



CONTAINER SHIPS SAFETY AND PERFORMANCE IN THE SUPERSIZE ERA



Move Forward with Confidence





PRESSURE TO PERFORM

Demand for ever more efficient global supply chains, combined with rising fuel prices and stricter environmental regulations, is putting pressure on container ship owners and operators. The keys to success? Innovation, technical expertise and a partner you can trust.



TECHNICAL LEADERSHIP TO ENSURE SAFETY AND PERFORMANCE

Bureau Veritas' technical skill and experience, and longstanding reputation for safety at sea enable owners and operators to rise to the challenge. We have been involved in every major innovation in container shipping since the industry's birth in the 1950s. Over the last decade, owners have consistently turned to us to classify their largest newbuilds, and we are currently classifying the largest ships under construction. Our significant investment in research ensures we remain industry leader in meeting structural integrity challenges, notably whipping and springing.

Safety is not the only reason operators choose Bureau Veritas. **Performance**, in the form of operating efficiency and fuel consumption are key to operator profitability, particularly in a context of rising fuel costs and volatile freight rates. Environmental performance has also moved center-stage as a result of tough new regulations on sulphur emissions.

Bureau Veritas offers a range of services to **improve the efficiency and performance of both new and existing vessels**. Every day, we put our extensive technical expertise, advanced software and in-depth knowledge of maritime regulations at the service of clients around the world.

The last decade has seen a revolution in the container shipping industry. A boom in global trade, together with increasing focus on supply chain efficiency, have created demand for ever-larger vessels offering significant economies of scale for exporters. The industry has responded by increasing the size of new vessels every year, with the result that recent models are able to carry more than twice the cargo of ships designed in the late 1990s.

This rapid transformation poses **significant challenges in terms of technical know-how and safety**. Innovations such as hull design optimization have provided the means for shipbuilders to increase the size of vessels: but ultra large container ships (ULCS) make structural integrity a major safety concern.

WHY CHOOSE BUREAU VERITAS?

- Safeguard your vessel, your cargo, your crew and the environment
- One of the oldest and largest classification societies (established 1828)
- The Bureau Veritas brand: a mark of reassurance and of technical excellence
- Industry-leading research, knowledge and expertise
- Advanced modeling and optimization software
- In-depth knowledge of regulations
- Extensive network across the world
- The first Class to make direct hydroelastic calculations for whipping and springing mandatory for ULCS

PROMOTE SAFETY

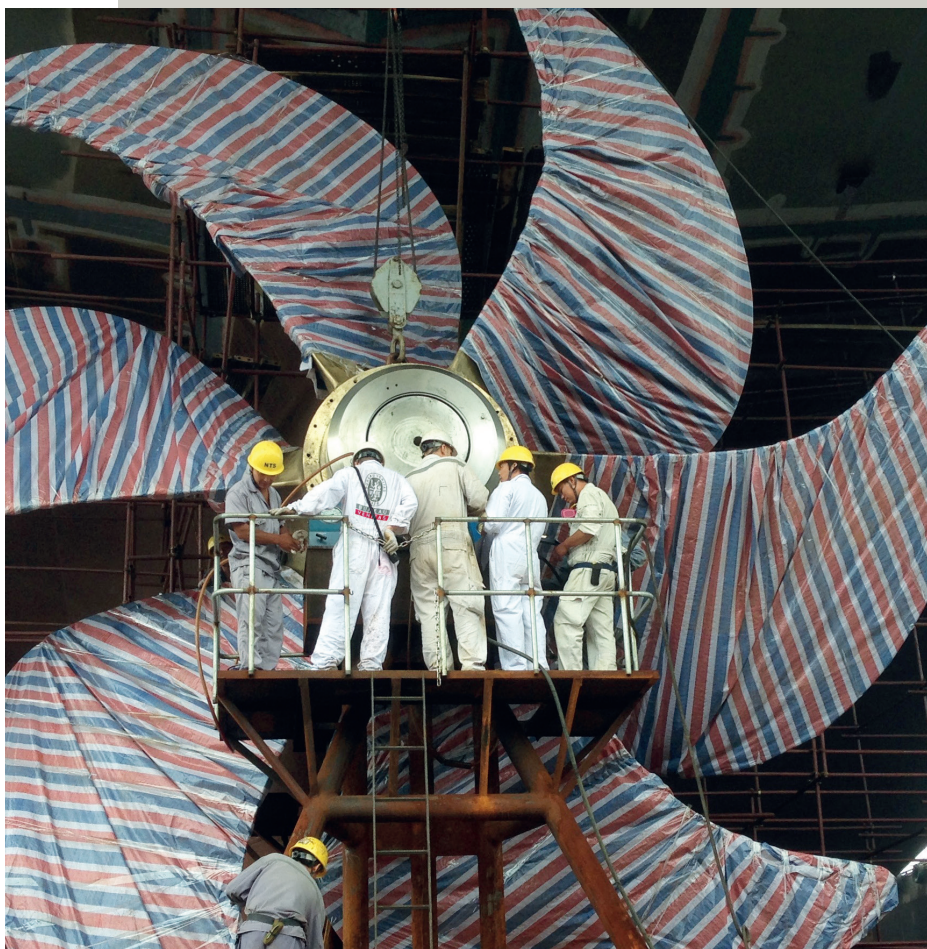
Reducing risk to crew, vessel and cargo starts with choosing the right class society.

Safety is the number one priority in container shipping. Poor management of risks can lead to loss of life, cargo, vessel and reputation. Owners and operators therefore look to their class society to guide them through design, construction and operation of their vessels to ensure safety at sea.

Bureau Veritas' mission is to help identify, prevent, control and reduce risk. Our class rules for container ships are among the most complete in the industry, and continually evolve as a result of internal research and our participation in a large number of joint industry projects.

We work with designers and shipyards from the outset, approving ship design and surveying it during construction in accordance with Bureau Veritas' high quality standards. Once the ship has been delivered, our role goes beyond the normal periodical inspections.

We are always close to the owner and the ship for any technical support. Our **global network** of experienced surveyors ensures convenience for shipowners, who can request an inspection anywhere in the world. Our classification rules also cover cargo safety: our LASHING notation has long been the route to securing containers on board to avoid unwanted movement or loss at sea.



SOPHISTICATED TOOLS AND SERVICES TO SUPPORT SAFETY AT SEA

We have developed a number of tools to support clients in managing risk. At the construction stage, our **VeriSTAR Project Management tool** enables members of the project team to track progress on agreed safety features. Once the ship is in operation, VeriSTAR HLC provides a holistic representation of the ship's condition. This ensures structural problems cannot be overlooked, and improves the effectiveness of maintenance. We also offer a range of technical advisory services relating to vibration, parametric and dynamic roll, and offloading.

At sea, an emergency situation can strike at any time. The first few hours following an incident are critical. Our **Emergency Response Service, available within 2 hours** for vessels enrolled in the service, provides technical assistance 365 days a year. It brings you confidence that in case of accident, you can rely on a fast response and precise advice from an experienced team.

Finally, we keep our clients regularly updated with new rules, tools and research, and ensure class and statutory certificates are easily accessible to owners and operators.

CLASSIFICATION NOTATIONS

- Veristar HULL
- DFL xx years
- WhiSP 1,2,3
- LASHING
- SDS
- ESA
- MON-SHAFT
- ERS-S
- ALP
- FORS
- VeriSTAR HULL-SIS
- MON-HULL

WHIPPING AND SPRINGING

Although hydroelastic effects in ships have been recognized for many years, the traditional rigid approach of examining the hull structure provided a good approximation for smaller and more rigid ships. Today, as ships have become ultra large, with an elastic structure due to their large openings, the dynamic effects of whipping and springing cannot be overlooked. Put simply, the longer the container ship, the higher the risk of structural collapse due to whipping caused by slamming and of accelerated fatigue cracking due mainly to springing.

Bureau Veritas was the first class society to make mandatory a complete hydroelastic analysis of springing for container ships over 300 meters in length, and of whipping, for ships over 350 meters. Built on years of research, our rule note NR 583 details the specifics of this assessment, which is performed using our advanced HOMER software.

The assessment is also used to highlight improvements at construction stage. We have carried out WhiSp calculations on a range of container ship designs, from 9,200 teu up to 18,000 teu, in Korea and in China. Having gained the industry's trust, we are currently working with designers on the new generation of ULCS passing the 20,000 teu mark.



ULCS

BIGGER, BETTER, SAFER

26

BUREAU VERITAS CLASSED
ULCS UNDER CONSTRUCTION

RELATIONSHIPS

WITH MAJOR SHIPYARDS IN CHINA AND KOREA



Bureau Veritas has surveyed the construction of more than 140 ships in major South Korean yards and more than 90 ships in the main Chinese yards building container ships. Currently the biggest ULCS contracted for construction in China are classed with Bureau Veritas.

GLOBAL VIBRATION ANALYSIS

Periodic vibrations induced from mechanical equipment can lead to localized structural failures, influence the behavior of the engine and other equipment and also have a negative impact on the comfort of the crew. With a dedicated global vibration analysis, these risks can be identified and mitigated.

Bureau Veritas has recognized expertise in ultra large container ships (ULCS), having classed flagship vessels such as the CMA CGM Magellan, the CMA CGM Marco Polo and the CMA CGM Kerguelen (pictured). Our in-depth research, advanced software, specific notations, and expertise in analyzing and managing phenomena such as whipping and springing, make us the classification partner of choice for ULCS owners and operators.

50 ULCS
CLASSED BY
BUREAU VERITAS

21,000 teu
3 NEXT-GENERATION SHIPS
CURRENTLY UNDER CONSTRUCTION
IN SOUTH KOREA

NEW RULES

In view of the new IACS UR S11A and UR S34 for container ships which are applicable from 1st July 2016, Bureau Veritas has performed a major update in its rules for container ships.

The powerful principle of equivalent design loads is now used to underpin development of this new set of rules.

New formulas are being derived for extreme and fatigue loads based on spectral analysis of a large number of vessels.

Ultimate strength, whipping and springing phenomena are also covered. The rules for lashing calculation are also updated taking into account the gaps in the lashing equipment.

Bureau Veritas has been in the forefront of research and has developed dedicated software and methodologies to tackle the technical challenges associated with ULCS.

ELASTIC SHAFT ALIGNMENT

The flexible hull of ULCS in comparison to their stiff shaft line may lead to damages to the shafting system during operation, which are costly to repair. In 2013, Bureau Veritas introduced the Elastic Shaft Alignment (ESA) Notation, mandatory for ULCS, with the aim of refining the typical shaft alignment calculation, taking also into account the flexible hull girder. This examination provides reassurance that the pressure distribution in the bearings is within acceptable limits during static and running conditions of the shaft and for all the loading conditions of the ship.

IMPROVE ENERGY EFFICIENCY

Fuel efficiency has come into focus, as owners and operators seek to combat rising costs by minimizing consumption, and comply with emissions regulations.



Many solutions exist today to improve the energy efficiency of new and existing container ships. Choosing the right ones to match the ship and its operational profile requires state of the art software and experience.

Bureau Veritas partners with Computational Fluid Dynamics (CFD) specialist HydroOcean to evaluate and optimize hull forms, also taking into account the propeller and other appendages, including energy saving devices. Using the most advanced RANSE-CFD solvers available today, and accounting for viscous and other non-linear effects, genuine fuel savings can be achieved across all the ship's operations. The solutions are co-developed with the Ecole Centrale Nantes fluid dynamic laboratory, one of the most advanced research teams in marine numerical simulation in the world.

CFD hull form optimization is only one part of the equation. The intense energy consuming operations on board ships are

responsible for a significant part of the total fuel burned. Bureau Veritas has developed **SEECAT, software for modeling numerically the ship's energy flows** and identifying solutions for minimizing energy consumption.

With ships operating in seas around the US, Canada and Europe facing tough regulations on sulphur emissions from 2015, and on NOx emissions from 2016, Bureau Veritas is helping owners understand and implement solutions to comply. One of the most attractive long-term solutions is to use natural gas as fuel. Bureau Veritas offers specific class rules and advisory services for owners using LNG as fuel for newbuildings, or considering converting existing vessels to LNG. Bureau Veritas has teamed up with designers and owners to identify specific technical solutions for LNG fuelled container ships ranging from 1,000 teu to 18,000 teu, and risk management solutions, such as HAZID, HAZOP and SIMOPS.

RULES AND NOTATIONS

ENERGY PERFORMANCE & ENVIRONMENTAL NOTATIONS

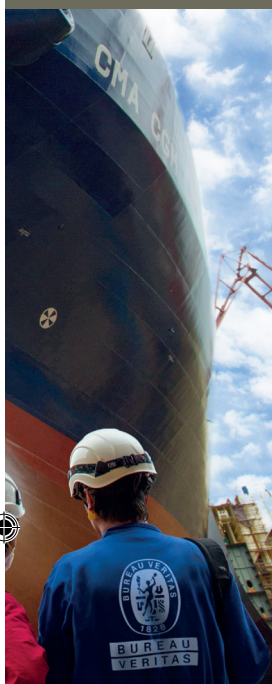
- CLEANSHIP
- CLEANSHIP SUPER
- SEEMP Notation
- GREENPASSPORT FORS

LNG AS FUEL FOR CONTAINER SHIPS

- NR 481, NR 529
- DUALFUEL, GASFUEL Notation

OPTIMIZE CARGO TRANSPORTATION

Cargo flexibility is of major importance for operators. Bureau Veritas provides solutions for safe and flexible loading.



Research and real measurements

on board large container ships show that the transverse accelerations currently used in lashing and stowage rules do not accurately reflect reality. This is particularly true for the newest generation of large box ships.

The transverse accelerations are closely related to the area of operation and the natural roll period of the ship which itself depends on the actual loading condition. With **Bureau Veritas's LASHING-WW notation** these factors are taken into account and ships fitted with an approved lashing calculator will be able to optimize their loading patterns. With LASHING-WW, heavier stack weights can be obtained for each loading condition compared to traditional Rules and/or heavier boxes can be placed in higher tiers.



ULCS DRIVE DEMAND FOR LARGER FEEDERS

Another way we are supporting the industry in its efforts to optimize cargo transportation is in meeting demand for different types of vessel. Larger main line container ships have created a need for bigger and more fuel-efficient feeders. Bureau Veritas is currently classing more than 130 Feeder and Handy vessels. We are also working with designers on the new generation of fuel-efficient larger feeders. A number of these ships will be required to operate in the Baltic which is a SECA area but also requires increased Ice capabilities. Bureau Veritas has been working with designer Deltamarin on the Deltaseries, a highly fuel-efficient 2000-2800 teu container ship which can be customized for specific trades including icy areas. An LNG fuel option is under consideration, making these ships ideal for operating in areas impacted by new regulations on sulphur and NOx emissions.

HISTORICAL PARTNER TO THE MARINE INDUSTRY

Bureau Veritas was founded in 1828 for the initial purpose of collecting, verifying and providing maritime insurance companies with precise and up-to-date information about the condition of ships and their equipment around the world.

EXPERTISE THROUGHOUT THE GLOBAL SUPPLY CHAIN

Our involvement in the container industry goes beyond marine transportation. Bureau Veritas is one of the leading testing, inspection and certification providers to the global consumer goods industry, and a key partner of governments and international trade bodies for import control and inspection. As such, we have the deepest involvement and understanding of the global supply chain of any of the major classification societies.

OVER 1,000 ACCREDITATIONS AND AUTHORIZATIONS

Our wide range of accreditations and authorizations across a range of industry sectors prove that we operate professionally and that our reports and certifications are recognized and respected. We hold 130 delegations of authority on behalf of national maritime authorities.

A KEY PLAYER IN MARITIME RESEARCH AND DEVELOPMENT

Alongside our own research, Bureau Veritas' Marine business is involved in a number of European research programs, and several joint industrial projects with the oil and gas industries. This has led to the development of areas of expertise such as hydrodynamics, vibration and structural fatigue. We have also developed advanced calculation and simulation tools to analyze the behavior of ships and offshore structures.

BE PREPARED FOR THE UNEXPECTED

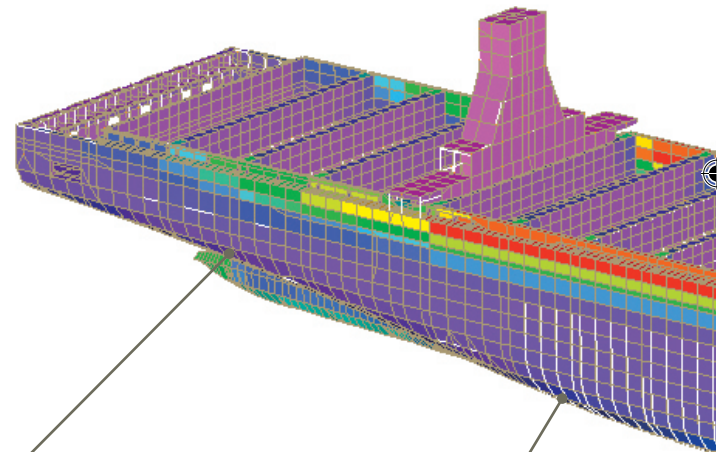
Emergency response
services

DEMONSTRATE COMPLIANCE

Statutory certification

REDUCE RISK

Classification



AVOID DAMAGE

Elastic shaft alignment

ENHANCE ENERGY EFFICIENCY

ESD* evaluation

IMPROVE PERFORMANCE

Propeller & appendages
optimization

ASSESS DAMAGE

Complete ship FEA**
& spectral fatigue

*ESD: Energy Saving Device **FEA: Finite Elements Analysis

PARTNER OF CHOICE

FOR SAFETY AND PERFORMANCE

Bureau Veritas offers a wide range of services to safeguard your crew, vessel and equipment, and to improve efficiency and performance.

IMPROVE SAFETY AND COMFORT

Global vibration analysis

SAFEGUARD AGAINST EXTREME WAVE MOTIONS

Parametric and dynamic roll analysis
Wave detection and warning

ENHANCE REEFER CAPACITY

SEECAT, our tool for ship efficiency calculation and analysis

OPTIMIZE CARGO EFFICIENCY

Cargo lashing (includes tuning stack loads to sailing routes)

OPTIMIZE FUEL USE

Gas fuel services

GET READY FOR THE FUTURE

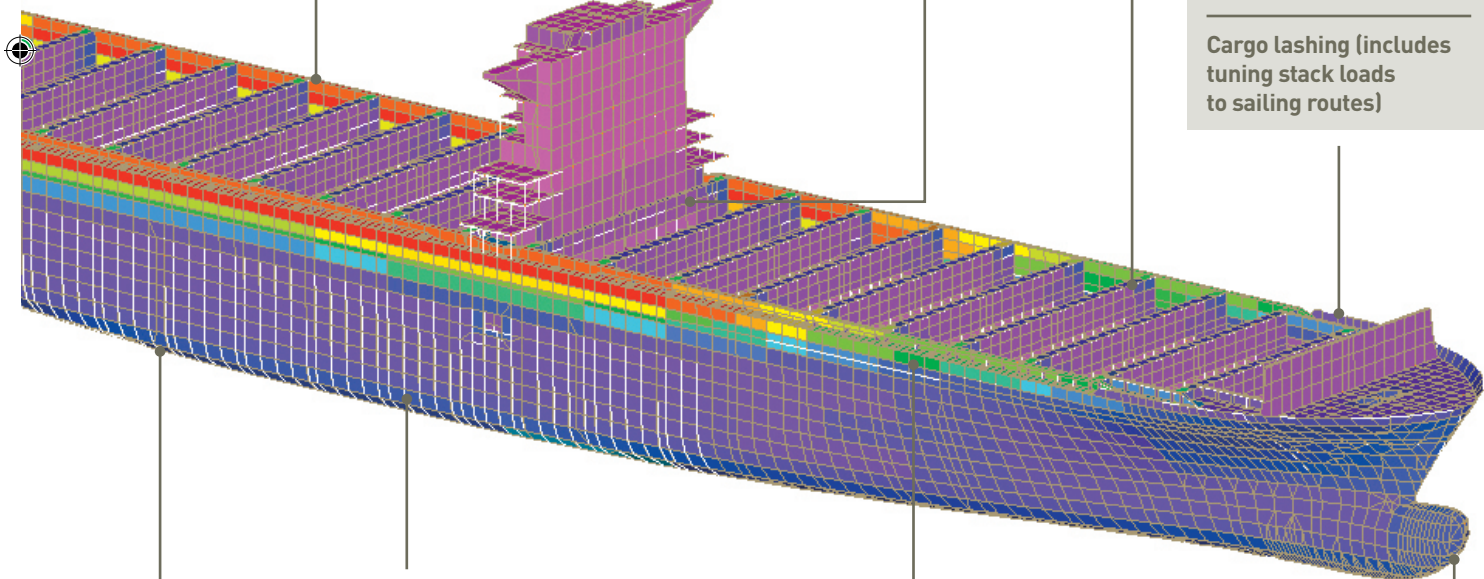
Gas prepared notation

SAFEGUARD SHIP INTEGRITY

Whipping & springing services

BOOST PERFORMANCE

Hull form optimization



180 YEARS OF CONFIDENCE

Our worldwide network ensures we meet your needs wherever you operate.

— **A global leader in testing, inspection and certification,** Bureau Veritas serves clients' needs around the world in quality, health, safety, environmental protection and social responsibility.

— **For over 180 years,** our clients have looked to us to provide technical support, verify compliance, or obtain certification. Our mission is to help identify, prevent and manage risks.

— **Our network of over 1,400 offices and laboratories meet our clients' needs,** wherever they are in the world. We pride ourselves on our technical expertise, impartiality and detailed knowledge of international and local regulations.

— **We offer three principal services.** Testing provides confidence that commodities or consumer goods are of the right quality, and conform to specifications. Inspections of facilities, equipment and products are designed to reduce risk and meet regulatory requirements. Finally, certification represents a third party stamp of approval that a product, service or system conforms to a specified standard.

— **Within the marine & offshore industry,** we are a leading classification society and employ more than 2,600 staff. Over 11,000 ships, representing more than 100 million gross tonnes, are classed to Bureau Veritas rules, and we provide a wide range of advisory services to the Marine sector.



AMERICAS
17,900 EMPLOYEES
330 LOCATIONS



**MIDDLE EAST, AFRICA
& EUROPE**
23,600 EMPLOYEES
670 LOCATIONS



ASIA PACIFIC
24,500 EMPLOYEES
400 LOCATIONS



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Move Forward with Confidence

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