



SAFETY LEADERSHIP IN A CHANGING WORLD

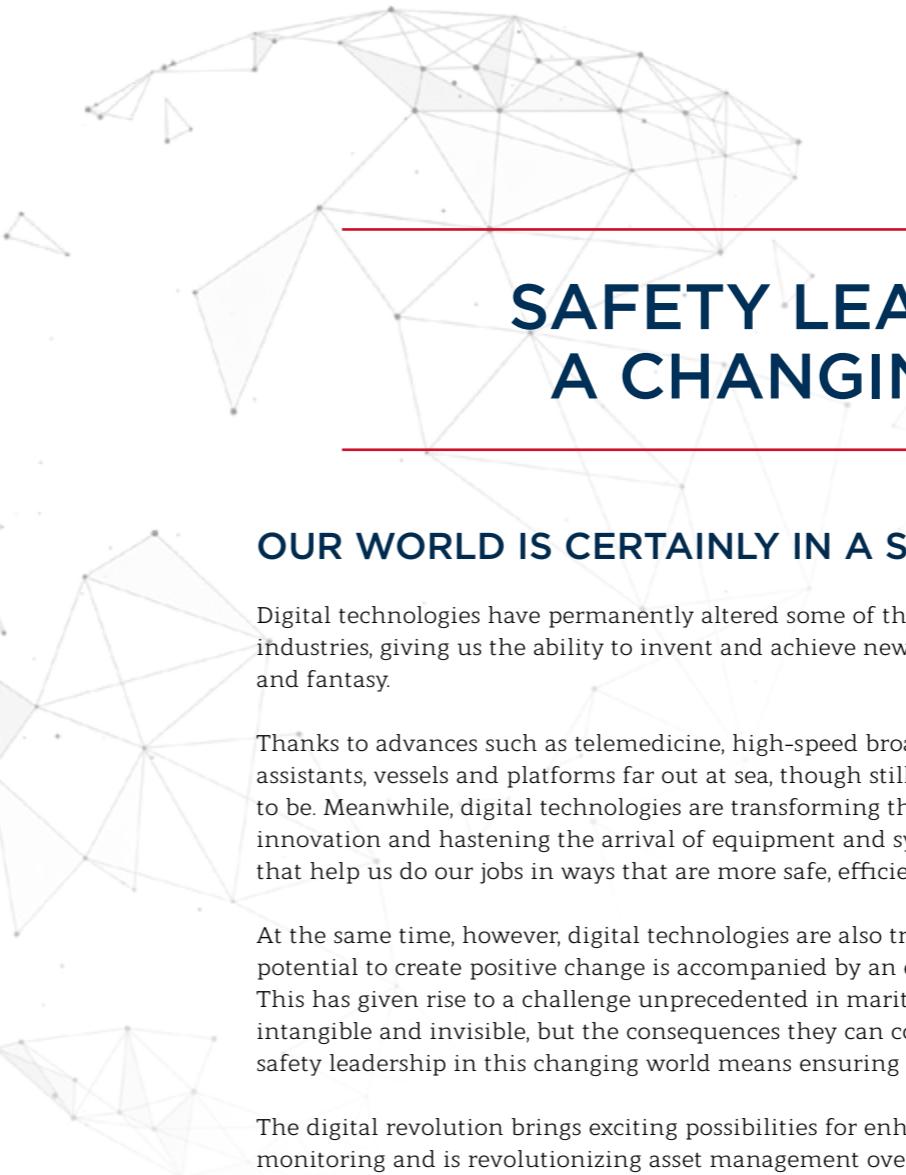
ANNUAL REVIEW 2019



ABS MISSION

The mission of ABS is to serve the public interest as well as the needs of our members and clients by promoting the security of life and property and preserving the natural environment.

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SAFETY LEADERSHIP IN A CHANGING WORLD

OUR WORLD IS CERTAINLY IN A STATE OF CHANGE.

Digital technologies have permanently altered some of the fundamental realities of the marine and offshore industries, giving us the ability to invent and achieve new technologies that once seemed like science fiction and fantasy.

Thanks to advances such as telemedicine, high-speed broadband communications and holographic technical assistants, vessels and platforms far out at sea, though still off in the distance, are far less isolated than they used to be. Meanwhile, digital technologies are transforming the nature of research and development, accelerating innovation and hastening the arrival of equipment and systems for monitoring, control and communications that help us do our jobs in ways that are more safe, efficient and productive than ever before.

At the same time, however, digital technologies are also transforming the nature of risk. Their seemingly limitless potential to create positive change is accompanied by an equal and opposite potential to generate fresh hazards. This has given rise to a challenge unprecedented in maritime history – not only are digital sources of risk both intangible and invisible, but the consequences they can conjure range from costly to catastrophic. As a result, safety leadership in this changing world means ensuring technology's potency is tempered by human needs.

The digital revolution brings exciting possibilities for enhancing occupational safety, survey and condition monitoring and is revolutionizing asset management overall. Balancing today and tomorrow, safety must be grounded in protection of life, property and the natural environment, while focusing on systems thinking, people, cyber security and predictive analysis because every facet of the industry is changing and evolving quickly.

The extent to which companies successfully manage this duality will be the determining factor in their performance in the years to come. This is why ABS spent 2019 further building the foundations of our digital future and developing products and services to help the industry and our clients do likewise.

As technology broadens our safety thinking – from a system-focused element concerned with physical structures that may be touched, towards intangible systems that cannot be seen such as software, cyber and communications – ABS continues to lead the way in understanding this new predictive paradigm and how it must redefine the industry's approach.

ABS made tremendous strides in 2019, developing tools that will be the cornerstones of tomorrow's marine and offshore industries. This annual review records a year of significant achievement for ABS and the additional building blocks of a continuing legacy in leadership.



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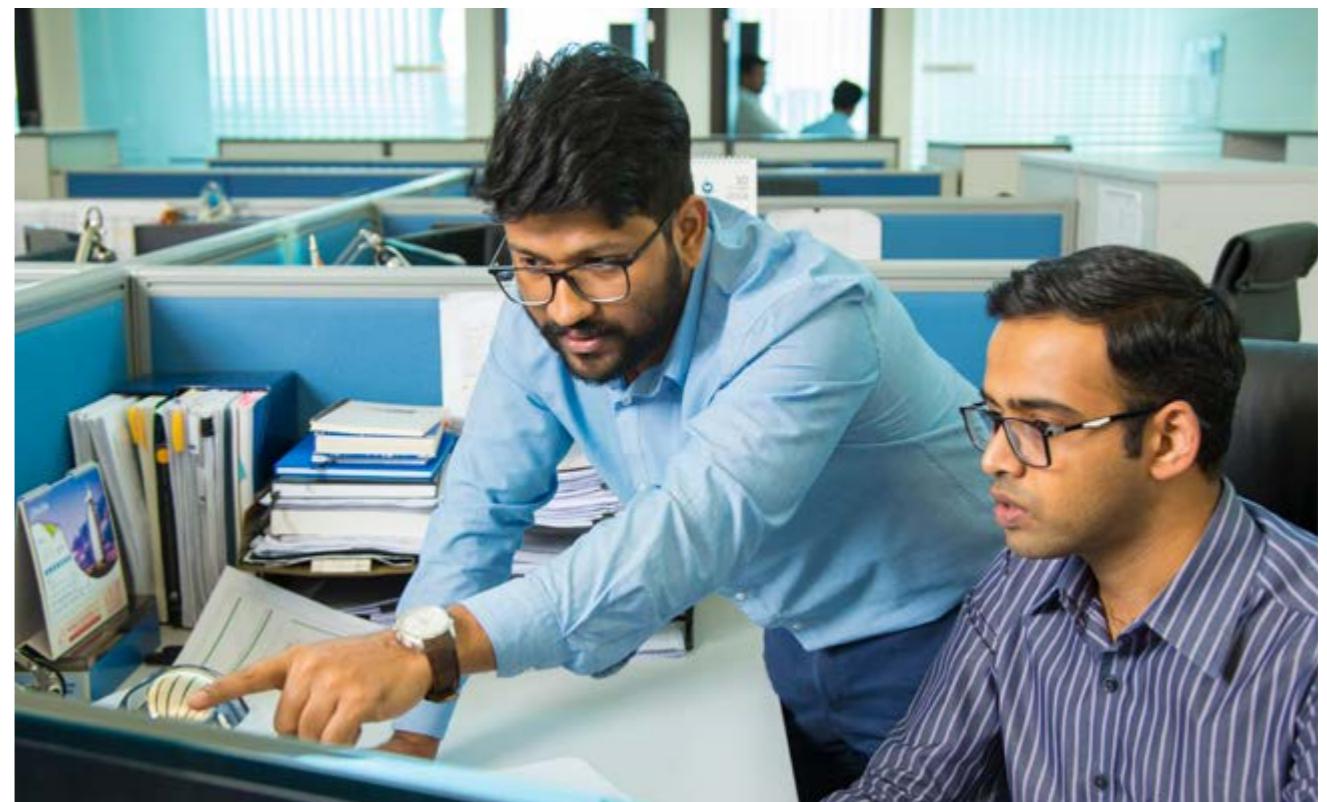
CHAIRMAN'S MESSAGE

As this annual review was being written, the world was in the heights of battle against the COVID-19 global pandemic. This unprecedented challenge subjected us all to turbulence and tragedy, but also drew forth from human kind acts of great nobility in all corners of the globe, from the heroic dedication of countless health care workers and first responders to the simple care and kindness exhibited by neighbors and strangers alike. Many positive lessons are emerging from this extraordinary experience.

One lesson is that the pandemic has sparked teamwork on a massive scale as numerous organizations are pooling their resources and technologies to combat it, and in that we can discern some things of value for the future of our industry. One is the power of collaborative teamwork and transparency in reaching a difficult goal. Another is the transformative power of digital technologies.

The family of technologies grouped under the rubric "digital" – from data analysis to smart manufacturing and distribution of equipment and supplies – has facilitated the global response to the pandemic in a rapid, efficient manner. This may be the first example of digital technologies having a massive impact on a global emergency response, and certainly indicates the vast potential for digital technologies to fundamentally change our industry and the ways in which business is conducted.

For ABS, these lessons reaffirm what we have always believed: that trust, transparency, teamwork and technology will help us navigate uncertainty in the future and achieve goals that today seem out of reach.



In terms of global achievement, 2019 was a fitting close to a decade that history may one day recognize as the opening bell of the digital revolution, a revolution that will continue to unfold around us for years to come and in which the accelerated pace of change is both unsettling and exhilarating. Unsettling because technology is evolving so rapidly that new developments are often superseded before they can be fully absorbed; and, on the other hand, exhilarating because that rapid evolution constantly leads us to new possibilities for advancement and new solutions to our most complex problems, often achieving what we once considered impossible.

"Trust, transparency, teamwork and technology will help us navigate uncertainty in the future and achieve goals that today seem out of reach."

CHRISTOPHER J. WIERNICKI
CHAIRMAN, PRESIDENT AND CEO
ABS

This is of great encouragement as we contemplate the path forward to 2050 and develop the environmental and safety related technologies that will turn the vision into reality.

As we build the future, we must not lose focus on the issues that emerged in the last decade and which our industry continues to face – three major changes and the four underlying challenges they raise. The changes are market uncertainty and predictability, regulatory impacts on the carbon journey, the introduction of new technology and the rate of change inherent in the development of new technology. The challenges they bring to the fore are: the drive to achieve low-carbon shipping; the speed and scope of digitalization; the ceaseless evolution of cyber security and its associated risks; and the need to recognize and mitigate unintended safety consequences as we address and manage safety risks.

These changes and challenges, and indeed all our efforts, are wrapped within three forces shaping activity on a global scale: Environmental, Social and Governance (ESG); International Safety Management (ISM); and digital technologies.



Through 2019, we saw growth in the global economy, improvements in energy pricing, and strengthening in industry fundamentals ahead of regulatory obligations that allowed ABS to grow our classed fleet to 267 million gross tons (m gt), maintain our leadership role in the Global Offshore industry, realize exceptional results in safety and port State performance, and retain a solid position in the Global Orderbook.

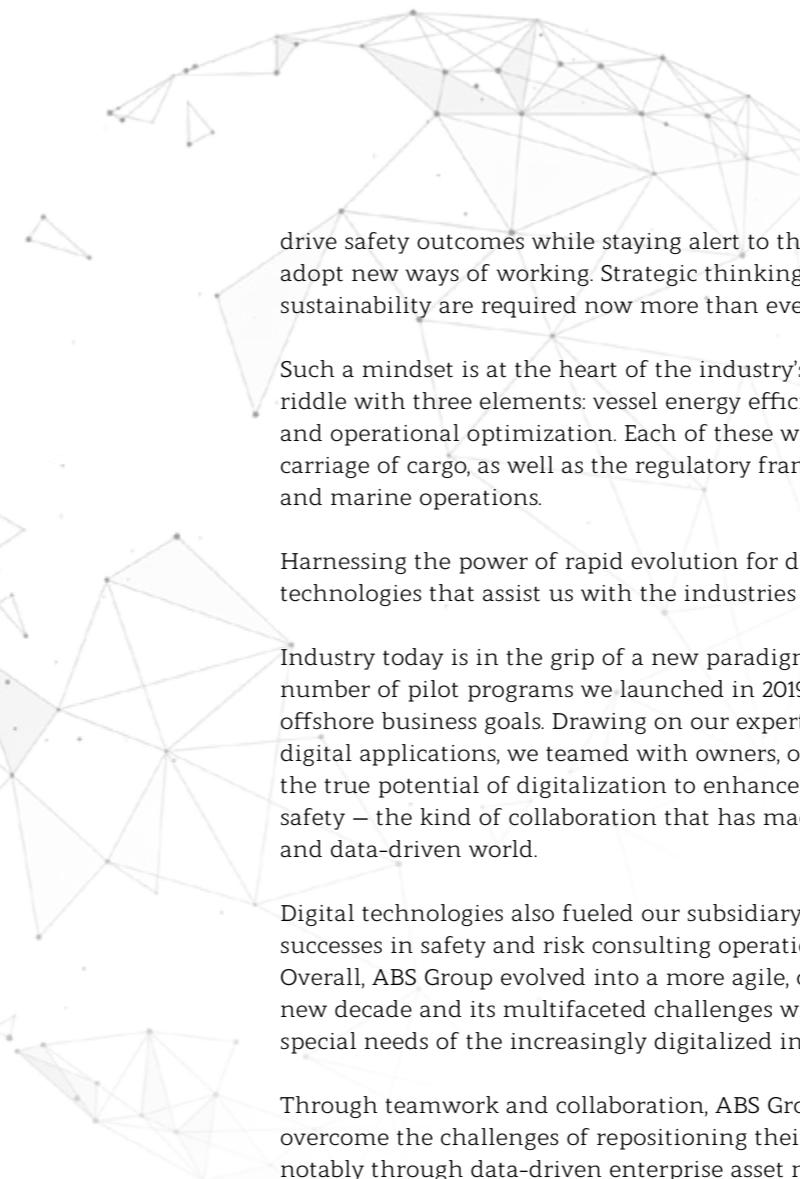
We also continued delivering award-winning digital technologies to transform the industry and established clear pathways for decarbonization goals for the next decade and beyond on the journey to 2050.

Most importantly, in 2019 ABS maintained its focus on safety and reliability to achieve a historic milestone – our third consecutive year without a lost time incident – demonstrating solid safety leadership at the heart of all we do. Our financial and operating success would not have been possible without the professional and dedicated employees who live and work with the values imbued in the SPIRIT of ABS every day. Through their relentless focus on Safety, People, Integrity, Reliability, Innovation, Teamwork and Quality – the SPIRIT of ABS remains our guiding beacon and unique differentiator.

As we continue our investments in people, systems and technologies, we remain a market leader because of our continuous learning models and robust career development programs. In 2019, we delivered more than 28,000 hours of newly designed training to our employees through scenario-based classroom and online learning opportunities. Our well-trained experts, who span traditional marine and offshore architecture, engineering and data sciences, support ABS in leading the industry toward a digitally-driven, low-carbon future.

Meanwhile, the maritime industry continues its own digitally-driven movement into condition-based approaches and real-time, risk-based, data driven decision-making, developing technologies that enable many of us to do our jobs without being physically present at the work site. In parallel, our regulatory landscape continues to transform under complex, performance-based, data-centric regimes. Shipping operations rely increasingly on integrated networks, software and data transfer solutions to operate with greater efficiency. Also, digitally powered interconnections between onboard equipment and shore-based systems are redefining the traditional ship-to-shore interface.

Rapid change remains our new normal, but unforeseen and unanticipated circumstances must never drive us to abandon proven solutions. Rather, we should rework our approaches and methods to fit this new reality, and build a self-renewing approach to the future. We should further harness the power of digital technologies to



drive safety outcomes while staying alert to the unintended safety consequences that may be introduced as we adopt new ways of working. Strategic thinking centered around technical feasibility, economic viability and sustainability are required now more than ever.

Such a mindset is at the heart of the industry's decarbonization challenge which can be regarded as a complex riddle with three elements: vessel energy efficient technologies; low carbon, zero carbon or carbon neutral fuels; and operational optimization. Each of these will impact capital expenditure, vessel design, trade routes and carriage of cargo, as well as the regulatory framework which will have to come to grips with changes in technology and marine operations.

Harnessing the power of rapid evolution for digital technologies, ABS developed new tools and innovative technologies that assist us with the industries we serve to do our work better, smarter and more efficiently.

Industry today is in the grip of a new paradigm of digitally-stimulated development. This was evidenced by the number of pilot programs we launched in 2019 in which digital technologies support a variety of marine and offshore business goals. Drawing on our expertise with data science, marine and offshore technologies and digital applications, we teamed with owners, operators, charterers, vendors and academia to jointly begin realizing the true potential of digitalization to enhance asset management, fleet performance, sustainability and crew safety – the kind of collaboration that has made ABS a recognized technology leader in our increasingly digitized and data-driven world.

Digital technologies also fueled our subsidiary, the ABS Group of Companies, Inc. (ABS Group), driving it to new successes in safety and risk consulting operations across the Americas, Europe, Middle East and Asia Pacific regions. Overall, ABS Group evolved into a more agile, customer-focused and data-driven organization, ready to meet the new decade and its multifaceted challenges with a renewed clarity of mission and a revitalized approach to the special needs of the increasingly digitalized industries they serve.

Through teamwork and collaboration, ABS Group helped its clients across the globe in their own efforts to overcome the challenges of repositioning their organizations for future growth in this era of digitalization, notably through data-driven enterprise asset management, cyber security and risk and reliability services as well as risk-based inspection and engineering studies geared towards intelligent maintenance and reliability strategies for next-generation vessels.

Throughout the year, ABS Group developed new capabilities based on its core values of safety and integrity, making strategic investments in people and technologies to position itself as a competitive business for 2020 and beyond.

The dedicated professionals of ABS will continue to lead the industry safely with the level of integrity and professionalism that our members and clients expect and deserve. We remain focused on a bright future in which digital technologies will enable us to lead effectively and drive new levels of achievement across our industry.

At the same time, however, the driving forces for success remain the same as ever: a leading position on safety; the vision to navigate constant change based on a core set of values; and the ability to harness knowledge and expertise to leverage ABS' strength and deliver consistent positive performance.

We must never forget that success is a team sport. All the great things ABS accomplished in 2019 in laying the foundation for a new era in the maritime industry can be attributed to the incredible employees and our loyal clients. I thank each of you sincerely as, together, you demonstrate safety leadership amidst the significant challenges of this changing world.

Christopher J. Wiernicki
Chairman, President and CEO, ABS
Chairman, ABS Group of Companies, Inc.

SAFETY LEADERSHIP IN A CHANGING WORLD

INDUSTRY LEADING SAFETY AND QUALITY

SAFETY LEADERSHIP

We at ABS have built our reputation as an industry leader in maritime safety underpinned by a commitment to continual improvement and the development of a strong safety culture for our workforce. For ABS, safety is a core value. It is more than just awareness; it is the foundation of all we do and an endless pursuit. What we do matters to the lives of people and the quality of the environment. ABS empowers employees with the knowledge, tools and authority to maintain safety at work and in everyday life. We are vigilant in our goals to improve safety practices and dedicated to making our workplace a safe environment.

ABS SAFETY PERFORMANCE

In our long safety tradition, each year's successes form the foundation of next year's achievements, fueling the voyage that has made ABS a global Health, Safety, Quality and Environmental (HSQE) leader. ABS maintained this leadership in 2019, recording our third year of zero work-related lost time incidents (LTIs) with a corresponding lost time incident rate (LTIR) of 0.00.

Our record of three consecutive years without a lost time injury stands as a historic achievement. It is proof that we are a safety-driven organization and a testament to the safety awareness of our staff, their commitment to safe practices and procedures and the success of our overall safety methodology.

OCCUPATIONAL HEALTH AND SAFETY PERFORMANCE

The ABS ongoing safety excellence initiative incorporates strong occupational health and safety processes and policies, including its Stop Work Obligation rule authorizing all employees to intervene if safety is in question in any aspect of their work. ABS continues to increase engagement in leading safety behaviors, including timely reporting of potential incidents or hazards and documenting near misses.

- ABS LTIR of 0.00 for three years running, can rightly be called a historic achievement.
- ABS total recordable injury rate (TRIR) of 0.30 remained extraordinarily low year-on-year.
- ABS employees continued to make good use of its own global reporting system to capture unsafe conditions, unsafe behaviors, near misses, and work-related injuries or illnesses.



“Safety drives us, and the incredible milestone that ABS reached – three years without a work-related lost time incident for ABS Bureau, and four years for ABS Group – underscores how we are living our mission every day. It is proof that safety is at the heart of everything we do.”

CHRISTOPHER J. WIERNICKI
CHAIRMAN, PRESIDENT AND CEO
ABS

- ABS collaborated with the American Club and Lamar University to deliver an industry-leading study of maritime injury claims, offering unprecedented shipping safety insights to advance the cause of safety at sea with a call for more comprehensive maritime injury reporting.
- ABS achieved ISO 45001 certification in 2019, with external audits performed by the British Standards Institute (BSI).

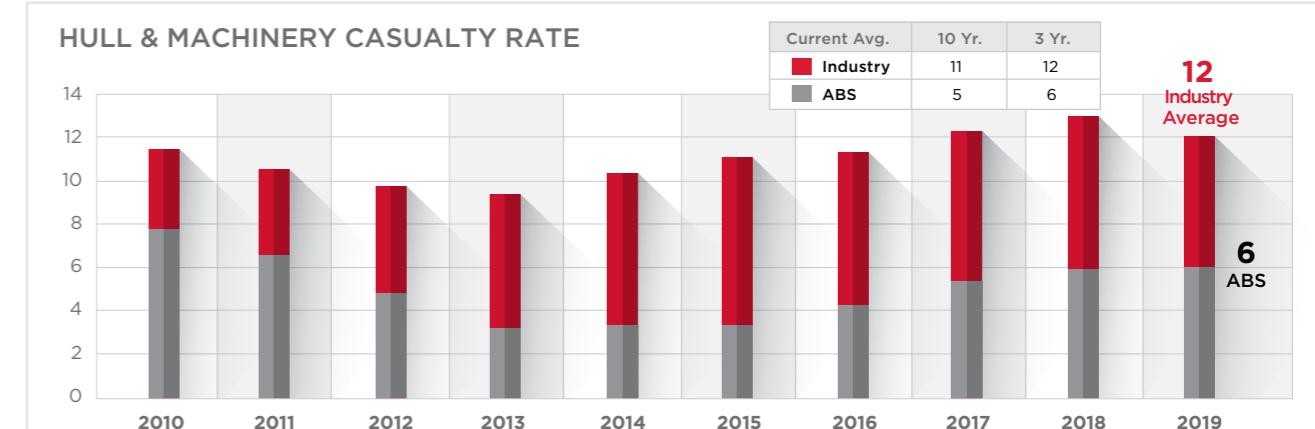
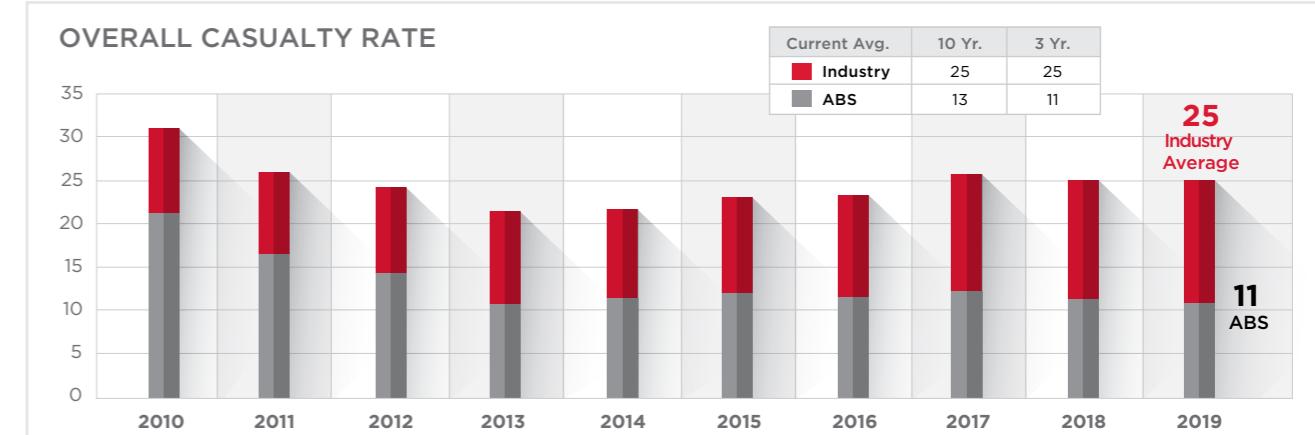
ABS GROUP OF COMPANIES, INC. SAFETY PERFORMANCE

Building on the parent organization's ongoing commitment to its safety mission, ABS Group of Companies, Inc. (ABS Group) surpassed four years without an LTI in 2019. This achievement demonstrates ABS Group's focus on continually improving the effectiveness of its health, safety, quality and environmental culture, performance and management system.



QUALITY PERFORMANCE

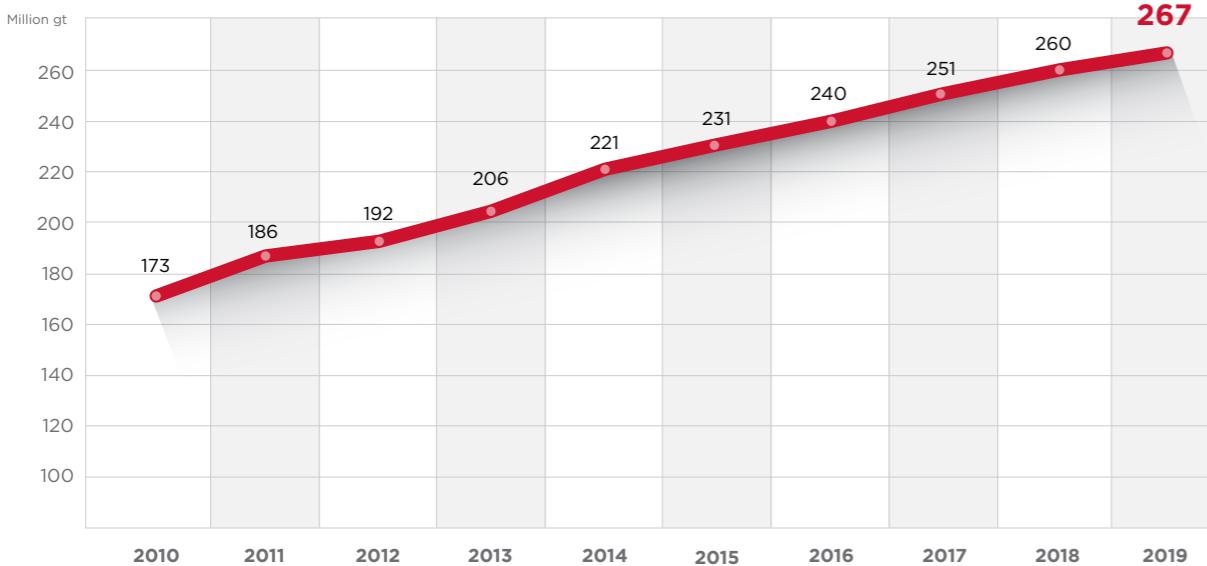
In 2019, ABS continued high-quality service delivery to our global client base. ABS maintained its leading position on overall Port State Control (PSC) performance, being one of the top performing Recognized Organizations (RO) in all three of the most active PSC regions of the world for the 2017 to 2019 period. Further, for the last 11 years, ABS has maintained zero RO-related detentions with the U.S. Coast Guard (USCG) and has averaged less than one RO-related detention per year in the Paris MoU.



SAFETY LEADERSHIP IN A CHANGING WORLD

INDUSTRY LEADING PERFORMANCE

EXISTING FLEET 2019



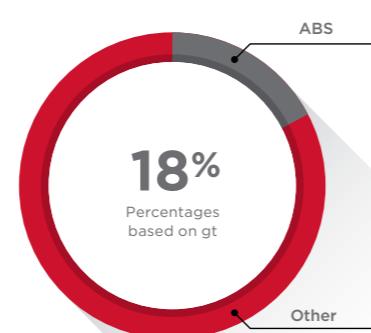
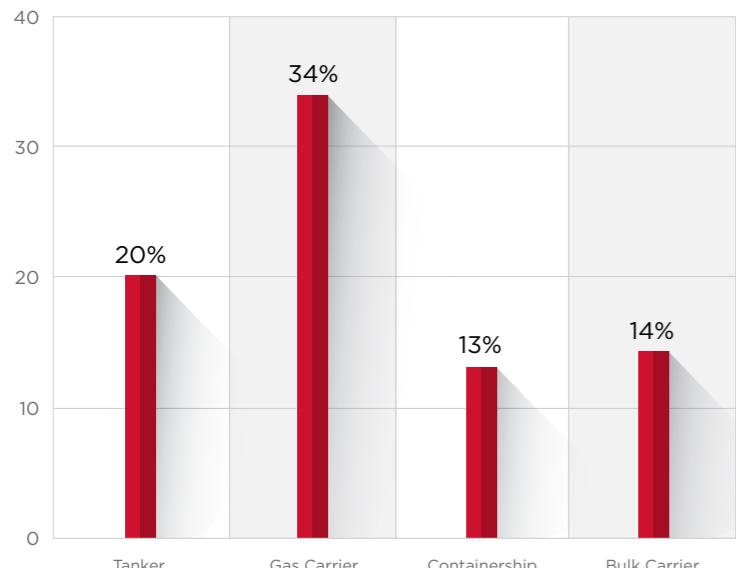
LEADING ORDERBOOK FOR SHIPBUILDERS

BRAZIL
CHINA
JAPAN
SINGAPORE
S KOREA
TAIWAN
USA

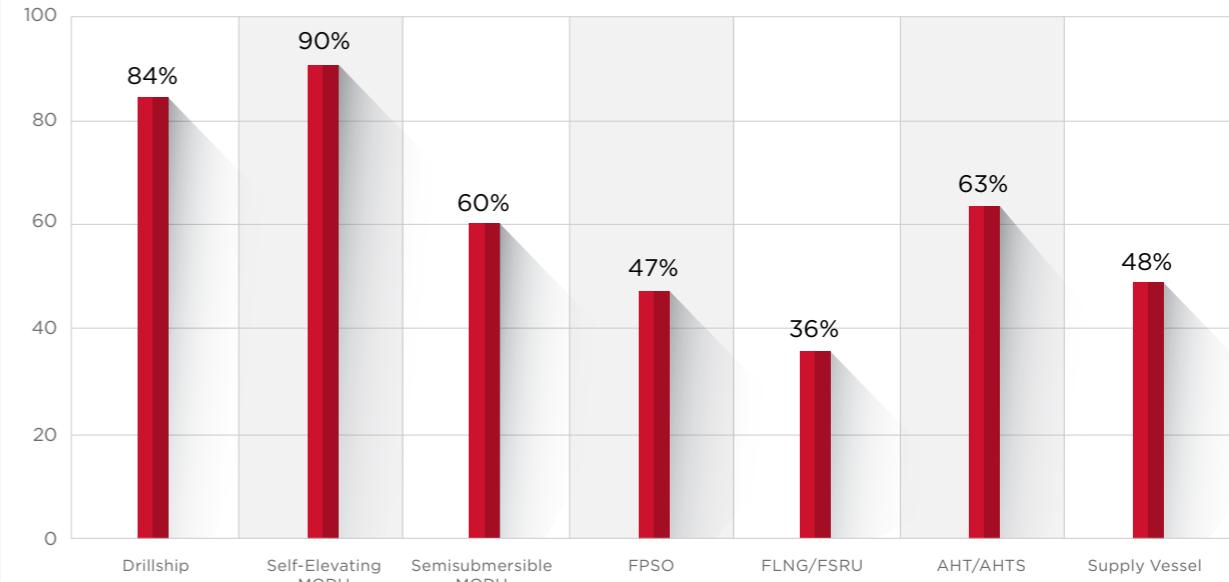
LEADING EXISTING FLEET FOR OWNERS

BRAZIL
CHINA
DENMARK
GREECE
JAPAN
SINGAPORE
S KOREA
TAIWAN
USA

MARINE ORDERBOOK SHARE 2019



OFFSHORE ORDERBOOK SHARE 2019



SAFETY LEADERSHIP IN A CHANGING WORLD

GLOBAL CORPORATE CITIZENSHIP

As the global maritime industry continues to transform with increasing digitization, automation, machine learning and big data analytics, digital technologies will be a key enabler in our quest to build a cleaner, better and more safe and sustainable future.

In this rapid evolution of technology, ABS is well-positioned as a technical and safety leader. The core engineering and technology competence of our people and the wealth of experience they bring to problem-solving is a key differentiator for us. That's why at ABS we are focused on continuing to develop our employee base to be best in class through continuous learning, training and preparation to support our commitment to set standards of excellence as a leader in maritime safety – now and in the future.

The path forward for ABS is clear based on three defining goals – safety, service and solutions. We have been able to achieve those goals through the innovative thinking, enthusiasm and professionalism of our highly experienced staff. Years of experience, training and continued education have made us confident in our actions and secure in our decisions.

DEVELOPING OUR TALENT PIPELINE

As an organization committed to investing in and cultivating a sustainable, multi-skilled talent pipeline across a broad range of disciplines – traditional marine and offshore architecture, engineering studies, data analytics and cyber security – ABS is well-prepared and ready to meet the challenges of evolving industry issues.

Our robust internal career development efforts at ABS are designed to provide a balance of development activities for employees, using a combination of job experience, mentoring, coaching and formal training.

In 2019, ABS designed and deployed more than 28,000 hours of new training to our employees, relying heavily on scenario-based learning both in the classroom and online.



The International Safety Management (ISM) training for ABS surveyors and auditors and our clients was a significant focus with the development of a new Keystone for Auditors program. During the week-long classroom course, auditors complete activities based on real-world scenarios to hone their auditing skills and to recognize their role in creating a positive safety culture in the maritime industry. Keystone is a three-year recurring validation training for technical staff. ABS also conducted ISM refresher training for all ABS auditors early in 2019.

Overall training for ABS surveyors and auditors increased to an average of 72 hours per person as they prepared for the release of ABS Freedom™, an integrated database and workflow that is at the center of our data strategy and the foundation for digital class. The pre-rollout training included numerous web-based courses, videos and the completion of a hands-on scenario in a training database. High levels of manager involvement helped ensure that our workforce was ready for the new software.

ABS also offered external training for companies seeking to improve safety performance through the Improving Your Safety Culture training course, which covers causal factors related to human error and complacency, as well as methods for mid-management to reinforce and support safety culture metrics in alignment with the ISM Code.

ABS provided scholarship commitments to 356 scholars at colleges and universities in the Americas, Europe, Middle East, Africa, China and Pacific regions.

Additionally, ABS supported endowed academic chairs at seven campuses:

- ABS Chair of Naval Architecture and Marine Engineering and ABS Chair of Marine Transportation at the State University of New York (SUNY) Maritime College
- ABS Chair at Engineering at the California State University Maritime Academy (formerly known as the California Maritime Academy)
- ABS Chair of Metallurgical and Materials Engineering at the Colorado School of Mines
- ABS Chair in Ocean Engineering at the University of California Berkeley (UC Berkeley)
- ABS Chair at Marine and Offshore Design Performance at the University of Michigan
- ABS Career Development Chair at the Massachusetts Institute of Technology (MIT)
- ABS Chair in Naval Architecture and Marine Engineering at the Webb Institute

ASPIRE PROGRAM

One of the ways ABS cultivates the talents of our people is through the Aspire program. In this program, newly hired graduates are given the opportunity to work alongside professionals in the Engineering, Survey and Technology groups through a series of developmental rotations. The Aspire program fosters broad-based knowledge development by exposing participants to the diversity of career paths across ABS, such as data analytics, naval architecture, ocean engineering and mechanical engineering. Since Aspire's founding, 77 employees have completed the program gaining a strong foundational knowledge of the mission of ABS and the role we play in supporting the marine and offshore industries.





SAFETY LEADERSHIP IN
A CHANGING WORLD

DIGITAL INNOVATION

SAFETY LEADERSHIP IN A CHANGING WORLD

LEADING DIGITAL SOLUTIONS AND INNOVATIONS

The “new normal” for the maritime and offshore industries is shaping up as a continuous state of accelerated change fueled by rapid evolution of digital technologies. That evolution not only provides new tools to help us do our work better, smarter and more efficiently, but also inspires us to think in new ways about old problems and, thereby, develop innovative applications for existing technologies and proven solutions.

This new paradigm of digitally-stimulated development is having a transformative effect in virtually all spheres of activity around the world.

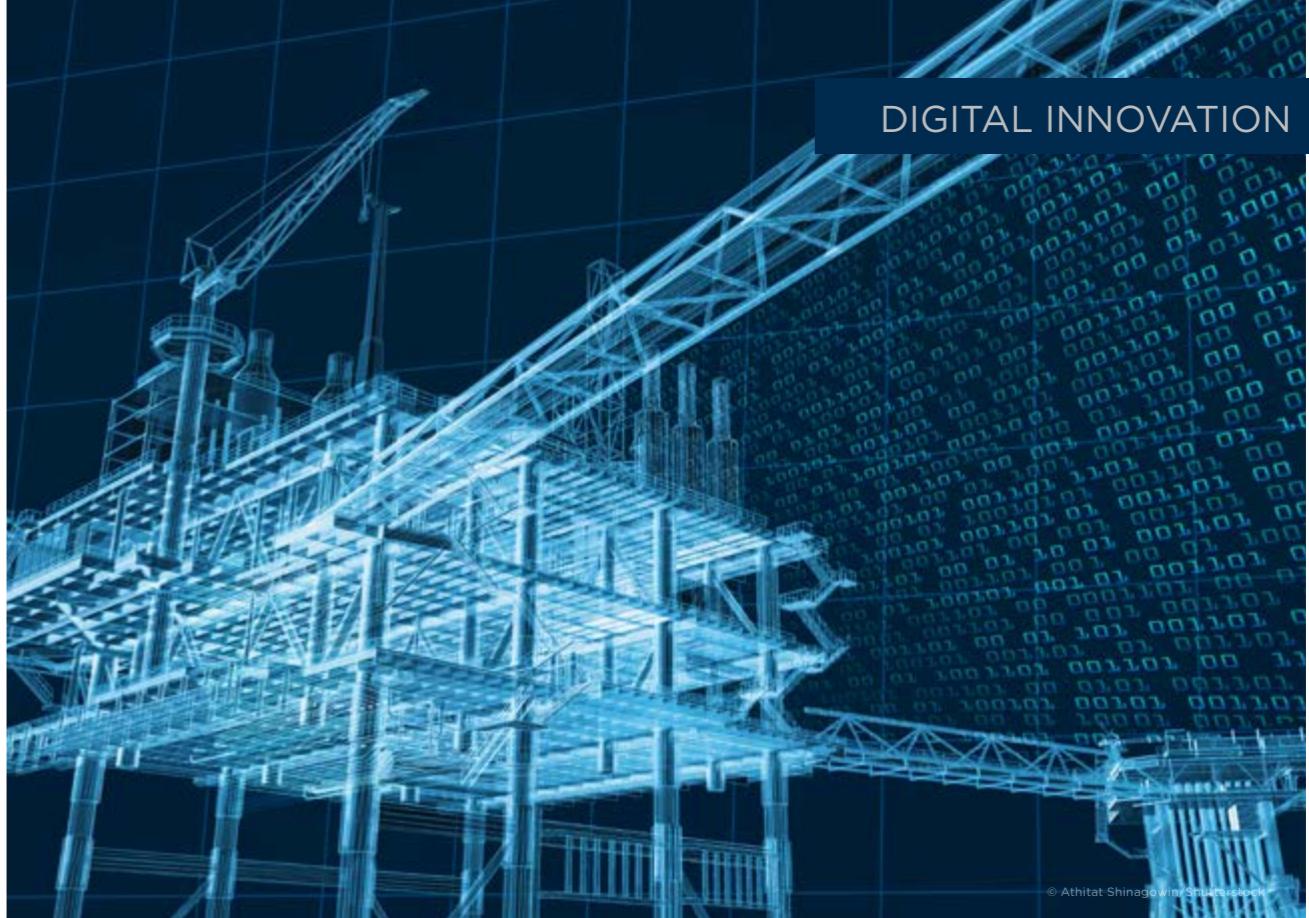
In our industries, digitally-stimulated development has turned ships and offshore assets into sophisticated sensor hubs, and has awakened in the organizations that own, operate and support those assets an awareness of the immense potential to derive practical insight and operational improvement out of the ocean of data they generate. This awareness has driven ABS to grow as data analysts and digital tool makers, in order to develop the products and services that help the industry extract the benefits in this potential and discover new opportunities to enhance both performance and safety.

Digital innovation and a willingness to capitalize on the significant optimization potential offered by new data- and AI-driven solutions has become a cornerstone for many forward-thinking maritime operators, which are building compelling new business cases on the connectivity and data-informed decision-making they facilitate. Digital information flows are now driving the automation of processes and functions, which in turn is driving both operational gains and enhanced safety and sustainability performance. As a result, data analysis and digital twin technologies have begun to influence virtually every aspect of how vessels and their components are designed, built and operated.

Pressure to decarbonize shipping and meet regulatory targets have emerged as key drivers behind many recent digital advances and, no doubt, will drive many more yet to come. What emerged along with these advances is a recognition that decarbonization challenges us to develop new technologies and scientific advances of such magnitude that they can only be achieved through collaboration and a shared commitment to innovation.



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The need to collaborate in pursuit of decarbonization technology is another characteristic of the new normal and the new paradigm in which our industries operate.

ABS, through collaboration with leading shipyards, operators and technology providers, has been at the forefront in developing a new digital mindset for the industry and in pioneering new digital-powered approaches that will ultimately lead to a reshaping of the way we work. In the new norm of rapid change and digitally-stimulated development, this means dramatic change to everything from operations and maintenance to the way industry manages risk.

ABS spearheaded the following digital initiatives in 2019 to support our commitment to our customers’ operational and safety goals. Ranging from new product development to innovative programs that enhance class services, these initiatives illustrate how we help the industries we serve meet the changing and expanding needs of the global economy.

DIGITAL SOLUTIONS

2019 saw the launch of several pilot programs in which digital technologies were used to support a variety of marine and offshore business goals. The products piloted in these programs combine ABS’ deep domain experience with data science, technology and digital applications, and are designed to help owners, operators, charterers, vendors and academia realize the full potential of digitalization to enhance asset management, fleet performance, sustainability and crew safety. As they help industry move forward safely through the digitalization journey, they will also reinforce ABS’ position as a recognized technology leader in our increasingly digitized and data-driven world.

“In constant collaboration with our clients and industry partners, we developed easy-to-apply and scalable applications recognizing that many people are in varying states of their digital journeys.”

KASH MAHMOOD
SENIOR VICE PRESIDENT,
DIGITAL SOLUTIONS
ABS

DIGITAL TWINS REVOLUTIONIZE ASSET MANAGEMENT

In 2019, ABS signed a landmark partnership with digital twin specialist Akselos to explore deploying new computational capabilities to develop industry's most advanced digital twin for maritime assets.

The project unites ABS' industry-leading experience in applying digital technologies to maritime and offshore assets with Akselos' patented technology for modeling huge-scale objects with unrestricted fidelity and simulating their behavior in real time.

Traditional Finite Element Analysis (FEA) has limitations modeling large-scale assets to the fidelity needed for powering next-generation digital services. By combining Akselos' patented Reduced Basis FEA with ABS' maritime and offshore digital expertise, the project aims to create new digital twin techniques that enable accurate modeling of whole-asset performance in various operating environments and lead ultimately to anomaly detection, the capability at the center of predictive analytics.

This invaluable asset management tool will improve uptime, increase reliability and bring a new level of efficiency and focus to maintenance and repair. It is at the heart of ABS digital class, supporting the transition to a condition-based future and away from calendar-based inspection.

By working with Akselos, ABS is transforming this experience into models that will help improve the performance of assets by better predicting and mitigating potential safety issues.



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DIGITAL PILOTS

- ABS and P&O announced implementation of a pioneering project to enable condition-based class surveys, marking a significant step forward in the transformation of the P&O fleet toward a condition-based class model. To bridge the transition, the first vessel in this groundbreaking project, platform supply vessel *Caspian Voyager*, has entered into an extended dry-docking program that will potentially extend its maximum dry-docking period from five to 7.5 years and allow in-water surveys, resulting in higher availability over the asset's life.
 - The historic agreement will see the vessel become the first to employ ABS Nautical Systems® (NS) as its computerized maintenance management system, which will transmit planned maintenance data and condition-based maintenance activities to ABS for the purpose of potentially crediting class survey requirements.
 - The project utilizes ABS' Remote Survey offerings and the ABS Guide on Smart Function for Marine Vessels and Offshore Units, which introduced the industry's first notations on Smart technology applications.
- PACC Offshore Services Holdings Ltd. (POSH) and Pacific Carriers Limited (PCL) also selected ABS NS fleet management software to be part of their digitalization strategy, in which multiple NS modules will support the digitalization of workflows including fleet maintenance, purchasing and compliance. Both PCL and POSH are part of the Kuok Singapore Limited (KSL) Maritime Group of companies, which operates a fleet of 245 vessels including tankers, bulkers and offshore support vessels.
- Arista Shipping is another marine company that began its journey towards smart shipping operations in 2019 with an ocean data agreement with ABS. Arista's fleet and its managed vessels will use data-derived insights from the ABS Metocean Hindcast Data application to guide operational decision-making.
 - In this advanced application, ABS applies data to over a decade of Metocean Hindcast model data from the U.S. National Oceanic and Atmospheric Administration, in order to determine the wind speed, wind direction, wave height, wave period, and wave direction corresponding to a specified vessel's route. This can be compared with a vessel's operational tolerances to guide safer voyages.
- ABS and Samsung Heavy Industries signed a joint development project (JDP) at Gastech 2019 to collaborate on the use of digital technologies for streamlining the design, construction and classification of assets. The project will pilot the use of artificial intelligence to supplement the shipbuilding's testing process.
- ABS, Hyundai Heavy Industries (HHI) and Hyundai Global Service (HGS) signed a framework agreement for digitalization and decarbonization joint activities with an emphasis on the development of new future proof designs. As part of the agreement, HHI, HGS and ABS will work together to implement data tools that address environmental compliance, leveraging the ABS Decision Support Center (DSC).

DIGITIZED SERVICES

DECISION SUPPORT CENTER

In 2019, ABS began development and construction of our DSC, a groundbreaking, state-of-the-art facility for conducting remote verification and monitoring services such as structural, machinery and cyber condition of assets, operational efficiency profiles and analyses – 24 hours a day, seven days a week. Construction of the DSC is scheduled for completion in mid-2020.

Key capabilities of the DSC include:

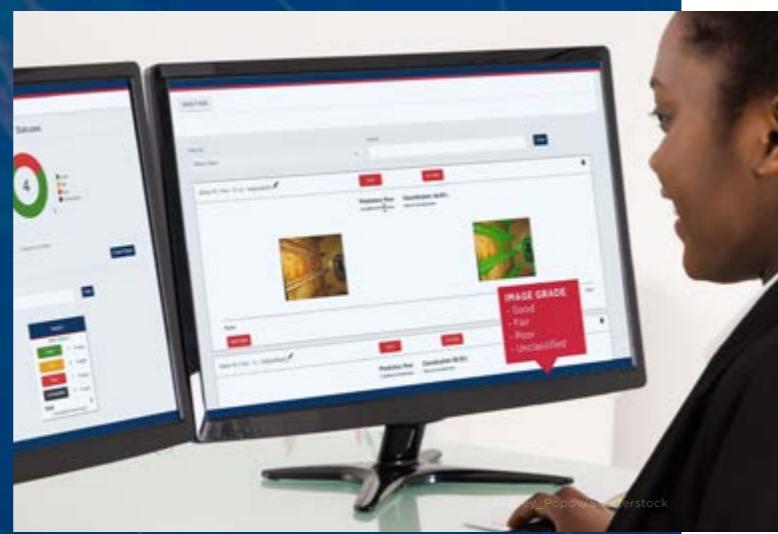
- The visualized foundation for analytics testing and remote monitoring
- Continuous data ingestion for real-time anomaly detection and alerts
- Tracking and receipt of alerts via the ABS Super Map, which shows global marine traffic, plus filtering for viewing ABS-specific customers and ports
- Ability to conduct remote surveys and testing through audio and video technology

ABS is also continuing to build our Predictive Compliance capability focused on three primary areas of risk including: Detentions and Findings Risk; Extreme Weather Risk; and Health, Safety, Security and Environmental Risk. By leveraging and continuously assessing multi-source operational data, we can provide real-time understanding and key insights for proactive class decisions. Through Predictive Compliance, we can predict the risk of a vessel or fleet going out of compliance from class or regulatory requirements as well as charter party compliance requirements, enabling corrective actions to be taken to minimize the chances of a class outstanding, Port State Control detention or contractual violations.

SPOTLIGHT

CO-INNOVATION PROJECT WITH SOFTSERVE AND GOOGLE

In 2019, digital technologies continued to exert their impact on physical reality, as ABS, Google Cloud and software developers SoftServe successfully concluded a pilot project in which artificial intelligence (AI) models were used to detect corrosion levels and coating breakdown on ships and offshore structures. The project demonstrated the accuracy of AI in detecting and assessing structural anomalies commonly found during visual inspection and confirmed the potential for AI to analyze images over time and help users develop insights and understanding of corrosion and coating breakdown trends on their assets.



ABS FREEDOM™ – TRANSFORMING THE WAY WE DO BUSINESS, DIGITALLY

Leading the way in digital class, ABS is transforming the traditional survey process by leveraging the abundance of available data to help our clients move from a calendar-based approach to a continuous, condition-based approach.

In November 2019, we took a major step forward in this journey with the release of ABS Freedom™, a single, integrated database and workflow that is at the center of our data strategy and the foundation for digital class.

An entirely new way of working that increases our capabilities and enables us to do more for our clients in support of our mission, ABS Freedom™ replaces our 15-year-old system for survey reporting and vessel information. From a systems point of view, it represents our biggest single investment in 30 years and one of the most important milestones in our 157-year history.

SURVEYOR WORKFLOW OPTIMIZATION

The unified Freedom workflow itself represents a significant step forward in the digital evolution of class because it affects the primary building block of the classification industry: vessel survey. It provides an easy, intuitive and simple digital way to prepare for, and complete, attendance on a vessel, enabling our surveyors to focus on doing what they do best – delivering surveys with excellent customer service.

CLIENT PORTAL ENHANCEMENTS

Freedom is also revolutionary for our clients because it provides a new, completely revamped customer portal that allows quick access to the data they need for monitoring and managing their fleets, information that is easy to find, easy to read and easy to navigate. Among its standout features are interactive maps and dashboards that greatly improve data visualization and help clients intuitively navigate the site with just a few simple clicks.

This groundbreaking achievement is just one of the many ways in which ABS' client-focused approach strengthens our partnerships with customers around the world, helping them engage the new normal and take advantage of the ever-increasing power of digital technologies to stimulate development and accelerate their own evolutions.

And this is just the beginning. The full transformative power of the Freedom portal will emerge over time, through enhancements that, among other things, will promote increasingly efficient interaction across our activities and provide increasingly sophisticated analytics to help clients derive insight and decision-making benefits from their data.

Transitioning to ABS Freedom is the result of an incredible team effort involving many employees from across the globe who have worked countless hours to make this a success – for ABS and for our clients.



REMOTE SURVEY

Perhaps one of the most powerful symbols of the “new normal” is the evolution of the remote survey. A decade ago, the idea of being able to complete a survey and get credit for it without having a surveyor physically in attendance was little more than a visionary dream, but today it is a real and growing reality.

For ABS, “remote survey” means augmenting traditional survey through the transfer of digital documentation such as reports, photos and videos for non-attendance verification of select surveys. Presently, 11 types of surveys are eligible to be performed remotely.

No longer a dream, remote survey has become part of digitally-driven business-as-usual scenarios for many of our clients around the world. Those who make use of remote survey universally report that the service reduces surveyor logistical costs and introduces scheduling efficiencies that minimize operational disruptions due to survey requirements.

ABS’ Remote Survey Program continued to expand throughout 2019, and now supports the following survey types:

- **Boiler Three-Month Extension Survey:** Traditionally, surveyor attendance has been required when a request is made to postpone the due date of a vessel’s Auxiliary Boilers Survey. Now, under the ABS Remote Survey Program, it is possible to remotely perform: external overall examination of the boiler; examination and operational tests of the safety valve relieving gear (easing gear) and protective devices (alarms and shutdowns). This remote survey coupled with a record review can allow for an extension of up to three months.
- **Concurrent Load Line:** Previously, surveyor attendance was required when a request was made to change a vessel’s freeboard assignments. Under the ABS Remote Survey Program, it is possible to remotely verify that all non-associated marks have been painted out (obliterated) and that the new marks have been painted in using a sharply contrasting color. In addition, the remote survey verifies that any certificates not in use are placed in a secure location.

“ABS has the most comprehensive remote survey services in the marine and offshore industry. It is an offer uniquely geared to the needs of vessel and offshore asset operators as well as equipment providers — and we continue to explore new and innovative ways to expand that offer still further.”

JOSEPH RIVA
VICE PRESIDENT AND CHIEF SURVEYOR
ABS



- **Condition of Class and Statutory Condition:** Vessels with Condition of Class or Statutory Condition that can be verified through documentary evidence are eligible for remote surveys upon ABS review and acceptance of the application. In some cases, Statutory Condition remote surveys require flag Administration authorization.
- **Continuous Machinery Survey (CMS):** Vessels carrying the Preventative Maintenance Program (PMP) notation are eligible for CMS remote survey, which allows the owner or operator to provide documentation for each machinery part item and receive credit without a surveyor’s physical attendance.
- **Drydock Extension:** Traditionally, a drydock extension request required a surveyor to go on board and determine if immediate repairs were needed. Today, within certain restrictions, ABS can send ABS-approved External Specialists to conduct an underwater examination in lieu of drydocking (UWILD) and accept the examination results remotely.
- **Minor Damage Survey:** Minor damage is eligible for remote survey, but within strict guidelines. Generally, the application will include digitally-submitted supporting documentation such as photos, sketches, videos and measurements. This remote survey may require flag Administration authorization, as well as physical examination by a surveyor during the next survey.
- **Outstanding Class Recommendations (OSRs) and Outstanding Statutory Deficiencies (OSDs):** These can be rectified remotely through digital submission of documentation, reports, photos and videos as appropriate, and may require validation at a later date. OSDs are subject to flag authorization.
- **Remote Underwater Examination of Offshore Units:** Offshore units can have their underwater sections surveyed remotely, subject to certain conditions. For example, the examination must be performed by an ABS-approved external specialist and witnessed remotely in real time by an ABS surveyor, which requires a real-time data connection that can handle the audio, video and communication feeds from the inspection equipment.
- **Safety Radio Survey:** Safety Radio Surveys are credited in collaboration with flag authorization and an approved ABS External Specialist who goes on board to test and confirm the functionality of safety-critical radio equipment.
- **Tail Shaft Survey Three-Month Extension:** Digital and communications technologies now make any vessel with a tail shaft eligible for a remote Tail Shaft Survey. Formerly, surveyor attendance was required for visual inspection of the shafting system, verification of the inboard seal, review of previous wear-down and clearance recordings, review of service records, review of test records and verification that no repairs by grinding or welding have been done. Now, owners can submit visual proof and supporting documentation data through the remote survey portal.



SAFETY LEADERSHIP IN A CHANGING WORLD

INNOVATION LIGHTS THE WAY IN CHALLENGING TIMES

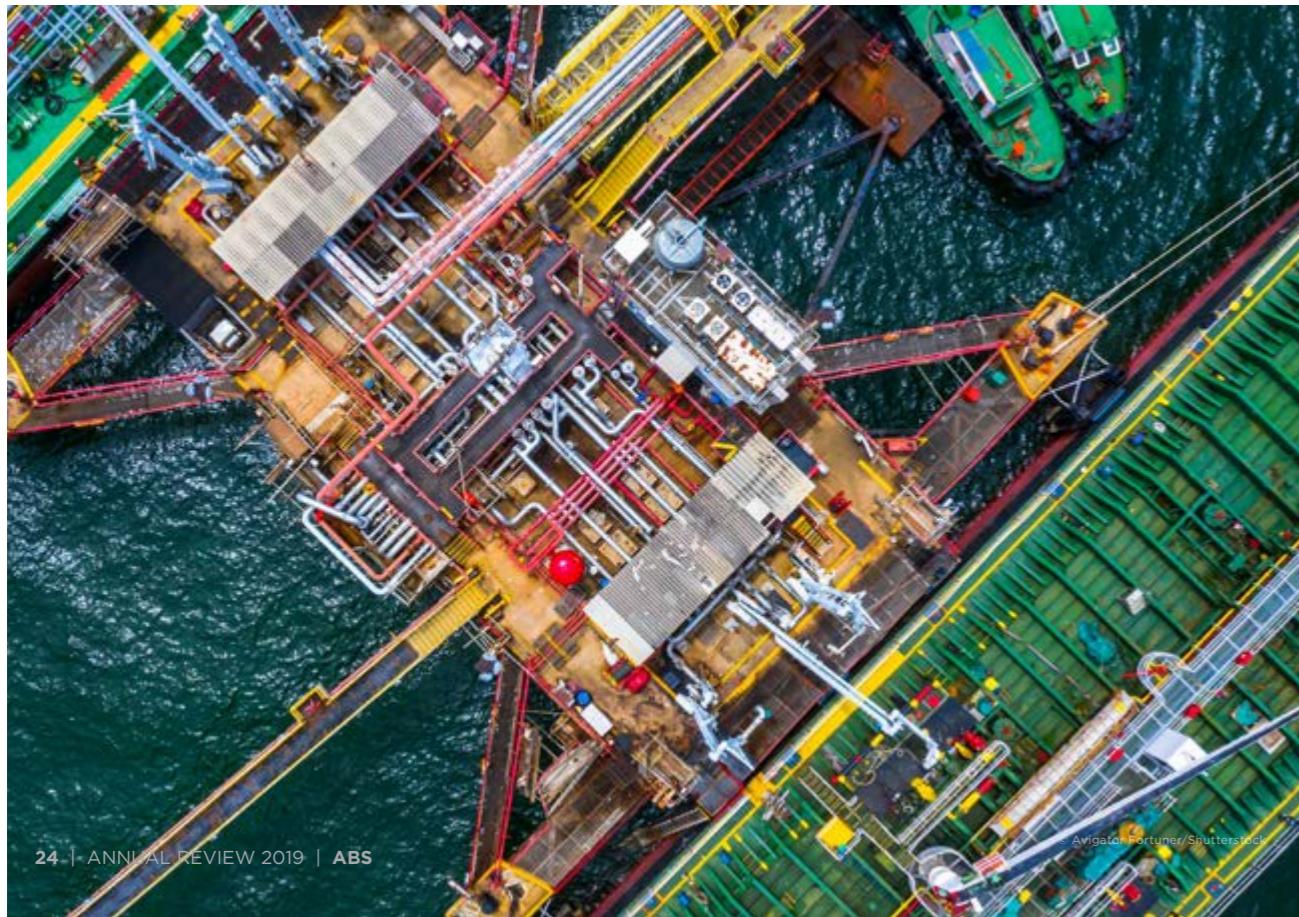
Geopolitical stressors exacerbated the challenges that compromised many marine market trajectories in 2019, as the anticipated recovery from the downturn experienced over the previous decade failed to gather steam.

Overcapacity in the world fleet experienced only a slow correction and venture funding declined significantly relative to the previous year, however, despite the rough waters a general optimism prevailed regarding benefits to be realized from achievements in the decarbonization journey, digital transformation and the technologies of working smarter.

ABS played a key role in assisting a broad range of ventures and boundary-breaking efforts seeking to produce the programs, tools and technologies on which the industry's future will be built.

Dominated by efforts to meet the emissions challenges of 2030 and beyond, such as expanding the list of viable alternative fuels, these projects covered virtually every sphere of activity important to the industry's voyage forward, ranging from personal safety and cyber security to advanced designs for decarbonization and the evolution of smart technologies. Of note were several projects in which ABS worked with industry leaders, innovators and early adopters guiding the development of novel gas carrier designs and new gas-as-fuel technologies.

Throughout the year, many forward-thinking shipyards, operators and manufacturers enlisted the help of ABS, strengthening their efforts through our unwavering commitment to developing practical, safe and sustainable solutions to even the most daunting challenges.



SAFETY

In 2019, ABS completed three straight years without a work-related lost-time injury, an unprecedented achievement in our sector that underscores both our historic commitment to safety and our tradition of leading by example. As an organization, our most valued trait is our dedication to safety in all its forms and in every workspace – real and virtual.

- ABS released its *Guide for Fire-Fighting Systems for Cargo Areas of Container Carriers*, an industry first in that it specifically addresses firefighting and safety systems for the cargo holds of container vessels, locations in which a series of high-profile fires have occurred. Fires involving containers can present a significant risk to the safety of both the crew and the vessel. The Guide specifies ABS requirements for addressing fire safety in four key areas: firefighting for containers stowed on deck, firefighting for containers stowed below, fire safety of the deckhouse, and container hold flooding as a measure for firefighting. Going beyond current Safety of Life at Sea (SOLAS) and related industry regulations, the notations will aid development of robust designs that effectively address this important challenge.
- ABS published its *Guidance Notes on the Use of Remote Inspection Technologies* detailing best practices for the use of pilot-operated Unmanned Aerial Vehicles, Remotely Operated Underwater Vehicles and Robotic Crawlers – equipment collectively known as Remote Inspection Technologies (RITs) – on class surveys and non-class inspections. RITs can reduce risk for surveyors and inspectors by limiting the need to access potentially hazardous locations. This Guidance builds on ABS' *Guidance Notes on Using Unmanned Aerial Vehicles* and signals another step forward in our commitment to new technologies that support safer and less intrusive surveys.

INDUSTRY AWARDS HONOR ABS' LEADERSHIP IN CYBER SECURITY

Industry's progress is, to an ever-increasing extent, based on computers, communications and data, which makes cyber security a firm foundational stone of its future — not only for defense against targeted attacks and random dangers, but also for regular health maintenance of the complex software systems beneath it all. One could argue that, in many ways, cyber security has become an unseen component of both operational effectiveness and workplace safety.

That is why classification societies, as guardians of safety in the maritime and offshore industries, must relentlessly pursue and vigilantly practice excellence in cyber security. It is also why ABS takes special pride in industry's recognition of its leadership in this area.

In 2019, four high-profile industry awards confirmed ABS as the global leader in cyber security for the maritime and offshore industries. The prize for Excellence in Data and Technology Innovation at the Lloyd's List Asia Pacific Awards, along with awards from Lloyd's List Americas, Seatrade and Smart4Sea magazines, underscored growing awareness of the importance of cyber security to the industry's future, widespread recognition of ABS' place in the vanguard of safety leadership in this challenging new area, and the value to industry of the ABS FCI Cyber Risk™ Methodology.

This new methodology, which simplifies cyber risk in marine and offshore environments, was developed following a two-year research contract between ABS and the Maritime Security Center — a U.S. Department of Homeland Security Center of Excellence — led by Stevens Institute of Technology and the U.S. Department of Defense. It measures cyber security risk associated with operational technology, providing clients a calculated risk index for vessels, fleets and facilities. This approach quantifies cyber security risk to give owners and operators both an actionable strategy to reduce cyber risks on board a vessel, and the ability to respond effectively when those risks become realities.



SHIP TECHNOLOGY

ABS has been in the vanguard of advancing ship technology ever since it pioneered the use of computers in naval architecture. Today, the hull envelope has reached a very mature stage of evolution and, for ABS, the challenge to enhance vessel performance lies in applying our accumulated knowledge and expertise to bring forward digital solutions, smart technologies and novel power and propulsion technologies.

- ABS released the *Guide for Smart Functions for Marine Vessels and Offshore Units* (the 'Smart Guide') to help marine and offshore owners and operators capitalize on their operational data. An industry first, the Smart Guide introduces notations that help qualify and utilize smart functions. Through analytics focused on managing asset health and performance, smart functions offer tools for better decision-making and improving asset uptime and sustainability. They also open the door for future condition-based approaches to maintenance strategy and class survey, which will be key factors in industry sustainability over the coming years.
- ABS, Hyundai Heavy Industries (HHI) and Hyundai Global Service (HGS) agreed on a framework for the exchange of Digitalization and Decarbonization (D&D) concepts, to apply to present and future designs. The industry's first D&D ecosystem agreement between class, a shipyard and a ship service company, it supports alternative means of compliance with remote survey capabilities through the newly-commissioned ABS Decision Support Center (DSC), with the ultimate goal of establishing a life-cycle partnership encompassing design, steel cutting and post-delivery of assets.
- ABS and Samsung Heavy Industries (SHI) commenced a joint development project (JDP) on the use of digital technologies to streamline design, construction and classification of assets. The JDP will focus mainly on piloting 3D-model-based plan review, developing a utility to import design data into ABS engineering software, and piloting use of artificial intelligence (AI) to supplement traditional non-destructive testing. As it involves 3D digital disclosure, data exchange, the use of analytics to support new construction processes and a pilot for the survey-of-the-future, the JDP is emblematic both of the digital revolution in the marine and offshore sectors, and of the ways ABS and its innovative partners are leading the way to the industry's future.
- ABS and Daewoo Shipbuilding and Marine Engineering (DSME) announced a JDP in decarbonization and digitalization strategies for very large crude carriers (VLCC) and ultra large container ships (ULCS). The project aims to develop ABS-approved VLCC and ULCS designs that meet IMO 2030 decarbonization goals. The JDP also covers onshore remote monitoring, smart technologies, vessel autonomy and related cyber security concerns.

ABS PRODUCES INDUSTRY'S FIRST GUIDE ON SMART FUNCTIONS

The application of machine learning and other analytics to operational data can increase understanding of vessel performance and thereby lead to better insights and better decision-making and can increase asset uptime by identifying early indicators of failure that can be addressed before a problem arises. That is why ABS' *Guide for Smart Functions for Marine Vessels and Offshore Units* (Smart Guide) introduces three new notations recognizing data infrastructure and health monitoring functions: **Smart INF**, for data INFrastructure related to smart function implementation; **Smart MHM**, for Machinery Health Monitoring; and **Smart SHM**, for Structural Health Monitoring.

The Smart Guide also supports integration of vendor products and services through a product design assessment scheme coupled with a service provider approval process that supports equipment manufacturers, shipyards, owners and third-party software providers as they develop products and services for smart functionality for use on board ABS-classed vessels.



- ABS, Singapore's Nanyang Polytechnic (NYP) and ShipParts.com signed a cooperation agreement aimed at providing standards for the certification of metallic components produced by additive manufacturing (AM), or three-dimensional (3D) printing, for maritime application. The project, part subsidized by the National Additive Manufacturing Innovation Cluster (NAMIC), involves NYP developing the metal printing test plan, procedures and processes, facilitating testing and analysis. ShipParts.com will provide the design criteria for parts produced by 3D metal printing licensed via their consortium of interested manufacturing partners, while ABS will develop new testing and qualification standards and audit the manufacturing process. The qualification will form the bedrock for future certification of 3D printing of critical components for marine use. ABS has already published *Guidance Notes on Additive Manufacturing* to introduce a qualification scheme that defines processes with enough clarity to achieve consistent, repeatable results. The outcome of this research project will be a comprehensive certification process.
- ABS and the Contemporary Amperex Technology Co. (CATL) announced a joint project in research, development and application of lithium-ion battery power for propulsion of future vessels. ABS and CATL will jointly carry out research on technical standards for battery-powered vessels, including key safety-related technologies such as the propulsion system, charging system, power battery compartment layout and fire control. The project also covers research into materials properties, combustion mechanisms and the performance of safety systems, and will support revision of the classification of lithium battery inspection guidelines.

GLOBAL GAS SOLUTIONS

Research and development in 2019 brought forward a diversity of innovations that together advanced technologies for both the cargo carriage and fuel use of natural gas and its principal alternatives. These include deliveries that put innovative equipment in service and several joint efforts dedicated to creating the platforms on which the future will be built. Among them:

- Delivery of the 45,000 m³ ABS-classed *Saga Dawn*. Built by China Merchants Heavy Industry for Saga LNG Shipping, it is the world's first LNG carrier fitted with the innovative LNT A-BOX® cargo containment system, an IMO independent Type A prismatic tank supported by laminated wooden supports and a liquid-tight thermal insulation attached to the hull compartment as an independent secondary barrier.

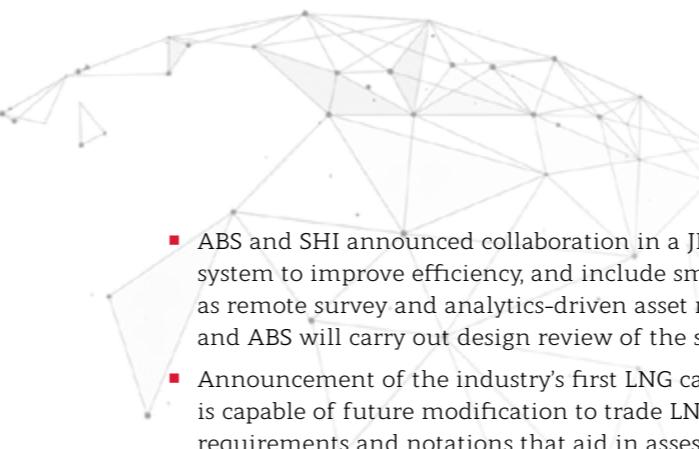


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APPROVALS IN PRINCIPLE REFLECT DIVERSITY OF GAS TECHNOLOGY DEVELOPMENT

One outstanding characteristic of 2019 was the large number of projects dedicated to developing new technologies related to the cargo carriage and fuel use of gas. The diversity of these novel concepts is indicated in the projects that received approval in principle (AIP) from ABS, including:

- **Hudong-Zhonghua Shipbuilding** — for novel designs for a 200,000 m³ LNG carrier and a 147,000 m³ very large ethane carrier (VLEC). The LNG carrier is designed for high efficiency in long-distance, large-scale LNG transport. The VLEC design is tailored for U.S.-China routes, satisfying U.S. Coast Guard (USCG) requirements with a dual fuel propulsion system that uses ethane as the main fuel.
- **Dalian Shipbuilding Group** — designs for two LNG-powered vessels, a 208,000 dwt bulk carrier and a 260,000 dwt very large ore carrier.
- **Jiangnan Shipyard Group** — for designs of a 91,000 m³ very large gas carrier and for a 99,000 m³ very large ethane carrier featuring an IMO Type B cargo containment system of its own development.
- **Deltamarin and GTT** — for an energy-efficient dual fuel newcastlemax bulk carrier design intended to meet current and future environmental targets. The design introduces GTT membrane-type LNG tanks sited aft in a way that exerts no impact on cargo space or hull dimensions.
- **Samsung Heavy Industries** — for an innovative gas expander for LNG reliquefaction systems. The 'X-Reli' LNG Boil Off Gas Expander is designed to optimize low- and medium-pressure operation, which the manufacturer says provides increased efficiency and reliability over existing high-pressure reliquefaction systems.
- **Daewoo Shipbuilding and Marine Engineering** — for a 165,000 m³ ethane/ethylene carrier design featuring novel IMO Type B cargo tanks constructed out of High-Manganese Austenitic Steel (Hi-MN Steel), a cryogenics-capable material that the builder claims is more cost-competitive than traditional Ni alloy steel, while also providing increased reliability and more robust containment.
- **SpaceTech4Sea Project** — for a conceptual design for carbon-fiber LNG fuel tanks weighing up to 80 percent less than conventional tanks of equivalent volume. The initial focus of this effort is to develop a lightweight containment for high-speed vessels having a small to medium tank capacity.



- ABS and SHI announced collaboration in a JDP on a next-generation LNG carrier that will use an air lubrication system to improve efficiency, and include smart-ship technologies to take advantage of evolving advances such as remote survey and analytics-driven asset maintenance. The concept will incorporate smart-ship technologies, and ABS will carry out design review of the structure and arrangements.
- Announcement of the industry's first LNG cargo ready class notation, which confirms that an ethane carrier is capable of future modification to trade LNG cargoes. ABS became the first classification society to develop requirements and notations that aid in assessing an ethane carrier's LNG cargo readiness level.

ABS' GLOBAL SUSTAINABILITY CENTER HELPS INDUSTRY BUILD ITS FUTURE

ABS established its Global Sustainability Center in 2019 to aid the maritime and offshore sectors in this journey. The Center aims to coordinate initiatives geared towards sustainability and decarbonization that cultivate innovation, advance technology and develop solutions that are safe, practical and commercially viable. Services and tools provided by the Sustainability Center assist clients in their journey to Environmental, Social and Governance (ESG) excellence. Sustainability milestones include:

- ABS launched its *Low Carbon Shipping Outlook*, a unique publication designed to help the maritime sector evaluate potential options for low-carbon shipping, and to reaching the 2030 and 2050 emissions goals. The transition to a low-carbon, clean-emissions future challenges industry to find solutions that are commercially viable, technically feasible and safe, and the Outlook provides a guide to the technologies, operational efficiencies and alternative fuels and energy sources needed to get there.



- ABS signed landmark digitalization and decarbonization JDPs with major shipyards that will help address the maritime industry's push to reduce its carbon and greenhouse gas emissions footprint. The JDPs encompass 3D digital disclosure, data exchange, and the use of analytics to support the new construction process, modify existing vessels and pilot surveying of the future. These projects are being completed with DSME, SHI, HHI and Keppel among other industry partners working to shape the future of our industry.
- ABS published its *Advisory on Gas and Other Low Flashpoint Fuels*, offering guidance on available technologies, regulatory requirements and installation and operational considerations for adopting gas or other low-flashpoint fuels. With many operators looking into alternatives such as low flashpoint and biofuels for short- and mid-term solutions to global fuel sulfur limits, the Advisory examines the regulatory requirements for all options as well as the specific benefits and technical challenges of each. It also examines viable fuel solutions that will support the longer-term transition to low and zero carbon fuels.
- ABS published its updated *Best Practices for Operation of Ballast Water Management (BWM) Systems*, designed to help owners experiencing problematic operations due to BWM system design limitations. The report gathers insights and lessons learned during ABS' global program of industry workshops to offer information on best practices for overcoming the key challenges to selecting, installing and operating a BWM system. Key insights provided in the report include discussions regarding recognized needs for ship-specific contingency measures to avoid downtime; system-specific training for shoreside support and vessel crew; and monitoring key data and operational trends.



- ABS published its *Guide for Fuel Cell Power Systems for Marine and Offshore Applications* to support design, evaluation and construction of fuel cell systems for vessels and offshore assets. Fuel cells are widely seen as part of the solution to the decarbonization challenge of 2050. The Guide covers all fuel cell types and focuses on the use of fuel cell systems and arrangements for propulsion and auxiliary systems, both in newbuild and retrofit projects. Release of the Guide followed completion of a joint development project with DSME in the use of hybrid solid-oxide fuel cell and gas turbine generator technology for future-generation LNG carriers.
- ABS will advise on compliance and safety considerations as MAN Energy Solutions (MAN) and the Shanghai Merchant Ship Design and Research Institute (SDARI) jointly develop designs for a low-emission feeder container vessel that will be able to use ammonia as fuel.

The decarbonization challenge directs our industry to transition to a sustainable operations model based on high-efficiency, low-carbon transportation, and compels us all to strive for the new fuels, technologies and operational efficiencies that will get us there.

ABS will continue its sustainability focus on developing services and tools which include:

- Studying the viability of alternative fuels and new energy sources in different shipping sectors
- Analyzing decarbonization options, the impact of seaborne trade growth and IMO targets on new designs
- Using digital technology to simplify transactions and increase operational efficiency
- Certifying, verifying and validating new technology

Today's regulatory landscape is both complex and rapidly changing. The IMO greenhouse gas (GHG) reduction targets cannot be met with current technology, meaning ABS has a vital role to play in helping the industry manage the transition safely. ABS has fostered cooperation between industry and academia, in projects that will develop the tools, technologies, philosophies, practices and programs necessary to building a truly safe and sustainable future.



SAFETY LEADERSHIP IN
A CHANGING WORLD

GLOBAL OFFSHORE

SAFETY LEADERSHIP IN A CHANGING WORLD

GLOBAL OFFSHORE

ABS holds a unique position among the class societies serving the world of offshore energy, because our work is embedded in the foundation of that industry. ABS support was sought when the first offshore platform was built out of sight of land, and every subsequent significant advancement in that sector for a generation was developed under ABS class or with ABS technical assistance – the first jackups, the first floaters, the first drillships and much more. It is not a stretch to state that ABS is the world's premier offshore energy classification society.

Today, more than three-quarters of the world's offshore drilling rigs and nearly half its floating production units are supported by ABS, and the programs and projects of 2019 provided further confirmation of our historic leadership in services for this vital world market.

The overall offshore industry inched towards optimism during 2019 as several sectors, such as subsea, continued a slow recovery that began at the end of the previous year. Drillers, meanwhile, urged into new thinking by years of low oil prices and dropping rig utilization rates, focused on improving operational efficiency and safety, extending the use of automation and remote controls and sensing systems. They adopted revolutionary advances such as the application of new analytical tools to the operational data generated by the sensors aboard their rigs in order to gain insights and better uptime.

Throughout the year, ABS addressed a broad spectrum of concerns as owners and operators sought to get more out of their assets through increased utilization and life extension, while developing ways to help them improve operational safety, leverage their operational data, streamline verification and validation for both new designs and existing assets.



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EXPLORATION AND PRODUCTION

ABS remained the industry leader in drillship, self-elevating mobile offshore drilling units (MODUs), and the semisubmersible MODU sectors in 2019, helping industry improve machinery and structural safety, while collaborating with industry to identify potential safety issues for working assets.

ABS helped bring the concept of floating production, storage and offloading (FPSO) units into reality, having worked with FPSOs and their developers since the technology's debut back in the 1970s. Today, FPSOs and their variations remain the pillars of offshore field development, and in 2019, ABS continued its historical leadership in the floating production sector with about 70 percent of all new units being classed or certified by ABS.

Continuing its historical leadership in the sector, ABS is proud to have classed the ExxonMobil *Liza Destiny* FPSO, the first production facility in Guyana. Converted by SBM Offshore at Keppel shipyard in Singapore with topsides modules fabricated at Dyna-Mac, the FPSO will be spread moored offshore the South American country of Guyana at a water depth of 1,525 meters (5,000 feet) to produce up to 120,000 barrels of oil per day (BOPD). The Liza field is operated by ExxonMobil's subsidiary Esso Exploration and Production Guyana Ltd. in the Stabroek block.

Other FPSO successes include:

- Classification of the ConocoPhillips *Barossa* FPSO, a newbuild FPSO developed by MODEC and built at Dalian, China to operate in Australia
- Classification of the *Reliance KGD6 Ruby* FPSO, a newbuild FPSO developed and built by SHI, Korea to operate in India; and
- Certification of the Shell *Whale* production semisubmersible built by SembCorp in Singapore to operate in the U.S. Gulf of Mexico.

Among our other achievements in offshore exploration and production for 2019:

- ABS partnered with Keppel Offshore and Marine to integrate smart functions into two new drilling rigs, which became the first in the industry to receive Smart Notations under the ABS Guide for Smart Functions for Marine Vessels and Offshore Units. Through this JDP with Keppel, ABS refined its methodology to verify and validate Smart Functions, supporting a more data-centric approach to survey after construction that will ultimately assist owners to move their units into rig-specific condition-based class programs. In a triumph of cooperation between builder and class society, ABS and Keppel underscored their leadership in offshore digital technology by developing the systems with which the rigs will collect data from a range of sensors to monitor machinery and structural health and thereby improve their performance.

PROGRESS TOWARDS GLOBAL STANDARDIZATION IN HP/HT CERTIFICATION AND VERIFICATION

A high-pressure/high-temperature (HP/HT) environment is defined as any reservoir requiring completion equipment or well control equipment with an assigned pressure rating greater than 15,000 psi and/or a temperature rating greater than 350° F. These harsh, extreme drilling environments present a safety challenge to offshore operators and service companies because they exceed the capabilities of existing equipment. This means that operators need to redesign equipment to accommodate HP/HT conditions and carry out advanced planning for modified operational procedures, and in addition submit the redesigned HP/HT equipment for design verification and validation under requirements from the U.S. Department of the Interior's Bureau of Safety and Environmental Enforcement (BSEE).

BSEE requires an independent third party (I3P) review to facilitate approval, certification and evaluation of equipment for HP/HT applications. ABS has acted as an I3P in this area, assisting in design qualification through verification, validation and documentation review of proposed HP/HT equipment, generating the various reports required for final approval of each piece of equipment. Using lessons learned in this service, ABS began establishing the baseline to standardize the certification process of HP/HT drilling equipment and other new technologies.

Through the downturn of recent years and continuing today, offshore operators have faced increased pressure from stakeholders to cut capital expenditure, reduce development time and improve return on investment. This pressure has energized movement towards standardization in certification as a means of reducing cost without compromising safety. In this effort, ABS collaborated with organizations such as the American Petroleum Institute (API), American Society of Mechanical Engineers (ASME) and the International Organization for Standardization (ISO) to put together HP/HT-related standards and with the BSEE to develop HP/HT-related regulatory requirements.

The offshore industry is still in developmental stages regarding HP/HT technology and, as it has done throughout its history when confronting disruptive advances, has turned to ABS for assistance with technology qualification and design verification. Class and certification can give offshore operators, regulators, insurers and the general public greater confidence that the equipment being used to conquer this new frontier is capable of dependable operations.



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- Continuing its history of standing with industry at the leading edge of research and development, ABS classed a unique and innovative self-elevating platform design by Calm Oceans Pte Ltd. Supported by a single column and capable of operating in depths of up to 70m, the Mono-Column Platform-Lite is a self-installing, mat-supported jackup featuring a square hull supported by a single truss column, that incorporates both living quarters and man-riding cranes. Usable deck area is larger than a conventional three- or four-legged jackup of equal size, and the single column does not require pre-loading, which is expected to add operational efficiency and lower risk during installation and jacking operations. In addition, the large mat support provides a solid foundation for operating on soft seabeds and virtually eliminates the risk of punch-through.
- ABS provided life extension services for the risers employed on the Hoover Deep Draft Caisson Vessel (DDCV) for ExxonMobil. The Hoover DDCV, a classic spar design, has maintained class and has been operating in the Gulf of Mexico since 2000. ExxonMobil engaged ABS to evaluate the global integrity of the riser systems used by the vessel and explore the possibility of life extension in a structured and systematic way. The goal was to extend riser design life by 10 years. ABS applied advanced analytical methods to assess the integrity of the vessel's steel catenary risers and top-tensioned risers, performing independent global analysis of all performance metrics including dynamic strength and fatigue, as well as the effects of wave fatigue.
- Supporting an important project in the South China Sea, ABS was called upon by the China National Offshore Oil Corporation to provide certification services for a fixed platform and related subsea pipelines and systems in the Lufeng Four field development. ABS was also awarded classification services for the conversion of a tanker into an FSO that will be used to replace an aging FSO currently on site, and for the life extension of a single-point mooring.
- ABS helped advance production technologies by granting approval in principle (AIP) to two new FPSO designs from MODEC, an industry pioneer that has remained at the forefront of design in that sector for decades. As a result of increases in required crude oil and gas production capacities, FPSO topsides have become bigger and heavier, which has cramped deck area and pushed crude oil storage capacity to the limit. Responding to this need, MODEC worked with Mitsui to develop the new offshore adapted hull (NOAH) and with Dalian Shipbuilding Industry Company to develop the MP350 design, both of which aim to provide the flexibility and increased capacities needed as the oil and gas industry moves into the future.



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ADVANCING GLOBAL SUBSEA TECHNOLOGY

Offshore oil and gas development in green or brown fields requires subsea equipment from the wellhead, subsea trees and pipelines to the dynamic risers for transporting oil and gas to the surface vessels. Investments in subsea technology over the past decade have paved the way for increased subsea development.

In China and Vietnam, subsea facilities are treated similarly to production vessels requiring independent verification and classification for regulatory compliance, and ABS continues to provide technical expertise to support this gradually maturing market. In 2019, ABS was awarded third party review and certification for significant subsea projects including the Husky Liuhua 29-1, part of China's first deepwater gas field development, and China National Oil Corporation (CNOOC) Lufeng 15-1/14-4, a development with four oil fields using subsea equipment to transport production from adjacent fields and from the two fixed platforms located in Lufeng 15-1 and 14-4. Of the two fixed platforms, Lufeng 15-1's 286 meters (938 feet) water depth is the deepest fixed platform in China.

In the Gulf of Mexico, ABS experienced steady demand in the subsea market for our certification and verification services for dynamic risers, HP/HT equipment, and life-extension of production platforms and production risers. In other areas, such as Africa and Brazil, ABS continued to expand its engineering review for subsea and land-based pipeline development, guidance on safety considerations, and verification and validation activities.

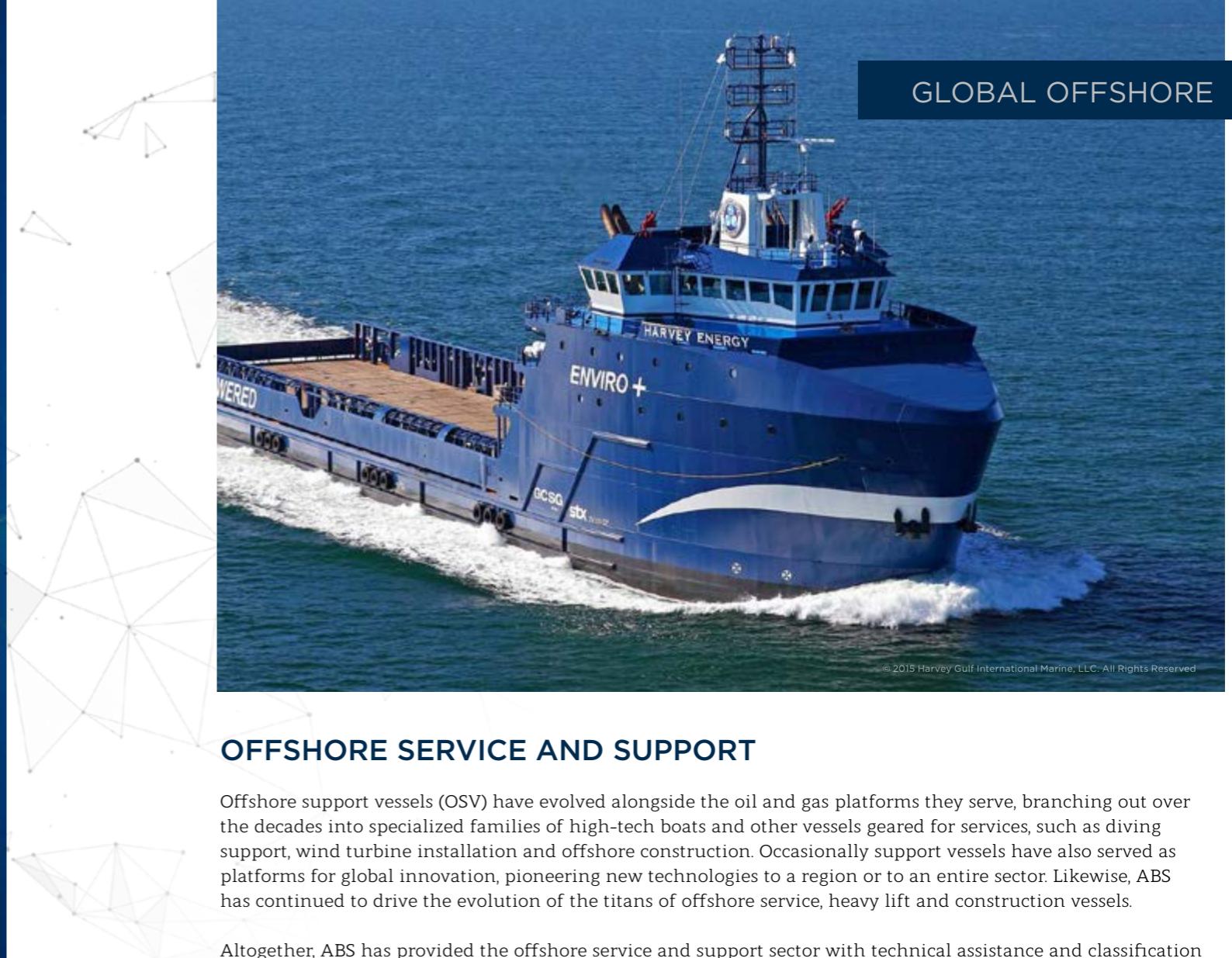
Along with increasing global subsea development comes an increased complexity of the enabling technologies and systems involved. At ABS, subsea technology, electrification and communication research initiatives are underway in our technology headquarters in Houston and in our global technology centers around the world supporting safe and reliable subsea development. We are also partnering with industry and universities for continued development of technical guidance for the design, maintenance and life extension of subsea assets.

Looking ahead, ABS sees increasing industry interest in subsea integrity management with a focus on planning, maintaining and extending the longevity of structures, equipment, and systems. Already in high demand, aging subsea equipment inspection and maintenance programs range from direct inspection of equipment to overall existing asset integrity management.

As the industry evolves, ABS is committed to being a trusted advisor continuing to lead with dedication to our mission of safety excellence.



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OFFSHORE SERVICE AND SUPPORT

Offshore support vessels (OSV) have evolved alongside the oil and gas platforms they serve, branching out over the decades into specialized families of high-tech boats and other vessels geared for services, such as diving support, wind turbine installation and offshore construction. Occasionally support vessels have also served as platforms for global innovation, pioneering new technologies to a region or to an entire sector. Likewise, ABS has continued to drive the evolution of the titans of offshore service, heavy lift and construction vessels.

Altogether, ABS has provided the offshore service and support sector with technical assistance and classification services ever since the first fishing vessels were adapted to become the first OSVs and continued this tradition in 2019 through participation in a number of advances and forward-looking projects.

- ABS provided classification services to the world's first "tri-fueled" OSVs, for Harvey Gulf International Marine. The *Harvey Energy* and *Harvey Supporter* will be retrofitted with battery/converter systems expected to significantly enhance the efficiency and environmental performance of the vessels, an achievement that will be reflected in the ABS class notation ESS-LiBATTERY. The batteries will power harbor movement and assist hotel loads when docked, reducing noise and pollution levels in the harbor area and adding back-up power to dynamic positioning operations.
- ABS and vessel operator SEACOR jointly won the "Hybrid Power and Propulsion Award" at the Sulfur Cap 2020 Conference in Amsterdam, highlighting the potential impact of batteries on emissions and the value of collaboration between operators and classification societies in realizing that potential. SEACOR integrated a lithium-ion battery system onboard its OSV, *SEACOR Maya*, a 285 ft dynamically positioned diesel-electric vessel, and ABS provided technical review, survey and verification of equipment and installations on board. The batteries have reduced the vessel's average fuel consumption by 20 percent, convincing SEACOR to convert up to nine more vessels.
- ABS granted an AIP to China Merchants Offshore Technology Research Center for design of the OOS *Zealandia*, a new semisubmersible crane vessel that, when built, will have the largest total lifting capacity in the world: 25,000 metric tons (mt), provided by two fully-revolving 12,500 mt cranes. Featuring a clear deck space of over 11,000 square meters, the unit is designed to lift and transport large offshore structures on its main deck, either for installation offshore in a single lift or for decommissioning old units in one piece and transporting back to shore for re-use, upgrade or dismantling and disposal. The vessel features a winterized main deck and will carry the ABS ice class notation for operation in a first-year arctic ice environment, while the accommodations design will support operation in remote areas for extended periods. Besides offshore installation or decommissioning, the vessel is also fit for other markets such as subsea installation, for which purpose the cranes have been designed with a heave compensation system.



OFFSHORE WIND

Floating installations currently account for a very small part of the world's total offshore wind farms but show promise of becoming increasingly important as global energy markets look to renewables in their quest for better sustainability.

In 2019, ABS classed the largest floating wind turbine yet built, an 8.4-megawatt (MW) unit installed offshore Portugal. The first of three ABS-classed, semisubmersible-type units designed by Principle Power and designated the Windfloat design, the trio will use MHI Vestas turbines for a total generating power of 25 MW and together will form continental Europe's first larger-scale floating wind farm.

Through this and other projects in development, ABS has remained in the vanguard of technology assistance to the floating offshore wind sector, working with designers and operators on risk and reliability solutions for these new installations. ABS has been instrumental in the formulation of global standards for wind platforms, notably chairing the committee for the International Electrical Commission on global standards for the design and fabrication of floating wind installations, and also contributing to standards for U.S. Offshore Wind Farms in the American Wind Energy Association's Offshore Compliance Recommended Practices initiative.

Among other forward-looking projects for the offshore wind power sector benefiting from ABS assistance during 2019:

- ABS was selected to provide classification services for Tranche 2 of Scotland's Kincardine floating offshore wind development for Aberdeen Bay. The project consists of five semisubmersible-type floating units supporting 9.5 MW turbines, each of which will be moored in water depths of 60 to 80 meters. Estimated to cost as much as £350 million (\$445 million), when completed the 50 MW wind farm is expected to generate up to 218 GW of electricity per year, said to be enough to power 55,000 homes.
- ABS granted AIP to VARD for design of a Jones Act service operations vessel (SOV), the primary functions of which include accommodation, personnel transfer, and the storage of spare parts and tools for offshore wind farms. The design is optimized to reduce motions and accelerations in all degrees of freedom for better operability and comfort, while also being environmentally friendly with a focus on low fuel consumption.



- ABS granted an AIP to Neptun Ship Design for its wind turbine transport vessel design, which when built will be the first such vessel to support transporting parts for turbines greater than 9 MW. Having such capacity available will allow wind turbine manufacturers onshore to produce full-length welded towers ready for installation offshore. The energy-efficient vessel is designed to pick up components direct from a supplier's berth and either transport them to an offshore harbor or feed them to an installation vessel.
- At the commencement of the 2019 International Workboat Show in New Orleans, ABS focused attention on the growing offshore renewable energy market through a session of its Offshore Focus Series entitled "Offshore Renewables: Leveraging Fleet Capabilities to Support Demand." Owners, designers, developers and shipyards gathered to hear leading experts from the offshore wind community address future development in the U.S. and understand how the industry can support this growing development with both new and existing vessels and technology.

OFFSHORE AQUACULTURE

Recognizing both humanity's need for open ocean fish farms and the aquaculture industry's need for practicable standards validated through experience, ABS applied its seven decades of experience with offshore oil and gas structures to produce its *Guide for Building and Classing Offshore Fish Farming Installations*. Virtually all known types of ocean fish farm design have predecessor technologies developed for offshore use – for example spars, column-stabilized units, platforms and ship-shape vessels, as well as non-buoyant installations. The Guide provides class requirements for the design, construction, installation and survey of non-self-propelled, sited offshore fish farms and addresses such major elements as hull structure, mooring, foundations and onboard equipment not related to the aquaculture systems.

ABS also published the *Guide for Building and Classing Aquaculture Service Vessels* providing the class requirements for design, construction and survey of various self-propelled vessels intended for unrestricted service, which are primarily engaged in aquaculture operations.





SAFETY LEADERSHIP IN
A CHANGING WORLD

GLOBAL GOVERNMENT

SAFETY LEADERSHIP IN A CHANGING WORLD

GLOBAL GOVERNMENT

Our uncompromising dedication to safety enabled by robust digital technologies energizes every area of our activities, especially our work with global government organizations.

SUPPORTING THE U.S. GOVERNMENT

The relationship between ABS and the U.S. government dates back to World War I, when the government sought assistance from ABS in creating a larger and up-to-date merchant marine to support the war effort. Over the century since, ABS has rendered invaluable assistance to numerous U.S. government organizations, helping realize important advances in engineering, technology and construction.

For more than 100 years, ABS has been the official classification organization of the United States and, under U.S. law, the only classification organization permitted to class U.S. Government vessels. There are over 200 Government-related ABS-classed vessels in the U.S. alone – a vast fleet that benefits from our committed support and dedication to advancing technology in the service of safety. Today, ABS continues to provide steadfast support for the U.S. Government and its required safety regimes, through classification services that help the Coast Guard, Navy and other Government shipowners maintain uninterrupted naval, law enforcement, research, survey and logistic operations.

- ABS' long history of collaboration with U.S. Government agencies and support of our Armed Forces was commemorated in 2019 when Members of Congress, congressional staff, representatives from Federal agencies and a number of industry leaders gathered to celebrate U.S. Maritime leadership in a reception on Capitol Hill. The theme of the event, "Celebrating American Support and Leadership," was explored during the evening through addresses, remarks and a timeline video highlighting the important moments in U.S. history when ABS provided critical support to the U.S. Government.
- The pioneering condition-based class program between ABS and the U.S. Navy's Military Sealift Command (MSC) was prominently featured in a keynote presentation to the American Society of Naval Engineers' annual conference. As part of the condition-based class program, ABS has defined a digital asset framework that encompasses everything from data collection and pre-processing, to a digital twin that maintains and analyzes the data, to visualizations and outputs that support decision-making. Condition-based classification will enable operational commanders to objectively assess mission ready priorities and, in partnership with ABS, schedule surveys and repairs to better support each vessel's operational commitments. Having a greater understanding of the condition of its vessels, MSC can better understand their asset integrity needs and perform preventative maintenance and repair before failure occurs. The condition-based class approach allows ABS to tailor onboard survey activities based on the actual condition of a vessel's critical structures and machinery, thus optimizing survey times relative to ship operations and, thereby, helping Naval vessels maintain a constant state of readiness.



- ABS renewed its commitment and support for the U.S. Coast Guard (USCG) through the development and execution of a comprehensive Memorandum of Understanding to serve as the backbone for all future ABS and USCG classification efforts. The USCG also extended its contract with ABS to support the Polar Security Cutter and Waterways Commerce Cutter programs. As part of these programs, ABS will class the first hull of the USCG Polar Security Cutter under contract with VT Halter Marine.

SUPPORTING INTERNATIONAL GOVERNMENTS

ABS continued to grow and develop its global partnerships in 2019, expanding the breadth and depth of its work with international governments.

- Recognizing that Naval vessels around the world face an increasingly sophisticated array of dangers, ABS updated its *Guide for Building and Classing International Naval Ships* to help combatant and non-combatant vessels keep pace with the numerous challenges they face. The Guide supports the creation of more reliable and mission-ready fleets, strengthening their safety and protection against a range of threats. The Guide features new sections on mission threats protection, including ballistics, fragmentation, and air blast protection. The new chapter on ballistics and fragmentation introduces technical guidance for achieving a level of protection for naval ships against direct fire weapons, based on mission requirements, anticipated threats and results of vulnerability assessments.
- 2019 also saw introduction of the new ABS NavalSafe notation, which determines safety and performance standards for government combatant and non-combatant vessels in line with the North Atlantic Treaty Organization's Naval Ship Code. Through compliance with the code, governments can learn from international best practices, realize the benefits of cost-effective regulation and demonstrate commitment to achieving greater levels of safety to stakeholders.
- The Canadian Department of National Defence (DND) assigned Recognized Organization (RO) status to ABS, meaning ABS is now authorized to survey non-combatant vessels and undertake certification activities in key hazard areas identified by the Naval Ship Code. This is a further step in a progression that began in 2017, when ABS was selected as the exclusive classification organization for all non-combatant vessels in service with the Royal Canadian Navy. That selection was followed by an expansion of ABS class and certification services to the entire Canadian Coast Guard fleet in 2018. This latest milestone further strengthens ABS' deep relationship with the Canadian Government and its commitment to cooperation for the advancement of fleet safety and reliability.
- ABS, the Royal Canadian Navy (RCN) and Defence Research and Development Canada (DRDC) also announced a pilot program to deliver the ABS Digital Asset Framework for the RCN's Maritime Coastal Defence Vessels. The ABS Digital Asset Framework forms the foundation of a broader condition-based class program that transforms ship classification from a calendar-based schedule to a condition-based model. In the pilot program, which starts with the HMCS Saskatoon, a network of data models will be generated from a suite of ABS digital solutions which include advanced condition analysis tools. This network of data models will support the execution of an integrity management program developed specifically for the RCN. The multi-year pilot program will enable the RCN to monitor the condition of the vessel throughout its remaining service life using digital twin technology and advanced ABS analytics to identify anomalies, guiding inspection and maintenance planning.

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SAFETY LEADERSHIP IN
A CHANGING WORLD

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SAFETY LEADERSHIP IN A CHANGING WORLD

ABS GROUP OF COMPANIES, INC.

ABS GROUP OF COMPANIES, INC.

CHARTING OUR COURSE: LEADING WITH DATA-DRIVEN RISK AND RELIABILITY SOLUTIONS

2019 was a transformative and dynamic year for ABS Group of Companies, Inc. (ABS Group), which encompasses safety and risk consulting operations across the Americas, Europe, Middle East and Asia Pacific regions. ABS Group renewed its focus on resolving customer challenges in key market sectors and repositioning for future growth in the global marine and offshore industries to support ABS as a leading classification organization.

ABS Group shifted gears in the first quarter to lay the groundwork for becoming a more agile, customer-focused and data-driven organization, reorganizing for a new decade with clarity of mission to reduce operational risk and uncertainty in an era of evolving risks and increased digitalization. ABS Group further strengthened its resolve to innovate with clients in need of digital solutions and began investing in and leveraging the latest digital tools and techniques to help clients perform better and protect their most critical assets, the public and the environment.

Staying true to the enterprise's core values around integrity, fostering a proactive safety culture and ethos focused on customer needs, and making strategic investments in people and new capabilities has positioned ABS Group into a competitive business in 2020.

STRATEGIC SHIFT TO GLOBAL MARINE AND OFFSHORE

Critical assets designed to seek, produce and harness the energy resources that drive our economy require careful maintenance and management strategies to optimize their service life and performance. In addition, those assets must operate with the appropriate levels of safety and compliance in the highly regulated

PROJECT PROFILE

FOSTERING HSE/PROCESS SAFETY EXCELLENCE FOR MAJOR OPERATOR IN DEEPWATER GULF OF MEXICO

In 2019, ABS Group was contracted by one of the largest U.S. oil and gas companies with global reach in the Middle East, Latin America and Africa to assess the company's offshore production facilities in the deepwater Gulf of Mexico for regulatory compliance condition and to determine a path forward to aid in the full life cycle of maintaining and/or decommissioning these assets. Combining nearly 50 years of expertise delivering technical engineering and risk-based services, ABS Group is helping the energy major assess the safety, integrity and reliability of the assets' topside production equipment and machinery, improve Health Safety and Environment (HSE) process and safety management system performance, and augment any gaps in data collection and data management.



industries we serve. Operators and owners also must keep pace with technological innovation and remain competitive in a rapidly changing, increasingly connected business landscape. Digitalization has become a market reality for the maritime sector, and both the marine and offshore industries are only now beginning to understand the impact of evolving cyber risks as a disruptive threat to operations.

Understanding the client needs of today and tomorrow, ABS Group made a strategic shift to focus on these key markets and strengthen the organization's data-driven enterprise asset management (EAM), cyber security and risk and reliability capabilities.

Globally, ABS Group made major investments to develop digitally enabled and mobile solutions across the commercial, industrial and government sectors. In 2019, ABS Group provided risk-based inspection and engineering studies utilizing the latest digital tools and creating intelligent maintenance and reliability strategies for next-generation vessels.

REDUCING RISK, IMPROVING DATA CAPTURE FOR MARITIME OPERATIONS

ABS Group began providing non-classification technical services over 45 years ago and continued to build on this heritage in 2019 by setting standards of excellence in the global marine and shipping industry in the areas of safety, risk, integrity and reliability. Our team assisted shipowners and operators with maintaining the efficient operation of vessels of varying ages through the Condition Assessment Program, which provides ratings for ships carrying cargo, such as bulk oil, freight and LNG. For marine clients, ABS Group delivered feasibility studies, independent engineering review – including life extension studies to optimize assets for extended service life – and third-party in-service inspections.

New regulations and operating requirements also placed increased pressure on shipowners and their crews to gather the information required to demonstrate compliance and improve the performance of their ships ahead of IMO and other regulatory deadlines.

ABS Group's proprietary fleet management software solutions support our clients' digital journey through compliance management and mobile applications that deliver insights in real time, whether on board or onshore, to drive safety and improve performance. In 2019, ABS Nautical Systems® (NS) continued to build the fleet management platform of the future with technical support from its facility in Pune, India, adding the most mobile applications available on the market today, including mobile apps for compliance management and crew safety. Recognizing the need to expand reliability-based services to the marine community, NS augmented its EAM capabilities and condition-based maintenance solutions for global fleets powered by the NS Enterprise software.

In 2019, NS remained a critical partner in support of classification activities, and its advanced fleet management system continued to enhance operational visibility and support faster – more accurate – decision-making on ABS-classed vessels. Globally, NS doubled the number of vessels powered by NS Enterprise in the Asia Pacific region to 400 and continued to provide a fleet management system designed with mariners at the center – improving emissions control in international seas and facilitating compliance throughout the nation's inland waterways.



CYBER SECURITY: A BUSINESS IMPERATIVE FOR GLOBAL ASSETS

The push for digitalization is driving the need for greater cyber protection across both information technology (IT) and operational technology (OT) systems. Increased connectivity between IT and OT assets continued to expand cyber risk exposure for marine and offshore clients, making their operations vulnerable to potential disruption, downtime and serious safety, financial and environmental consequences. In support of its digital technology development and efforts to protect critical assets and infrastructure, ABS Group appointed a Global Head of Cyber Security to work as a strategic partner and co-creator of cyber risk solutions with industry, regulatory and insurance stakeholders. To assist the marine and offshore value chain in managing the threat of a cyber incident, ABS Group began investing in full-suite cyber capabilities delivered through the new Cyber Risk Reduction and Cyber Risk Rating (CybeR²) Program.

In 2019, ABS Group continued to support international drilling contractors and owners of marine and offshore assets in securing their industrial automation control systems using the award-winning ABS FCI Cyber Risk™ method. In the U.S., ABS Group developed the nation's first facility security officer (FSO) cyber security training course addressing post-9/11 security measures for ports and terminals and offering specific guidance on the effective implementation of the National Institute of Standards and Technology (NIST)/U.S. Coast Guard Cyber Security Framework.

Globally, ABS Group carried out cyber risk and safety assessments on board vessels sailing in the Americas, Europe, Middle East and Asia Pacific regions. ABS Group also collaborated with Atos, a global leader in the IT, computing and cloud technology space, to deliver the first end-to-end IT/OT cyber security solution for global marine and offshore operations. By year-end, ABS Group began focusing efforts on helping mariners demonstrate compliance with IMO's Cyber Risk Management Guidelines for 2021 and other international standards.

PROJECT PROFILE

IDENTIFYING AND MITIGATING HAZARDS IN NEW LNG PLANT DESIGNS

In 2019, ABS Group assisted a large, international engineering and construction firm in facilitating multi-month process hazard analyses (PHAs) for several new LNG facilities proposed for locations in the U.S. and Australia. As part of these projects, three different proprietary LNG technologies were analyzed. Our engineers teamed with both the owners' and E&C company personnel and applied the hazard and operability (HAZOP) technique to help identify hazards associated with the new LNG plant designs. In addition, the teams used layer of protection analysis (LOPA) to further analyze high-risk accident scenarios to understand whether sufficient safeguards existed or whether additional safeguards were necessary to meet risk tolerance criteria. The PHA teams made numerous recommendations, including providing additional engineered and/or administrative safeguards and training, to help reduce the risk of potential accident scenarios associated with each LNG plant design.



ONSHORE OIL, GAS AND CHEMICAL

In 2019, ABS Group expanded its resources to support oil and gas/petrochemical midstream, downstream and LNG plant operations as the U.S. gas export market continued to grow. This investment will help ABS Group's onshore business unit capitalize on the impact that expanded oil and gas capacity in North America brings to industry as both an attractive fuel and a lower cost feedstock. Our Asset Integrity Management team is now supporting two major North American natural gas processing and transportation companies to manage pipeline safety and reliability with data analytics and machine learning to streamline the process of data collection and field inspections. Globally, ABS Group is supporting a major national petroleum and natural gas company based in the Middle East with risk-based Building Risk Assessment services across its Middle East and Asia-Pacific facilities.

Supporting the U.S. Chemical Safety Board and U.S. Department of Homeland Security in 2019, ABS Group's Extreme Loads and Structural Risk (ELSR) team continued to provide highly specialized engineering and blast testing services at its world-class facility in San Antonio, Texas.

DATA-DRIVEN PROCESS SAFETY SOLUTIONS FOR MIDSTREAM OPERATIONS

As a continuation of its North American Oil and Gas initiative launched four years ago, ABS Group expanded its business in the midstream segment by helping companies improve their integrity management, implement pipeline safety management best practices and prepare for compliance with evolving U.S. regulatory requirements, in particular with the U.S. Pipeline and Hazardous Materials Safety Administration (PHMSA) Future of Data Operations project outlined below.

A VITAL ALLY TO GOVERNMENT AGENCIES

A vital ally to public organizations in learning how to understand and manage risk, ABS Group's Global Government team has worked with key agencies for over 20 years, creating enterprise-level security and risk management solutions that help defend the nation's most critical infrastructure. This team of multidisciplinary risk analysts and consultants addresses some of the world's toughest challenges, innovating with clients to bring resiliency initiatives to the forefront.

MITIGATING PUBLIC RISK, BUILDING RESILIENCY AND INNOVATING FOR THE FUTURE

In 2019, ABS Group continued its support of key federal agencies, including the U.S. Coast Guard (USCG), U.S. Department of Transportation and U.S. Department of Homeland Security (DHS). Working closely with the Government team, ABS Group's ELSR division assisted affected communities through damage assessments, incident investigations and forensic assessments globally as they recovered from natural disasters and other public safety hazards. ABS Group was selected to provide project management services to DHS's National Risk Management Center (NRMC). NRMC is the Cyber Security and Infrastructure Security Agency's (CISA) planning, analysis and collaboration center working to identify and address the most significant risks to the nation's critical infrastructure. Our efforts help establish a business framework facilitating NRMC's management of numerous strategic initiatives which address these critical risks.

In alignment with our longstanding support of USCG along with ABS' heritage in the maritime sector, ABS Group also began providing specialized training to USCG marine inspectors on board liquified gas carriers and tank vessels in 2019. This work leverages both ABS Group's and ABS' subject matter expertise in vessel design, construction and operation to provide USCG personnel with the specialized training necessary to enhance their knowledge and understanding of these unique maritime vessels.

ABS Group also evolved its data-driven risk solutions and cloud-based technologies as part of the digital transformation changing the way both governments and the transportation industries communicate and work. Building on the digital capabilities already under way to help agencies become more effective and efficient in visualizing, mapping and mitigating risk, ABS Group's Government team made significant improvements to our data analytics products and services. Use of these technologies is the vision for the future of risk management, prompting ABS Group to launch the Product Development and Innovation Center (PD&I Center) in December 2019. The PD&I Center will help enable clients to

PROJECT PROFILE

PROTECTING THE NATION: DISCOVERY OF EMERGING AND DISRUPTIVE TECHNOLOGIES

A U.S. government agency needed to build a repeatable, scalable process for the discovery of emerging or disruptive technologies that may affect the mission to counter weapons of mass destruction, such as chemical, biological, radiological or nuclear weapons. ABS Group is part of a multidisciplinary team providing the agency with a system to meet that need, leading and supporting work on all components with a combination of custom software development. Our services include the creation and administration of an expert elicitation platform, as well as data mining and machine learning-based text analytics components, expert elicitation methodology development and implementation, and measures for compliance with government information assurance/cyber security requirements.



innovate and become more informed in the strategic use of data to make operations more safer, more secure and more reliable into the next decade. Quickly leveraging the skills and technologies of the PD&I Center, the Oil, Gas and Chemical business unit and PD&I Center are developing a solution for digital collection and management of inspection data for launch in 2020.

ADVANCING THE SAFE TRANSPORTATION OF ENERGY WITH DATA OPERATIONS

The mission of the Pipeline and Hazardous Materials Safety Administration (PHMSA) is to protect people and the environment by advancing the safe transportation of energy and other hazardous materials that are essential to our daily lives. ABS Group is supporting the Office of Hazardous Materials Safety to evaluate and improve data management, analysis and visualization capabilities. To do this, ABS Group's Global Government team, based in Arlington, Virginia, is defining and implementing a vision for centralized and automated data management, along with enhanced analytics, to improve data driven decision-making across the organization. Proper data preparation and management will allow a more in-depth picture of PHMSA activities with the same manpower and greater transparency into PHMSA's regulations and activities. In addition, the team is delivering organizational change recommendations needed to achieve the desired program outcomes. This important work will support OHMS in making informed risk-based decisions that promote the safe transportation of hazardous materials.

INDUSTRIAL MARKETS

ABS Group applies its experience in safety and risk management, performance optimization and quality assurance to other diverse markets, including aerospace, automotive, commercial properties, mining, pharmaceuticals and other process-driven industries. In 2019, ABS Group's Asset Performance Management service line continued to help clients in these markets reduce maintenance costs and adopt world-class asset management practices.

INNOVATING TO OPTIMIZE RELIABILITY AND PERFORMANCE

ABS Group provides fully integrated EAM systems expertise and reliability-based engineering solutions across the industrial sector, servicing clients in the agribusiness, commercial, energy, facilities management, manufacturing and pharmaceutical spaces. Key services delivered across this value chain include helping organizations apply the latest digital solutions and techniques to lower maintenance costs, manage and prioritize critical assets, upgrade or implement EAM software systems and optimize business processes for improved asset performance.

Our reliability engineers continued to educate a diverse range of clients on how to adapt advanced technologies and analytical tools that leverage EAM systems data to improve operational effectiveness and efficiency. ABS Group enhanced its reliability capabilities in 2019 to deliver more systems knowledge and applications powered by Internet of Things (IoT), predictive and prescriptive analytics, artificial intelligence and machine learning programs.

A major development in 2019 was the joint release of the Validated Maximo in the Cloud product, an IBM Maximo EAM solution for the Life Sciences market based in a cloud environment supported by product partner Projetech Inc. This was the first Maximo as a Service (MaaS) product available as of 2019 to help pharmaceutical, medical device and biotechnology companies validate their EAM systems and comply with the latest FDA regulatory requirements.

DRIVING HSQE SUSTAINABILITY, INCREASING CONSUMER CONFIDENCE

ABS Quality Evaluations, Inc. (ABS QE), the management systems certification subsidiary of ABS Group, remained a world-leading certification body providing accredited management system certification audits, supply chain assessments, and training services in over 40 countries. In 2019, ABS QE strengthened its commitment to certifying and guiding organizations in critical areas such as quality, safety, environmental, corporate social responsibility, risk and asset management. ABS QE joined as an auditor member of the Association of Professional Compliance Auditors (APSCA) to advance social compliance activities and workplace conditions addressed in the Social Accountability (SA8000) labor standard, and the Business Social Compliance Initiative (BSCI). SA8000 and BSCI are internationally recognized standards requiring global brands and retailers to uphold the highest standards in social performance and corporate responsibility for increased consumer confidence in the workplace.

In addition, ABS QE continued to focus on ISO 45001 occupational health and safety conformance which became the first globally recognized management systems standard with a goal of reducing occupational injuries and diseases in the workplace. A major milestone in 2019 was certifying the City of San Antonio's Office of Risk Management – Safety Division to the ISO 45001 standard, which encompasses health and safety activities across Solid Waste Management, Parks and Recreation, Transportation, Capital Improvement (Building and Equipment) and Development Services. Among the first global cities to be certified, San Antonio's government raised the bar for cities across the nation to prioritize the need to reduce workplace risks and create better, safer working conditions.

Globally, ABS QE continued to deliver solid financial performance by focusing in key market segments including Transportation, Oil, Gas and Chemicals, Retail, EPC and Government delivering best in class compliance audits and certificates towards the ISO 55001:2014 (asset management), ISO 9001:2015 (quality management), ISO 14001:2015 (environmental management), AS9100D:2016 (aerospace quality management), IATF TS 16949:2016 (automotive quality) and ISO 27001:2013 (Information Technology) standards.

REDEFINING SAFETY AND OPERATIONAL EXCELLENCE

In 2019, ABS Group continued to adapt to new challenges in a changing marketplace, with our global network of operating companies dedicated to addressing the needs of diverse industries worldwide. ABS Group is focused on adding value to the key industry verticals of marine and offshore, oil, gas and chemical, government and industrial, and will continue to redefine safety and operational excellence as a strategic partner to commercial, industrial and government clients.

PROJECT PROFILE

NUCLEAR PHYSICAL SECURITY ENGINEERING AND CONSULTING SERVICES

ABS Group recently completed a year-long project providing nuclear physical security engineering and consulting services at nuclear units currently under construction, which will be the first in the United States to use Westinghouse AP1000 advanced pressurized water reactor technology. The project included several tasks ranging from vehicle crash barrier designs to performing vulnerability assessments that examine the adequacy of plant security defenses. The deliverables for this project were a series of calculation documents that demonstrate compliance with Nuclear Regulatory Commission (NRC) security regulations.

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Dennis M. Houston

T. Peter Pappas

ABS GROUP OF COMPANIES, INC. CORPORATE OFFICERS

Ryan P. Moody
President and Chief Executive Officer

Karim K. Shehadeh
Secretary

Robert G. Clyne
Assistant Secretary

Jeffrey J. Weiner
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