UKP&I

Risk Focus: Gas Carriers

Exploring vessel diversity, cargo hazards, modern risks and claims experience

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Exploring vessel diversity, cargo hazards, modern risks and claims experience

Over the past decade, the global gas trade has evolved from a specialised shipping niche into one of the most strategically important pillars of maritime energy.

As the world's major economies raced to secure energy supply, move away from coal, stabilise their electrical grids and pursue ambitious decarbonisation plans, the demand for Liquefied Natural Gas (LNG), Liquefied Petroleum Gas (LPG) and a growing suite of new gaseous cargoes surged. What was once a field understood only by a small circle of experts has become an essential part of global energy security. With new cargoes, new ship types, new dual-fuelled propulsion systems and new regulatory pressures, there is no longer a single 'gas trade'; instead, there is an entire ecosystem, diverse, technologically complex and deeply interwoven with global energy security.

A decade ago, trade patterns were simpler. LNG moved along predictable long-term routes, Very Large Gas Carriers (VLGCs) carried propane from the United States to Asia, and ammonia and liquefied CO_2 were mainly niche industrial cargoes. The US shale revolution changed everything, turning the country into one of the world's largest exporters of both LNG and LPG. Asian demand accelerated as propane dehydrogenation capacity exploded across China and Southeast Asia. Europe's abrupt break from Russian pipeline gas forced a dramatic rerouting of flows toward LNG and spurred rapid terminal development. Meanwhile, ammonia and liquefied CO_2 emerged as potential pillars of a low-carbon future. Throughout this shift, gas carriers have reliably linked these new supply chains with exceptional operational discipline and navigated complex contractual responsibilities.

Understanding the cargo: Chemistry, hazards and control

Different cargoes bring different hazards. LNG at minus 162°C is intensely cryogenic; LPG is flammable and heavier than air; ethane and ethylene require strict temperature control; ammonia is acutely toxic; and CO_2 can cause instantaneous asphyxiation or create dry-ice blockages due to rapid phase change. Despite their differences, all these cargoes rely on one shared safety principle: tanks and piping that are kept under positive pressure. This prevents oxygen ingress and eliminates the possibility of forming an explosive atmosphere. This design foundation is a quiet but critical contributor behind the sector's extraordinary safety record.

Evolving ship designs for an expanding trade

Modern gas carrier design continues to evolve in response to the increasing complexity of the global LNG trade.

LNG carriers span a wide range of capacities. While the modern 'workhorse' vessels are typically in the 174,000 – 180,000 m^3 range, favoured for their balance of cargo capacity, shipyard standardisation, canal compatibility and fuel efficiency, other classes also operate globally. Smaller 30,000 – 80,000 m^3 ships serve regional trades and break-bulk distribution, while large Q-Flex (210,000 – 217,000 m^3) and Q-Max (260,000 – 266,000 m^3) vessels support high-volume long-haul routes.

LNG cargo tanks may be membrane, free-standing spherical (Moss-type) or free-standing prismatic in design. Most LNG newbuilds, regardless of size class, use membrane-type containment systems with high-performance insulation that achieves very low boil-off rates. Cargo is carried at atmospheric pressure. In what is now the dominant configuration, membrane systems hold cargo using thin-walled invar or stainless-steel membranes supported by insulation, which transfers loads to the inner hull.

Propulsion has also evolved significantly. Historically, LNG carriers relied on steam turbines before transitioning to dual-fuel diesel-electric (DFDE) systems. Today, the global fleet is dominated by direct-drive gas-injection engines, particularly EverIlence's (formerly MAN Energy Solutions) ME-GI and ME-GA engines, and WinGD's X-DF engines, which now form the backbone of the global orderbook. Depending on trade requirements, ships may either burn boil-off gas for propulsion or employ advanced reliquefication systems that reduce power consumption and maximise cargo recovery. Each successive propulsion innovation has improved fuel efficiency, while advances in cargo containment technology have dramatically reduced boil-off rates, contributing to the premium commanded by modern, fuel-efficient vessels.

The LPG fleet has undergone similar modernisation. Fully pressurised carriers (typically small pressurised LPG ships) continue to serve regional and coastal trades. These vessels carry cargo at ambient temperature with the product fully pressurised, typically up to ~20 bar for propane. Their cargo tanks are simple, robust cylindrical pressure vessels mounted in saddles within the inner hull. Despite being the most numerous class, these ships remain structurally straightforward, highly durable and well protected. Their pressurised tanks are located well inboard and are shielded by double-bottom ballast spaces.

Semi-pressurised / semi-refrigerated ships

Semi-pressurised/semi-refrigerated ships provide greater versatility. Their bi-lobe pressure tanks operate at lower pressures (commonly up to 7 bar) but use refrigeration and insulation to control temperature, enabling efficient carriage of products such as butane, propane, propylene and ammonia. Modern reliquefication plants maintain cargo tank pressure and temperature by condensing boil-off and returning it to the cargo tanks. With capacities up to roughly 20,000 m^3, these ships form the backbone of the petrochemical gas trade, balancing pressure capability with refrigeration efficiency.

Fully refrigerated carriers

Fully refrigerated carriers, including the modern VLGC class (typically 70,000 – 90,000+ m^3), transport cargo at near-ambient pressure and temperatures down to approximately minus 48°C. Their free-standing prismatic tanks, made from low-temperature steels and heavily stiffened, are surrounded by double bottoms and sometimes side ballast tanks. This configuration provides both structural protection and a secondary barrier should cold cargo escape the primary tank. Fully refrigerated ships carry the full range of LPG products and, in many designs, petrochemical gases such as ammonia and propylene. Reliquefication systems with significant reserve capacity manage boil-off and ensure cargo stability during long-haul voyages.

Across the LPG fleet, the combination of cargo versatility, modern reliquefication systems and the growing adoption of LPG-fuelled propulsion, particularly on VLGCs, has materially improved environmental performance and operational flexibility.

New ship types

Entirely new ship types are also emerging. Liquid CO_2 carriers with high-pressure Type C tanks are being built to connect emitters with offshore sequestration sites. Ethane carriers have created a new trade that did not exist before the shale boom. Ammonia-ready and ammonia-fuelled vessels are moving from concept toward commercial reality. Hydrogen carriers, despite the daunting challenge of minus 253°C, are beginning to map out the earliest routes for the world's coldest cargo.

Every cargo tells a different chemical and thermodynamical story. The safe movement of these molecules rests on a delicate balance of containment technology, crew competence, shore system compatibility and operational discipline.

Semi-pressurised / semi-refrigerated ship

Fully refrigerated carrier

Ammonia-fuelled vessel

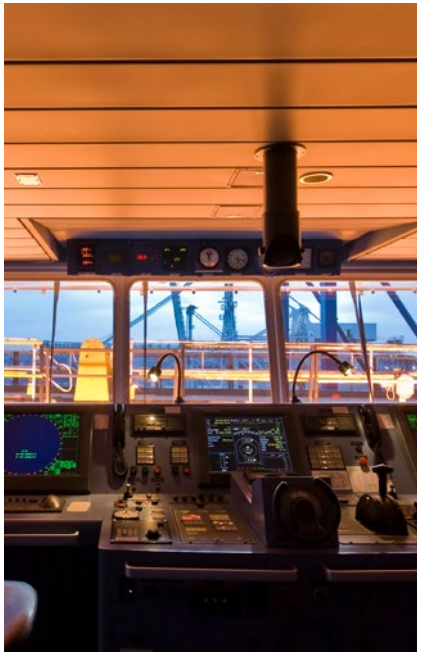
Modern ports and high-tech interfaces

Ports and terminals have evolved alongside ships. Mooring systems now incorporate automated vacuum units and real-time tension monitoring. Loading arms include emergency release devices to protect both ship and terminal. Vapour return lines, once associated mostly with LNG, are increasingly common in LPG and petrochemical trades. Digital platforms now connect ship and shore, synchronising pressure, temperature and data throughout cargo operations. These advances have reduced traditional risks but increased the complexity and interdependence of operations.

New vulnerabilities in a digital era

The rapid digitalisation of the gas sector brings new risks. Cybersecurity is now one of the most significant emerging concerns. Gas carriers rely on interconnected automation, tank monitoring, remote diagnostics and integrated control systems. As these systems link together, the impact of cyber disruption grows more severe. High-energy cargo combined with high-technology architecture introduces a category of vulnerability that did not exist in earlier generations.

The high level of automation on modern gas carriers has become an operational challenge. These ships contain complex webs of software logic and sensor-based controls. A single failed sensor or data-bus interruption can cascade through propulsion, power and cargo systems. Several incidents have left ships drifting not because machinery failed, but because crews could not diagnose or override automated systems. As equipment becomes more 'black-box' in nature, traditional hands-on troubleshooting becomes limited. This trend reinforces the importance of rigorous training, system familiarisation and continuous competency development to prevent minor faults from escalating into operational standstills.



Operational realities and P&I implications

Despite technological progress, familiar risks remain. Ship to Ship (STS) transfers, especially in swell-prone anchorages, continue to produce incidents. Terminal claims often involve over-pressurisation or incompatible emergency shutdown systems. Crew safety claims arise from ammonia exposure, sub-zero handling or fatigue during busy trading cycles. New regulatory exposure under EU ETS and FuelEU Maritime introduces additional compliance and reporting challenges. Yet, the sector maintains an exceptional safety culture supported by SIGTTO (International Society of Gas Tankers and Terminal Operators), OCIMF (Oil Companies International Marine Forum), class societies and P&I Clubs.

Cargo chemistry and commercial risk

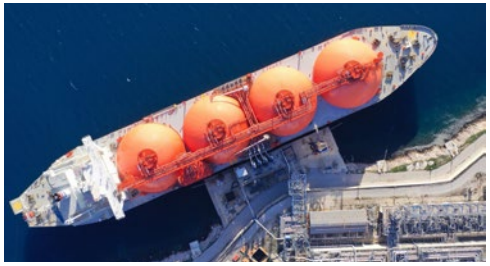
The diversity of gas cargoes drives a corresponding variety of commercial arrangements. LNG requires insulated atmospheric tanks and constant management of boil-off. LPG can be carried under pressure or refrigeration, or both, creating multiple vessel classes. Ethane's intermediate temperature led to the rise of Very Large Ethane Carriers (VLECs). Ammonia brings corrosiveness and toxicity, while CO_2 requires strict phase-control throughout the voyage.

These technical differences shape charter party forms. Pressurised LPG carriers typically use GASVOY and GASTIME. Ethylene carriers need detailed technical riders. VLECs follow LNG-style contracts such as LNGTIME and ShellLNGTime, with clauses covering boil-off, minimum heel, temperature guarantees and reliquefication performance. LNG itself is a prime example of physics translating into commercial exposure, with boil-off disputes often requiring detailed analysis of logs, temperatures and operational conditions to determine causation.

As cargo types and ship designs diversify, documentation becomes increasingly important. Accurate logs, tank histories, sequencing checklists and clear terminal communications often determine the outcome of contamination or shortage claims. Careful STS vetting, disciplined use of Letters of Indemnity and selecting charter forms and clauses aligned with vessel capability all help prevent disputes that might otherwise be unavoidable.

A growing role for the UK P&I Club

As global gas trade continues to evolve, P&I Clubs have become essential partners. The UK P&I Club supports owners, charterers, traders and operators with operational advice, legal guidance, technical investigation, contract interpretation and proactive loss prevention. Whether addressing LNG quality claims, ammonia exposure, compromised containment or the latest IGC Code requirements, the Club's expertise spans the full lifecycle of risk. Gas carriers may be safer than ever before, but the legal and commercial framework surrounding them has grown significantly more complex, making the Club's role more critical than at any point in their history.



Claims experience

As the leading liability insurer for the LPG and LNG seaborne gas trades, the Club has extensive experience and expertise handling and managing disputes and incidents for and on behalf of vessel owners, charterers and trader Members operating in these markets.

The following is a snapshot of recent matters in which the Club has assisted Members:

1. Investigation of cargo contamination

The full investigation into an alleged free-water contamination of a butane cargo during loading, carried out on behalf of a trader Member (and the Freight On Board (FOB) cargo buyer).

2. Contractual review of Terminal Use Agreement

The detailed contractual review of a Terminal Use Agreement (TUA) for a trader Member and prospective seller under an LNG Sale and Purchase Agreement.

3. Defence of off-spec bunkers claim

The handling and defence of an alleged off-specification bunkers claim brought by a third-party vessel owner against an LPG trader Member and the vessel's time charterer.

4. Emergency response for LNG vessel casualty

The emergency response coordination and casualty management for an LNG vessel owner Member following a collision and damage to laden vessel off Singapore.

5. Damage to Hull (DTH) claim defence

The investigation and defence of a DTH claim made by a third-party vessel owner against a trader Member following an unsuccessful STS transfer of butane.

6. Advice on Conditions of Use Agreement

The provision of advice and guidance to an LNG vessel owner Member regarding the negotiation of a Conditions of Use Agreement with a third-party terminal.

7. Charterparty performance dispute management

The management of an LNG charterparty performance dispute for a vessel owner Member where elevated nitrogen content in the loaded LNG (and therefore in the boil-off gas) led to significantly reduced Boil-Off Gas (BOG) heating value, increased fuel consumption and alleged breach of speed and consumption warranties. The Club coordinated technical experts, nitrogen/BOG modelling and charterparty wording analysis to defend the Member's position. The Club's guidance was later reflected in the article Nitrogen in LNG.

8. Machinery damage and off-hire exposure (VLSFO degradation)

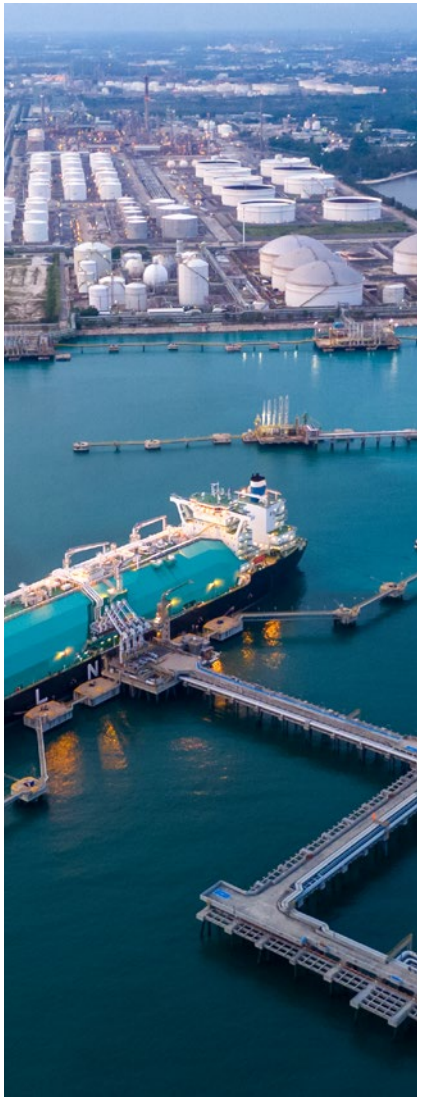
The handling of machinery damage and off-hire exposure for a dual-fuel LNG carrier Member arising from degradation of Very Low Sulphur Fuel Oil (VLSFO) that had been stored on board for an extended period while the vessel primarily operated on LNG. The Club assisted with evidence preservation, engagement of fuel chemists, de-bunkering strategy and charterparty defence regarding fuel quality and bunker management obligations, consistent with issues examined in Managing Risks in Dual-Fuel Vessels: Lessons from Recent Claims and Operator Practice.

9. LNG heavies – Operational delays and equipment impact

The support provided to an LNG carrier Member following operational delays, filter clogging and potential equipment damage caused by the presence of long-chain hydrocarbons ('LNG heavies', C6+) in a loaded cargo. The Club's surveyors and technical experts oversaw sampling, advanced GPA 2286 testing, and documentation of delay and mitigation costs to preserve the Member's rights against contractual counterparts, as subsequently discussed in LNG Heavies: Addressing Operational Challenges Onboard Ships.

10. Concurrent carriage of ammonia and propane: Technical and legal assistance

The technical and legal assistance provided to an LPG vessel owner Member planning the concurrent carriage of ammonia (NH_3) and propane (C_3) on the same gas carrier. The Club's technical risk assessment team, together with external consultants, undertook a detailed review of cargo system design, segregation arrangements, valve integrity, gas detection and emergency procedures, and confirmed P&I cover response once enhanced safeguards were implemented. This support mirrors the case study described in Expanding Gas Trades: Perspective on LPG, Ethane and Ammonia Carriage. The operation was successfully completed without incident, with both cargoes delivered on spec.



Looking towards 2030 and beyond

The next decade will bring even greater change. LNG will remain central to global energy stability. LPG will continue to drive petrochemical expansion. Ammonia and hydrogen will shape decarbonisation strategies. CO_2 shipping will become a critical link in global climate-mitigation infrastructure.

Tomorrow's gas carrier will be more digital, more fuel-flexible, more energy-efficient and more environmentally accountable. Yet, it will rely on the same foundations that have always defined the industry: rigorous design, disciplined operations, skilled seafarers and a robust safety culture.

Gas matters more than ever, and its seaborne trade will occupy a central place in global economic and environmental strategy for decades to come. And as we look to 2030 and beyond, our ability to innovate while staying true to industry fundamentals will determine not only the future of gas shipping, but the resilience of the global energy system itself. In this evolving landscape, the Club's ongoing commitment to technical excellence, safety leadership and operational insight will remain a vital source of value, supporting Members, strengthening industry standards and helping shape a safer, cleaner and more resilient future for gas shipping.

About Us

UK P&I Club

The UK P&I Club is a leading provider of Protection and Indemnity insurance, supporting the global maritime industry with over 150 years of technical expertise, financial strength and responsive service. Our international team delivers specialist claims handling, risk management insight and operational guidance across every major shipping sector. Today, the Club covers more than 250 million tonnes of owned and chartered vessels, remaining a trusted and forward-looking partner to the world's fleet.

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