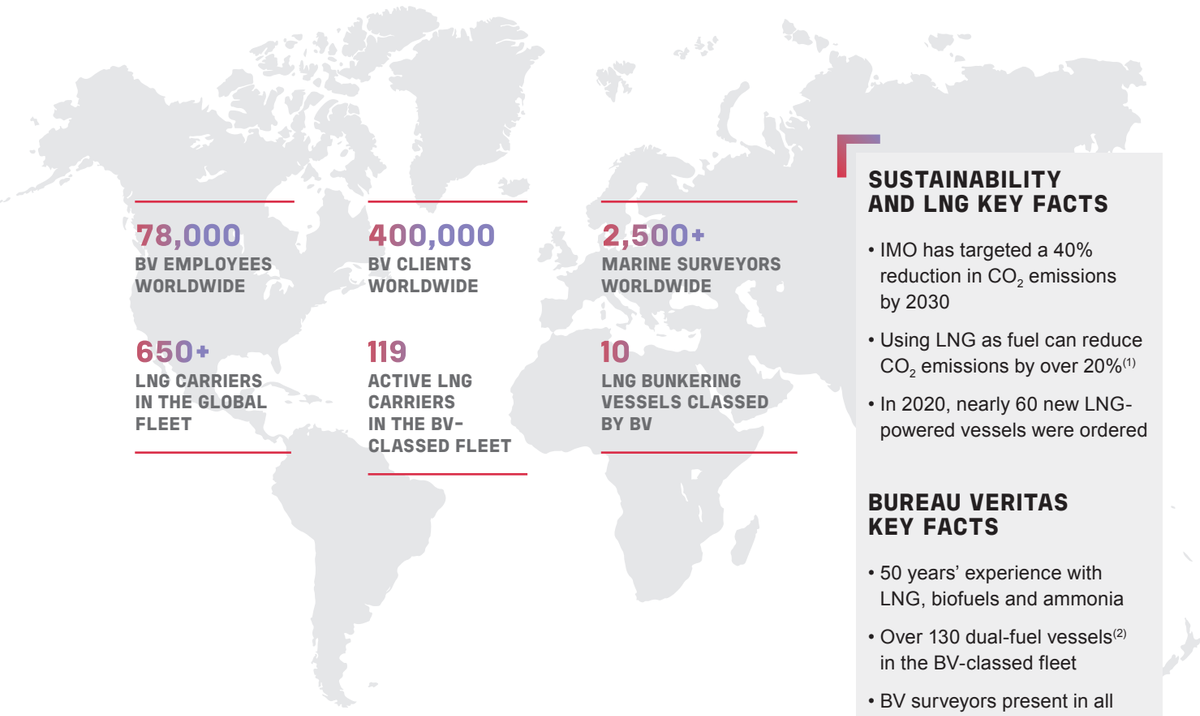
YOUR PARTNER FOR LIQUEFIED NATURAL GAS

ADVANCING MARINE DECARBONIZATION

BUREAU VERITAS

FROM DE-RISKING THE GAS SUPPLY CHAIN, TO INNOVATING FOR LNG CARRIERS, TO CLASSING LNG-FUELED SHIPS, BUREAU VERITAS HAS DECADES OF EXPERIENCE WITH EVERY ASPECT OF LNG. WE USE THIS CRUCIAL EXPERTISE AND TECHNICAL KNOW-HOW TO SUPPORT RELEVANT STAKEHOLDERS IN USING LNG AS A TRANSITION FUEL AND PREPARING FOR THE NEXT PHASE OF MARINE DECARBONIZATION.

THE SHIPPING INDUSTRY'S LNG EXPERT



78,000
BV EMPLOYEES WORLDWIDE

400,000
BV CLIENTS WORLDWIDE

2,500+
MARINE SURVEYORS WORLDWIDE

650+
LNG CARRIERS IN THE GLOBAL FLEET

119
ACTIVE LNG CARRIERS IN THE BV-CLASSED FLEET

10
LNG BUNKERING VESSELS CLASSED BY BV

SUSTAINABILITY AND LNG KEY FACTS

- IMO has targeted a 40% reduction in CO_2 emissions by 2030
- Using LNG as fuel can reduce CO_2 emissions by over 20%[1]
- In 2020, nearly 60 new LNG-powered vessels were ordered

BUREAU VERITAS KEY FACTS

- 50 years' experience with LNG, biofuels and ammonia
- Over 130 dual-fuel vessels[2] in the BV-classed fleet
- BV surveyors present in all major LNG bunkering hubs.

(1) Depending on engine type.
(2) Vessels that are in-service and on order, excluding gas carriers.

A COMPLETE ECOSYSTEM FOR LIQUEFIED NATURAL GAS

Over the past decade, liquefied natural gas (LNG) has come into its own, with major strides in infrastructure development across the gas value chain. Energy providers are producing and exporting LNG worldwide; the LNG carrier fleet continues to grow; and more bunkering facilities and LNG-fueled vessels are being built every day.

This ecosystem supports the nowmature LNG industry, where demand is expected to grow by 3.4% per year between now and 2035. LNG is also the only fossil fuel expected to see growth beyond 2030, giving it staying power as a transition fuel[3]. For the next decade, when shipowners think of low-carbon fuels to reduce their vessels' emissions, LNG will be a top contender.

At Bureau Veritas, we know that no part of the LNG ecosystem stands on its own.

This is why we have spent over 60 years developing uncontested technical, environmental, regulatory and classification knowledge for LNG systems for production, transport, bunkering, storage and use. We have developed rules and approved technologies for the entire LNG value chain, helping secure LNG projects from emerging markets in South America to the Arctic.

This longstanding expertise and ongoing engagement with LNG innovation is what gives Bureau Veritas a key role to play in helping clients integrate this low-carbon fuel onboard. With mounting calls for shipping to go green, and the International Maritime Organization (IMO) passing new environmental regulations, shipowners are seeking guidance. Today, the primary solution for minimizing vessels' emissions is using LNG as fuel – an area in which Bureau Veritas is uniquely positioned to guide owners.

At the same time, we are using our expertise in classification and technology approval for LNG technologies as a starting point to de-risk future fuels. We are funneling the knowledge and experience gained from working with low-carbon

LNG into the development of zero-carbon alternative fuels. This will be crucial to decarbonizing the shipping industry in the long-term, helping shipowners minimize their environmental footprint and comply with IMO regulations.

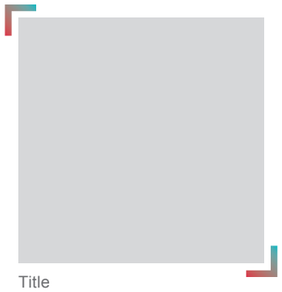
Carlos Guerrero
Global Market Leader for Gas Carriers and Oil Tankers
Bureau Veritas Marine & Offshore

NO PART OF THE LNG ECOSYSTEM STANDS ALONE. THIS IS WHY BUREAU VERITAS HAS DEVELOPED TECHNICAL, ENVIRONMENTAL, REGULATORY AND CLASSIFICATION EXPERTISE FOR LNG SYSTEMS FOR PRODUCTION, TRANSPORT, BUNKERING, STORAGE AND UTILIZATION.

(3) https://www.mckinsey.com/industries/oil-and-gas/our-insights/global-gas-outlook-to-2050#

ACTIVE THROUGHOUT THE GAS VALUE CHAIN

BUREAU VERITAS WORKS WITH THE WORLD'S LEADING ENERGY COMPANIES THROUGHOUT THE GAS VALUE CHAIN TO PRODUCE AND DISTRIBUTE GAS WORLDWIDE. WE SUPPORT ONSHORE AND OFFSHORE GAS PRODUCERS, LNG CARRIER OWNERS AND CHARTERERS, AND TERMINAL OPERATORS IN CONDUCTING THE SAFE EXPLORATION, EXTRACTION, LIQUEFACTION, TRANSPORTATION AND DELIVERY OF NATURAL GAS.



Title

PRODUCTION

Bureau Veritas' services lower risk and ensure compliance of onshore production plants and offshore floating production units.

We supported safe construction of the world's first Floating Liquefied Natural Gas projects. Bureau Veritas classed Exmar's TANGO FLNG, the first ever FLNG to reach completion, and BV Solutions M&O, the technical advisory component of Bureau Veritas Group, provided engineering and third party services to Shell for the construction of Prelude, the world's largest FLNG. Today MatthewsDaniel, a BV company and a global leader in pre and post risk services, risk assessment and loss adjusting, is providing Eni with marine warranty services for the Coral Sul FLNG, to be used for production offshore Mozambique from 2022.

RULES AND GUIDANCE NOTES

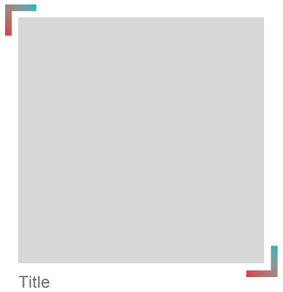
NR 542 – Classification of floating gas units[5]

—

NI 554 – Design sloshing loads for LNG membrane tanks[5]

—

NI 546 – Strength assessment of LNG membrane tanks[5]



Title

TRANSPORTATION

Bureau Veritas is a classification partner of choice for owners of innovative gas carriers and their charterers, with over 30% of the world's orderbook[6].

We classed a number of industry firsts, including the first LNG carriers to run on dual-fuel diesel-electric propulsion, the first ships propelled by WinGD engines, the first icebreaking gas carriers, and ships that set new records in cargo capacity. These carriers today serve flagship energy projects, from Yamal LNG in Russia's far north to Icthys in offshore Australia.

Bureau Veritas also classed two 180,000 m^3 LNG carriers, the SK AUDACE and SK RESOLUTE, for the Sabine Pass project, the first LNG export terminal in the United States.

RULES AND GUIDANCE NOTES

BOG-reliquefaction

—

LNG-subcooling

—

NR 467 – Classification of Steel Ships – Liquefied Gas Carriers[7]

—

NR 517 – Compressed natural gas carriers

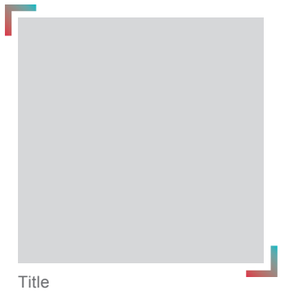
—

NI 623 – Condition assessment program for LNG carriers

200
OFFSHORE FLOATING UNITS USING BUREAU VERITAS SERVICES

1 IN 3
LNG CARRIERS ARE ORDERED TO BV CLASS

(5) These guidance notes apply to multiple vessel and unit types.
(6) As of December 2020, including gas carriers for the Arctic LNG-2 project.
(7) Part D, Chapter 9.



Title

BUNKERING

Bureau Veritas' experience with LNG bunkering vessels (LNG BV) enables us to provide guidance for cargo handling, reliquefaction and cooling systems, and propulsion.

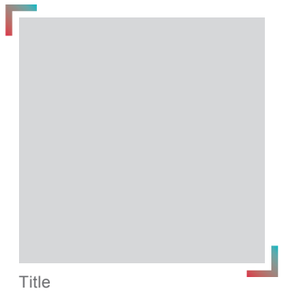
We classed the first ever LNG BV, Green Zeebrugge (previously the Engie Zeebrugge), along with the Coralius, the second LNG BV to enter service. Since then, we have been involved in most bunkering vessel projects. The latest, Gas Agility, is currently the world's largest bunker vessel in operation, and is chartered by Total to supply gas to a fleet of LNG-fueled CMA CGM containerships, also built to BV class.

RULES AND GUIDANCE NOTES

NR 620 – LNG bunkering ship

—

NI 618 – Guidelines on LNG bunkering



Title

STORAGE

Bureau Veritas has supported the fast-growing market for Floating Storage and Regasification Units (FSRUs) and Floating Storage Units (FSUs) with dedicated rules and services for both newbuildings and LNG carrier conversions.

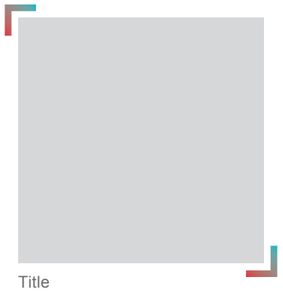
Long-term partner to FSRU market leader Excelerate Energy, we classed the Excelerate Sequoia, owned by Maran Gas Maritime Inc. under a bareboat charter to Excelerate, in 2020. Our Rules and expertise enable us to class units of all sizes, from the MOL FSRU Challenger, still the largest FSRU in operation today at 263,000 m^3, to the latest FRU and FSU for Gasfin Development.

RULES AND GUIDANCE NOTES

NR 645 – Classification of FSRUs and FSUs

—

NI 655 – LNG carrier conversion to FSRU or FSU



Title

POWER

Bureau Veritas is at the forefront of power unit development, working on both classic gas-to-power and LNG-to-power projects. We provide approvals in principle (AiP) for innovative designs, and classification services for gas and LNG power barges.

In the past two years alone, Bureau Veritas has provided AiPs for Hyundai Heavy Industries' Hyundai Innovative Floating LNG to Power and Technip's iLNGP Barge, two innovative LNG-topower concepts. We provided classification for the world's first barge-based FSRU for Exmar, and are now working with Wison Nantong Heavy Industry on China's first floating gas power plant.

Bureau Veritas is also providing classification for the conversion of two MOSS Type LNG carriers into FSRUs. This Karadeniz and MOL joint venture will deliver LNG to Senegal and Mozambique.

RULES AND GUIDANCE NOTES

NR 656 – Power generation units

50%
OF LNG VESSELS IN OPERATION ARE BV-CLASSED

37%
OF FSRUs ARE BV-CLASSED

50%
OF POWER BARGES ARE BV-CLASSED

FUTURE-PROOFING THE WORLD'S GAS FLEET

WITH THE ENERGY TRANSITION ACCELERATING, LNG IS A PROVEN ALTERNATIVE FUEL FOR SHIPOWNERS WORLDWIDE. FOR GAS PRODUCERS AND DISTRIBUTORS, BUREAU VERITAS' EXPERIENCE WITH LNG TECHNOLOGY IS KEY TO BUILDING THE INNOVATIVE AND EFFICIENT GAS CARRIER FLEET OF TOMORROW.

MEETING DEMAND FOR LNG AS AN ENERGY SOURCE

The use of LNG as a cleaner, alternative energy source is growing worldwide, spurring the development of gas carriers. Industry players in recognized hubs for gas development and transportation need cutting-edge expertise to take advantage of the expanding LNG landscape.

Thanks to our extensive expertise with gas carriers of all kinds, Bureau Veritas is uniquely positioned to support shipowners, shipyards and equipment manufacturers in the classification of new-generation LNG carriers.

OPTIMIZING GAS CARRIER CARGO CONTAINMENT SYSTEMS

Constructing safe and fuel-efficient LNG carriers is a highstakes balancing act for shipyards and designers. To achieve optimal performance, gas carriers must seamlessly match state-of-the-art cargo containment systems (CCS) with reliquefaction and subcooling technology, and the right propulsion system.

Bureau Veritas' long collaboration with leading LNG carrier owners, shipyards and equipment manufacturers has helped us master this balance. BV Solutions – M&O has extensive knowledge of CCS' technical challenges, and has learned how to choose the right propulsion and boil-off gas handling systems. It has applied these skills to LNG carriers of many types, designs and sizes, taking a flexible, yet robust approach to gas carrier development and construction.

GRAPHIC OR TABLE TITLE

EXPERTISE IN ALL LNG TANK TYPES

Bureau Veritas has classed large-scale gas carriers with every type of tank currently available, and can fully support companies in their choice of technology. For Type B tanks, fitted with partial secondary barriers, we have worked with spherical and prismatic shaped tanks. For newer membrane tanks, we have firsthand experience with onboard tank integration and membrane and insulation technology. Bureau Veritas also offers a comprehensive understanding of Type A and Type C tanks for other gas carriers.

© BV

DELIVERING MAXIMUM LNG WITH ADVANCED RELIQUEFACTION

LNG carriers currently rely on advanced subcooling and reliquefaction systems to manage boil-off gas (BOG), maintain optimal temperature and pressure inside the CCS, and reduce BOG waste.

- This enables ship operators to deliver maximal LNG during discharge without compromising safety.
- BV Solutions - M&O has acquired technical expertise with subcooling and reliquefaction systems for gas carriers and bunkering vessels. By leveraging our know-how, clients can maximize efficiency by balancing LNG vaporization and regasification, while remaining safe and compliant with regulations[8].

TARGETING OPTIMUM EFFICIENCY FOR PROPULSION SYSTEMS

LNG carriers need to maintain a delicate balance between their propulsion system and CCS to ensure that boilers, propulsion engines and auxiliary engines use the right amount of BOG and have a minimum reliance on GCUs. To achieve peak efficiency, and shipyards must be flexible, matching the right reliquefaction or subcooling system with evolving propulsion and CCS.

323
BV-CLASSED GAS CARRIERS

80+
GAS CARRIERS ORDERED IN 2019-2020

35%
MARKET SHARE IN SMALL-SCALE LNG CARRIERS

(8) E.g., The International Code of the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk

"Ship owners face a great challenge in choosing the best way forward when considering the range of design options in development. Our long-time collaboration with leading LNG carrier owners, shipyards and equipment makers, combined with our always being involved in the leading LNG projects, have enabled us to acquire practical knowledge of currently available propulsion and containment technologies. This means we can readily help clients make the right choice for their projects – to reduce risk and drive performance."

Paillette Palaiologou
VP Hellenic, Black Sea and Adriatic Zone
Bureau Veritas Marine & Offshore

ASSESSING THE MARKET FOR LNG AS FUEL

SWITCHING TO DUAL-FUEL LNG POWER OFFERS SEVERAL ADVANTAGES, INCLUDING A BOOST IN SUSTAINABILITY AND REDUCED COSTS. HOWEVER, CERTAIN CHALLENGES REMAIN THAT CAN CAUSE BULK CARRIER OWNERS TO HESITATE WHEN CONSIDERING A SWITCH TO LNG AS FUEL.

THREE MARKET CHALLENGES OF LNG AS FUEL

1. COST

Building or retrofitting a bulk carrier to use LNG as fuel requires short-term CAPEX. Some owners are also concerned by the price of LNG, which, despite years of relatively low prices, is subject to price variation and market fluctuation.

2. BUNKERING

Bunkering can present an obstacle for bulk carrier operators that travel flexible trade routes. For vessels sailing over the course of several weeks or months, it is indispensable to know where and when a ship can bunker. The more restrictive trade patterns dictated by LNG bunkering facilities can be less favorable for bulk carriers.

3. SUSTAINABILITY

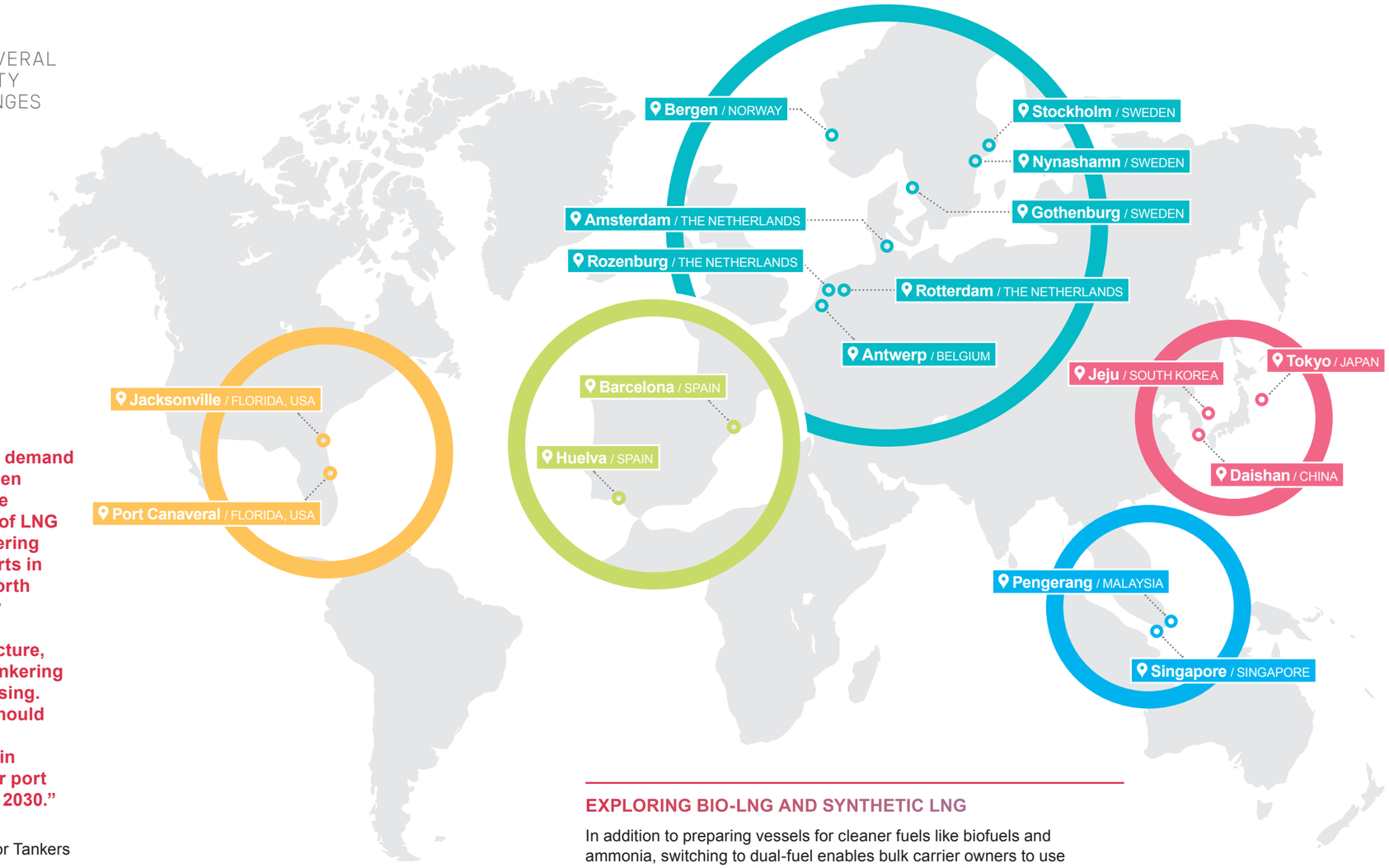
With zero-carbon fuels like hydrogen and ammonia under development, some owners worry that integrating dual-fuel onboard will not be sufficient within a decade. However, dual-fuel capabilities can help prepare vessels to transition toward low- and zero-carbon fuels in the long-term.

"Alongside growing demand for LNG, we have seen a corresponding rise in the development of LNG terminals and bunkering vessels. Over 30 ports in Europe, Asia and North America are already equipped with LNG bunkering infrastructure, and ship-to-ship bunkering activities are increasing. At this rate, ships should have access to LNG bunkering facilities in virtually every major port worldwide by about 2030."

Carlos Guerrero
Global Market Leader for Tankers and Gas Carriers
Bureau Veritas Marine & Offshore

37%
OF LNG UNKERING VESSELS ARE BV-CLASSED

SHIP-TO-SHIP LNG BUNKERING LOCATIONS



EXPLORING BIO-LNG AND SYNTHETIC LNG

In addition to preparing vessels for cleaner fuels like biofuels and ammonia, switching to dual-fuel enables bulk carrier owners to use alternative forms of LNG. One such option is bio-LNG. This is a more sustainable version of LNG that is produced by the anaerobic digestion of organic matter, a process similar to that used for biofuels. Bio-LNG can be delivered using existing LNG infrastructure, and can reduce ships' CO_2 emissions by more than 30%[4]. Synthetic LNG is another possibility, being derived from biomass or the process of electrolysis. This is a carbon-neutral solution when renewable electricity is used during production.

(4) https://www.spglobal.com/platts/en/market-insights/latest-news/natural-gas/112420-industry-groups-push-potential-of-bio-lng-as-transportation-fuel

THE FIRST STEP TOWARD NET ZERO

WITH THE ABILITY TO LIMIT CO_2 EMISSIONS BY 20%[5], LNG IS CURRENTLY THE MOST WIDELY USED ALTERNATIVE FUEL. HOWEVER, THE SHIPPING WORLD IS QUICKLY DEVELOPING OTHER LOW-CARBON ALTERNATIVE FUELS AND PROPULSION METHODS.

BIOFUELS, A CLEAN COUNTERPART TO LNG

Biofuels are a sustainable form of energy derived from the harvesting and processing of biomass, such as waste, charcoal and wood. As marine fuel, biofuels can have a net-zero carbon impact[6], helping reduce GHG emissions. They offer multiple advantages, including compatibility with modern engines and little need for specialized infrastructure. However, experts estimate that at most, biofuels could supply fuel for 30% of the global fleet. This means that biofuels will likely be used alongside LNG and other clean drop-in fuels.

AMMONIA, A SOLUTION ON THE RISE

Ammonia is another fuel poised to help ship owners limit GHG emissions. Nonetheless, while the processes for ammonia storage and transport are well established, innovation is still needed to manage ammonia's technical challenges. Bureau Veritas has already developed Rules for the use of ammonia as fuel and a corresponding class notation, Ammonia-Prepared. Our experts have also delivered two Approvals in Principle (AiP) to GTT for a Mark III system suitable for the containment of ammonia in LNG as fuel applications.

Title of picture

HYDROGEN, AN UPCOMING ALTERNATIVE

Hydrogen, which can be produced using renewable electricity, is another long-term solution for clean fuels, and already present in fuel cell applications onboard small vessels. The next challenge for marine stakeholders will be the long-distance and long-term onboard storage of hydrogen for seagoing vessels. Bureau Veritas is currently developing Rules for the safe use of hydrogen as fuel, to be published by 2022.

WIND PROPULSION TO LIMIT EMISSIONS

Wind-assisted propulsion is emerging as a powerful alternative for reducing ships' environmental impact, as rotating, rigid and kite sails can be installed onboard. This limits vessels' reliance on conventional propulsion, minimizing GHG emissions and reducing environmental footprint. To help clients move forward with wind-assisted propulsion, Bureau Veritas has developed a classification framework for wind propulsion systems and two corresponding notations, WPS-1[7] and WPS-2[8].

(5) Depending on engine type and ship profile.
(6) If produced as part of a sustainable supply chain.
(7) For wind-powered ships with standing rigging.
(8) For vessels with both standing and running rigging.

YOUR CLASSIFICATION PARTNER OF CHOICE

WE KNOW
COMMODITY TRADERS

Our experts at Bureau Veritas Commodities, Industry and Facilities have built longstanding, close relationships with major commodity trading companies around the world. We understand the technical, logistical and financial challenges of helping clients minimize their environmental impact and improve full supply chain sustainability. We provide a range of key services to help companies meet the evolving expectations of charterers, governments, regulatory bodies and consumers.

WE KNOW
BULK CARRIERS

Bureau Veritas Marine & Offshore has decades of experience in the classification of large bulk carriers. We support ship owners in addressing safety, environmental, security and design challenges, providing crucial services from the design phase through to operations. Home to over 2,650 classification experts and 400 marine surveyors trained to conduct bulk carrier inspections, Bureau Veritas helps ensure the long-term safety and reliability of bulk carriers.

WE KNOW
LNG

Bureau Veritas provides a wealth of expertise in the safe handling, consumption and bunkering of LNG. We have actively contributed to the development of LNG extraction, processing and transportation for over 60 years, helping bring LNG projects to safe, successful conclusions. We provide key support for overcoming the technical, structural and safety challenges of LNG-powered vessels, helping construct newbuilds and retrofit in-service vessels to use LNG as fuel.

WE KNOW
ALTERNATIVE FUELS

Bureau Veritas is on the front lines of innovation for existing and alternative fuels, helping players across the maritime industry safely develop the low- and zero-carbon fuels of tomorrow. Building on our class experience with LNG, Bureau Veritas is actively working on JIPs and AiPs for hydrogen and fuel cells, wind propulsion and carbon capture and storage.

WE KNOW
SUSTAINABILITY

Bureau Veritas helps commodity trading companies and ship owners achieve full supply chain sustainability by minimizing the environmental impact of their operations and assets. Our solutions are designed to help optimize fuel efficiency, limit GHG emissions, and protect the marine ecosystem. Our BV Green Line of services helps clients implement, measure and achieve their sustainability objectives, while improving health and safety.

BV GREEN LINE

FOR MORE INFORMATION,
CONTACT BUREAU VERITAS MARINE & OFFSHORE

8 cours du triangle
92937 Paris La Défense Cedex - France
+33 (0)1 55 24 70 00

marine-offshore.bureauveritas.com

Bureau Veritas | Marine & Offshore

@BV_Marine

@bureauveritas_marine

BUREAU VERITAS 1828

BUREAU VERITAS

Shaping a World of Trust