelli:

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