

SAFETY LEADERSHIP
DRIVING SUSTAINABILITY
ANNUAL REVIEW 2018



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

DRIVING SUSTAINABILITY

The greatest challenge raised by the Fourth Industrial Revolution lies not in realizing digital transformation, but in navigating the complexities of digitizing our industry to safely enable—and ultimately achieve—industry sustainability.

Sustainability is a significant challenge affecting the marine, offshore, government and energy industries. Meeting regulatory targets for the low-carbon economy will require radical operational and technology advances, in which safety and environmental management is the cornerstone and digital technologies are key enablers. Although digital transformation is a daunting task, it is, in the end, an enabler to cost-effectively reach sustainability targets.

For this reason, ABS continues expanding our digital capabilities to transform the ABS Class experience for the industry and our clients—providing highly-rated independent guidance to leverage data throughout the life of their assets—all founded on a solid tradition of innovation in the service of safety. This extends to helping our clients pursue the decarbonization necessary for the low-carbon economy—which requires balancing long-term investments in innovation, against immediate and shorter-term business imperatives.

Meeting these future demands is a complex endeavor requiring organizations to manage the impact of technology—on the evolving personal practices and organizational processes—essential to protecting the environment. Adopting new technologies and business models often produces unintended consequences, and ABS will continue to help navigate these disruptions through steady change-management leadership.

As companies increase their dependence on digitally-enabled technologies in pursuit of sustainability, the industry must continue to maximize its resiliency, while minimizing its risk. Cyber security is an all-encompassing example that impacts every part of our industry; it is the safety system that no one sees. As the industry leader in maritime cyber security, ABS is advancing its groundbreaking cyber risk methodology and mitigation strategies—empowering the industry to effectively measure and manage cyber risk.

We are proud to say that through our industry leadership in helping protect people, property and the environment, we distinguish ABS as a sustainability, digital and safety leader—innovating to achieve our own goals and helping the industry and our clients achieve theirs.



CHAIRMAN'S MESSAGE

Rapid change and complex challenges characterize today's maritime world. Success in this environment requires a strong position on safety, digital and sustainability fronts, and just as importantly, the vision and commitment to lead industry transformation. Such an organization needs a solid foundation, resident expertise and ambition to navigate the uncertainties and instabilities that are the new norm in the maritime industry—and to emerge from them better, stronger and smarter, as an enterprise that continues to post positive performance across the board. This is ABS.

This new norm of constant change and challenge combines the regulatory expansion that has been shaping our industry since the 1990s, with the tsunami of possibilities presented by the breathtaking rate of change in computing, communications and emerging technologies.

During 2018—in the face of these continually evolving forces—improvements in global economic growth, energy price stabilization, stronger industry fundamentals and pending regulatory expectations paved the way for ABS to grow our classed fleet to 260 million gross tons (gt), maintain our 70-year-strong leadership position in the global offshore market, lead the industry in safety and port State performance, and seize the top position in the global orderbook.

At the same time, we continued to be a leading force in the digital transformation, driving innovation on which industry will build a sustainable future and open new pathways to success, through improved performance, better cyber security protection of assets, and clearly identified opportunities to achieve decarbonization goals.

Most importantly, throughout this year of achievement, ABS maintained its focus on safety and reliability, the foundation of our efforts since our beginning in 1862.

We are especially proud that our financial and operational successes in 2018 were accompanied





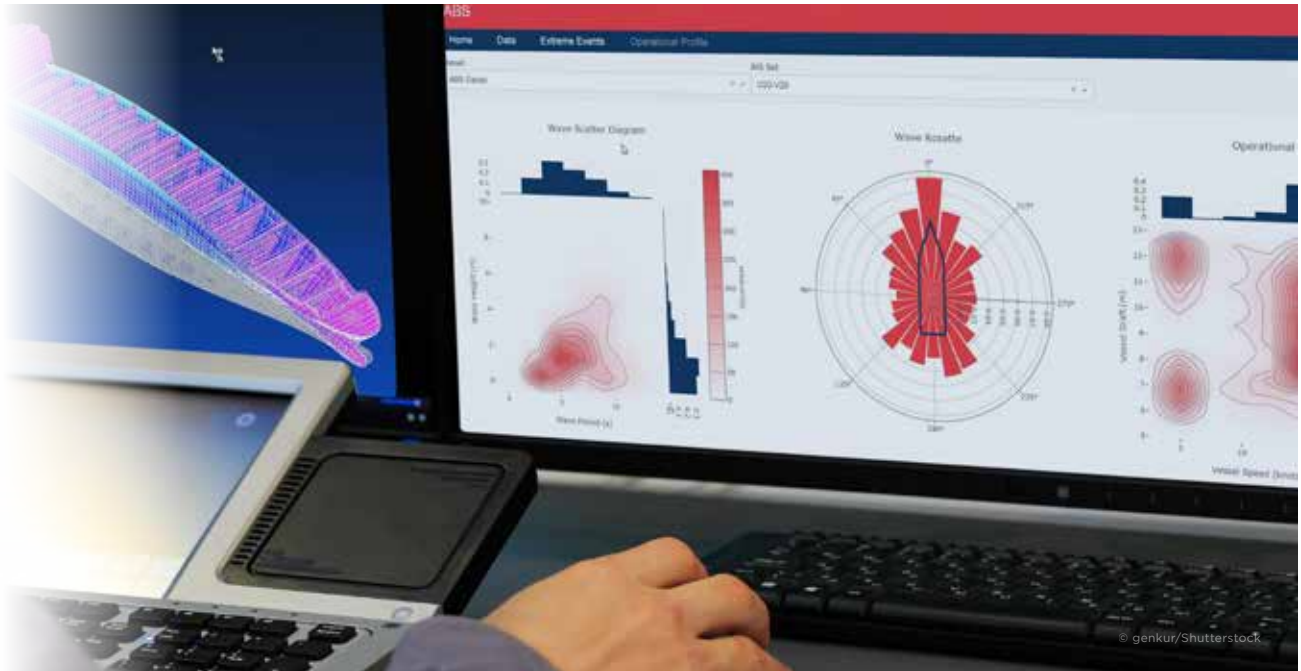
by a remarkable safety record—two consecutive years without a lost time injury across the global enterprise comprising ABS and ABS Group of Companies, Inc. The fact that our teams achieved such a milestone on numerous ships, offshore facilities, shipyards and industrial sites globally, is living proof that safety is in our DNA and remains a cornerstone value for us.

Because we continue to make the right investments, develop the right technologies and enhance the right skills at the right times, we have built our organization into a sustained market leader, the best-positioned in our sector to both support industry as it faces its challenges and our members and clients as they pursue their business objectives—safely and sustainably.

Leading class into the future was never more evident for ABS than during 2018, as we continued building on our Mission and Values to implement our strategic ABS FutureClass™ plan. This transformation of service delivery, through hemisphere-based operating teams and a connected network of world-class professionals, solidified our position as a global leader, strengthened our operating model to enhance the client experience and broadened our capacity to help industry optimize operational efficiencies as it progresses on its digital journey.

For ABS, although our service delivery is evolving and transforming to meet future needs, our objective remains the same as ever: to set standards for safety and excellence in design, construction and operation. This transforming evolution affects every step of an asset's class cycle, from concept through decommissioning, as well as many critical aspects of its owner's and operator's activities.

Additionally, the journey toward decarbonization and environmental sustainability requires us to develop self-improving initiatives and solutions that are technically viable, cost efficient and, most importantly, safe—meeting these three criteria is absolutely critical to achieving results that are both practical and sustainable.



Already an efficient industry, shipping continues to achieve reductions in fuel consumption through design and operational improvements, so it will be a true challenge to achieve additional improvements that are significant using today's technology.

Digital technologies will power the future, and ABS is already delivering new services in this area and leading by example. Our list of groundbreaking initiatives includes the use of digital technology to simplify transactions and increase operational efficiency, the study of alternative fuels and new energy sources suitable for different shipping sectors, and the analysis of the effects of seaborne trade growth and regulatory targets on new ship designs—and a better understanding on how these factors correlate and mutually influence each other. Additionally, we continue our efforts to incorporate new technologies into our certification, validation and verification activities.

Our own digital transformation is already well underway; digitizing our core has provided a base of achievement that we continually improve to help our clients on their own journeys toward a digitally transformed, safe and sustainable future. Ultimately, this digital transformation will benefit and shape the industries we serve.

From concept to coding, from design to development, from abstraction to application, the digital age for us is marked by collaboration, in which the expertise and innovative imaginations of widely diverse people throw open the doors to the future. This collaboration stretches beyond traditional barriers of position, place and platform to overcome challenges related to enhanced safety, smarter risk and reliability solutions, improved operational efficiency, better asset management, continuous self-improvement and feasible environmental sustainability, alongside other technology-centric endeavors.

'Technology-centric' is a phrase that captures the focus of ABS Group for its almost fifty-year existence. What began as a technical services organization has evolved into a diversified global leader in providing risk and reliability solutions, asset integrity management, and independent technical advisory and certification services across multiple industrial sectors. Throughout 2018,

ABS Group contributed sustained and exceptional value to ABS, helping its clients solve problems, succeed in their projects and reach milestone goals, all while continuing to draw upon and contribute to our unique accumulation of knowledge and expertise.

Looking forward, our industry faces three fundamental changes and five particular challenges, each of which offers the opportunity for either success or failure, depending on how they are confronted.

The changes are: a new norm of market uncertainty and instability; regulations that aspire to shape global behavior; and the rapid evolution in digital technologies. The challenges are: sustainability and decarbonization; digitization; cyber security; performance improvements; and maintaining safety in an ever-changing world.

The solutions developed to address such sweeping changes and challenges often themselves produce unintended consequences. To anticipate and formulate remedies for such consequences takes a highly evolved risk and reliability culture, in which decades of experience accumulated on innumerable projects combine with cutting-edge technologies such as data analytics to deliver creative responses to unforeseeable, unwanted events. This nimble agility is the foundation on which ABS has built its global reputation as a trusted service provider.

Altogether, we see a bright future ahead, one in which digital-enabled technologies will make us more effective, efficient, informed and flexible, and will spawn innovation and a new level of achievement across our industry. As that digital future unfolds, we will continue to be well-positioned to navigate the coming transformation and thereby provide the necessary and valuable support that our members and clients expect and deserve.

The dedicated professionals of ABS will chart this exciting path forward, upholding our Mission and standing fast by our core values as they have done for each and every day of our 157-year history. Through the collective global accomplishments of these talented experts, ABS will continue to sail on as an industry leader, distinguished by integrity and reliability and driven by a profound dedication to safety.



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

“We are proud to say that through our industry leadership in helping protect people, property and the environment, we distinguish ABS as a sustainability, digital and safety leader—innovating to achieve our own goals and helping the industry and our clients achieve theirs.”

CHRISTOPHER J. WIERNICKI
CHAIRMAN, PRESIDENT AND CEO
ABS

INDUSTRY LEADING SAFETY AND QUALITY



SAFETY LEADERSHIP

Safety is the foundation of all we do at ABS. Our safety record has been compiled on countless ships, offshore facilities, shipyards, industrial sites and corporate offices globally, all with varying safety regimes in place. The safety culture is woven into the fabric of life and work at ABS and, because of that, our employees truly are safe everywhere—living proof that, for us, every day is safety day. The result is, first and foremost, that safety is not conditional to **where** we are, but integral to **who** we are.

Safety management is critical to navigating the industry journey to sustainability. As industry develops and implements the radical new technologies and business models required to meet regulatory targets for the low-carbon economy, ABS will continue to aid the industry in accurately assessing the efficacy and maturity of available technologies—to safely manage and minimize the risk of the novel approaches essential to this transformation.

ABS SAFETY PERFORMANCE

Founded on a solid tradition of innovation in the service of safety, ABS is a global health, safety, quality and environmental leader. ABS maintained this leadership through 2018, recording our second year of zero work-related lost time incidents (LTIs) and a corresponding lost time incident rate (LTIR) of 0.00.

Our record of two consecutive years without a lost time injury stands as a remarkable achievement for two prominent reasons. First, on an individual level, it is a testament to the safety awareness of our staff and their collective adherence to safe practices and procedures. Second, on a corporate level, it is a testament to the success of our overall safety methodology. As part of this exemplary safety culture, ABS introduced its 'Life Safety Rules', 10 key focus areas that aid in the recognition and correction of hazards in various environments—further proof of our commitment to leading safety and driving sustainability in all we do.

OCCUPATIONAL HEALTH AND SAFETY PERFORMANCE

The ABS 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 incidents, on-time completion of any corrective actions identified and monitoring of safety training completion rates.

- ABS LTIR of 0.00 for two years running, can rightly be called a remarkable achievement.
- ABS total recordable injury rate (TRIR) of 0.32 remained very low year-on-year.
- ABS employees continued to make good use of the global reporting system to capture unsafe conditions, unsafe behaviors, near misses and work-related injuries or illnesses.
- ABS worked with Lamar University to carry out a global safety culture survey to engage its employees on safety-related issues.
- ABS maintained its Occupational Health and Safety Assessment Series (OHSAS) 18001 certificate with external audits performed by the British Standards Institute (BSI).

“A world-class safety culture requires care, attention and consistent actions to drive safety excellence, positive behavior and beneficial change. I am proud to see these values passionately put into practice each day by our employees worldwide.”

CHRISTOPHER J. WIERNICKI
CHAIRMAN, PRESIDENT AND CEO
ABS

QUALITY PERFORMANCE

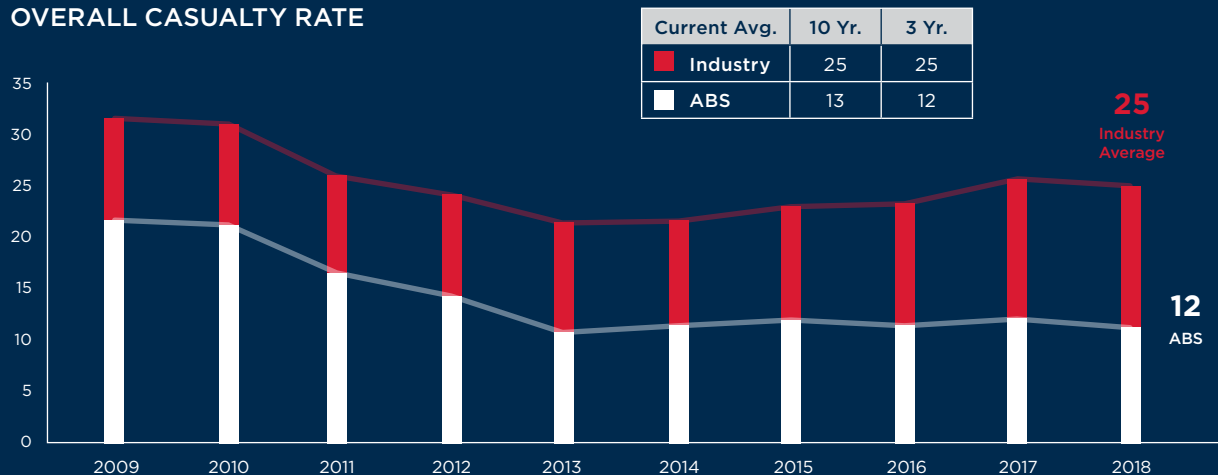
In 2018, ABS continued high-quality service delivery to our global client base. ABS maintained its leading position in overall Port State Control (PSC) performance, being one of the top performing Recognized Organizations (RO) in all three of the most active PSC regions of the world for the 2016 to 2018 period. Further, ABS has averaged less than one RO accountable detention per year in the Paris MoU, for the last 10 years.

ABS GROUP OF COMPANIES, INC. SAFETY PERFORMANCE

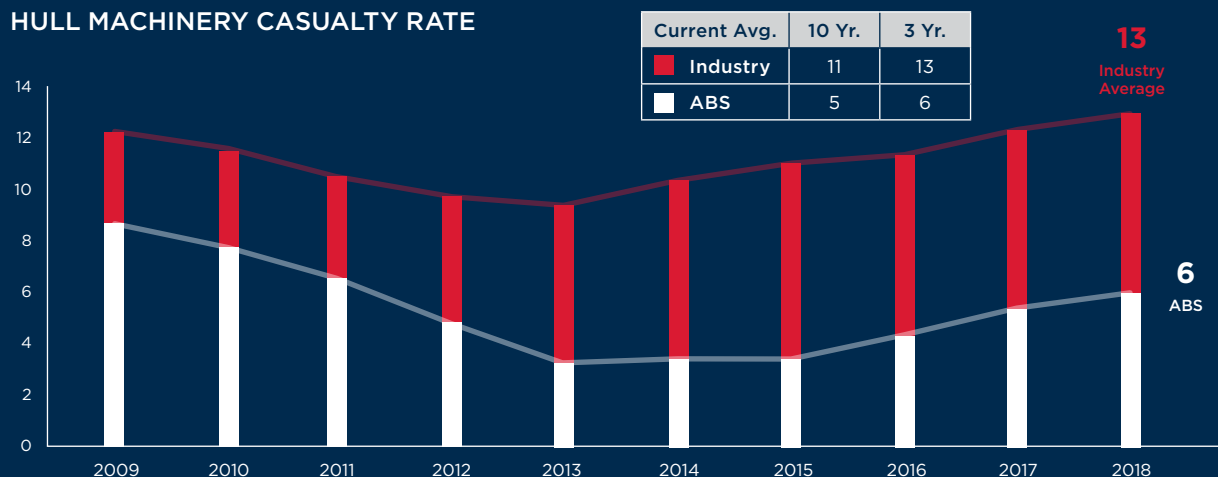
Building on the parent organization's ongoing commitment to its safety mission, ABS Group of Companies, Inc. (ABS Group) surpassed three years without an LTI in 2018.

This achievement demonstrates ABS Group's focus on continually improving the effectiveness of its health, safety, quality and environmental culture, performance and management system. With 2018 as a milestone year for ABS Group, we are setting standards of excellence in health, safety, quality and environment leadership.

OVERALL CASUALTY RATE

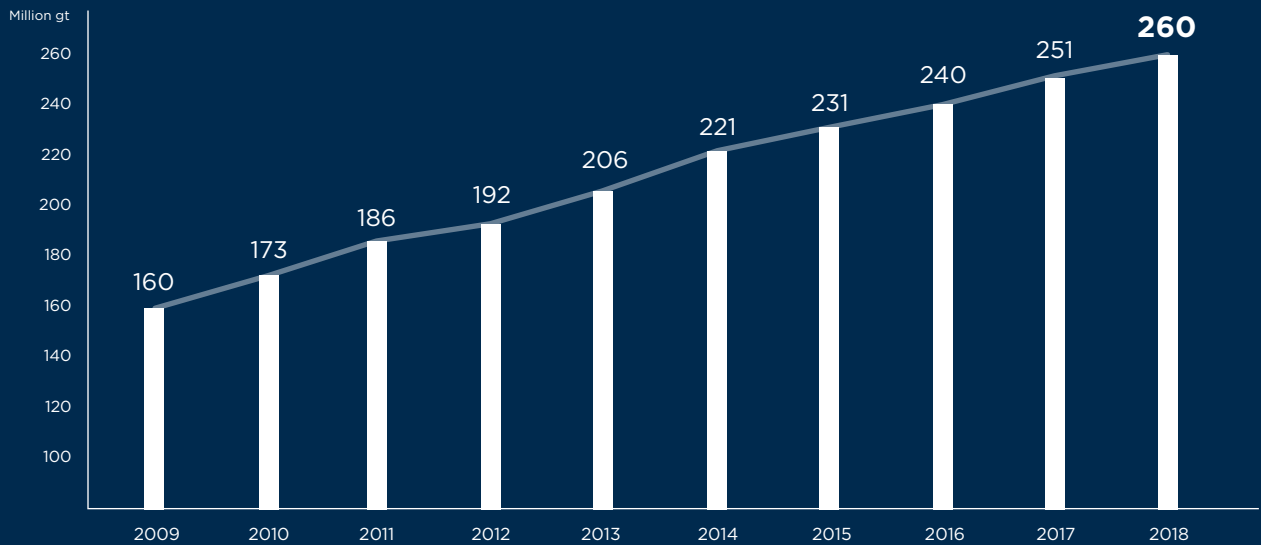


HULL MACHINERY CASUALTY RATE

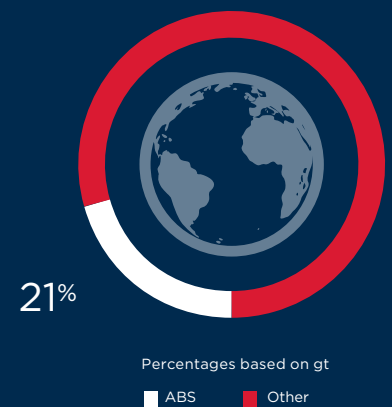
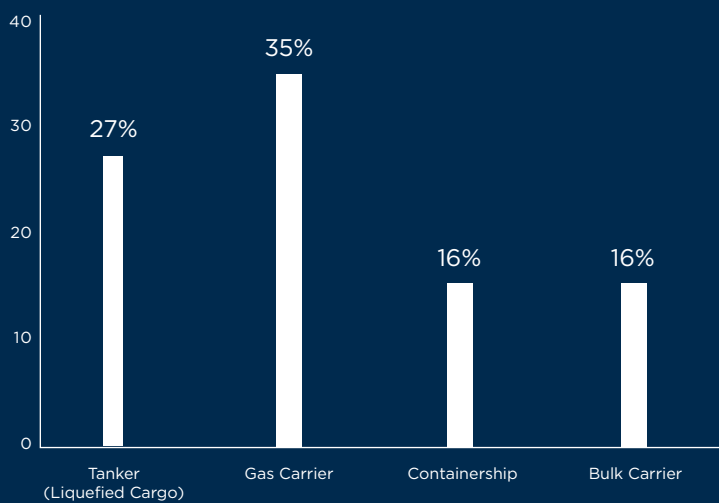


INDUSTRY LEADING PERFORMANCE

EXISTING FLEET 2018



MARINE ORDERBOOK SHARE 2018



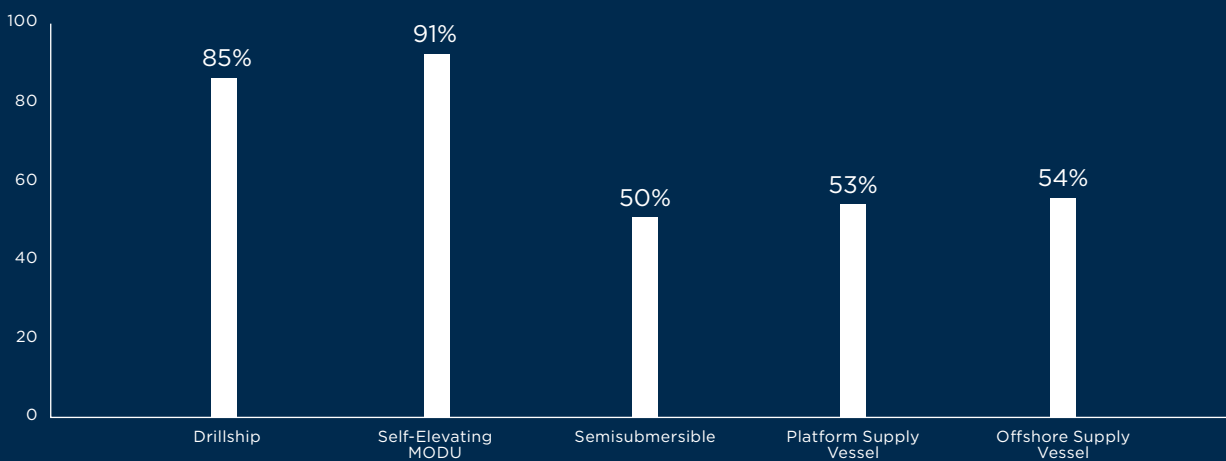
LEADING ORDERBOOK FOR SHIPBUILDERS



LEADING EXISTING FLEET FOR OWNERS



OFFSHORE ORDERBOOK SHARE 2018



NEW WORLD HEADQUARTERS

In October, ABS Chairman, President and CEO Christopher J. Wiernicki officially welcomed ABS employees into the organization's new global headquarters, a 10-story, state-of-the-art building located in Houston. The 328,600 square foot structure houses ABS and its affiliated companies' employees.

The product of a five-year design and construction effort, the energy-efficient building is LEED (Leadership in Energy and Environment Design) Gold certified, a globally recognized symbol of sustainability achievement, and independent verification of its socially responsible features. These range from resource-efficient design, construction, operations and maintenance to healthy and efficient spaces for work and rest. Importantly, from a human element perspective, the new facility is attached to a modern, high-quality amenity base that includes premier hotels, restaurants and fitness facilities.



The global headquarters visibly represents the industry's data-driven sustainability journey, as it is home to the ABS cyber and digital laboratories. These technology acceleration centers bring together employees, clients, industry and academia to develop, test and apply smart technology solutions, which enable informed decisions in the face of fast-moving environmental requirements.

Altogether, its open and inviting spaces, flooded with natural light, allow us to gather with colleagues and industry partners to effectively collaborate and engage in advancing the innovation that directly supports our safety mission. Further, it is an environment where we are proud to invite our clients, partners, vendors, and other visitors, in which our employees share knowledge, partner on solutions and solve problems faster.



“This is a significant milestone in our history and reaffirms our commitment to provide industry-leading safety and practical technology solutions for marine and offshore industry challenges.”

CHRISTOPHER J. WIERNICKI
CHAIRMAN, PRESIDENT AND CEO
ABS



GLOBAL CORPORATE CITIZENSHIP

DEVELOPING OUR TALENT PIPELINE

To us, Global Corporate Citizenship means adhering to the belief that companies consciously take a big-picture view of themselves as having a role in society that goes beyond their own strategic business objectives. In other words, we see ourselves as stakeholders in society alongside governments, other organizations and the citizenry. In terms of corporate action, this is realized through good corporate governance, effective workplace safety standards, employee empowerment and recognition, adoption of environmentally sustainable procedures and a healthy philanthropic program; and the emerging concept of corporate social entrepreneurship, the development of solutions that generate a positive return to society.



At ABS, this belief is realized in a number of ways, particularly through our commitment to training and education of staff in a broad range of disciplines, research partnerships with educational institutions, and endowments to universities and maritime leadership schools and programs.

In 2018, ABS designed and deployed nearly 12,000 hours of training to its employees, combining blended, simulation-based and classroom-based training methods. ABS introduced continuous learning programs during the year, additional Shaft Alignment curriculum, Multi-Cable Transit Systems and Dropped Objects Prevention. These programs were implemented worldwide adding to an already robust online and instructor-led technical curriculum, addressing today's pressing industry issues.

Further, ABS released its new Keystone program, a three-year recurring validation training for its surveyors and engineers. More than 96 percent of participating employees and their managers report improved performance on the job three months following completion of the Keystone program. Averaging more than 60 hours of training and development per year for technical employees, ABS personnel are well prepared and ready for evolving industry challenges.

ABS and its industry and university partners are accelerating innovation through collaboration and knowledge-sharing. Research conducted through joint industry projects (JIPs) and university partnerships targets technologies supporting the future of classification and sustainability solutions. Among the critical technologies under study are sensors and autonomous inspection, materials innovation and nanotechnology.

Partnering with world leading universities globally, ABS helps in shaping research between academia and industry. Vital research areas include marine safety, environmental stewardship and compliance, data analytics, cyber security and digital connectivity. University partnerships are collaborations of applied research, enabling new technologies that support the maritime industry. ABS continues to lead marine and offshore innovation through its work with industry and university partners.

In 2018, ABS held industry dialogue sessions with its endowed university chair professors to strengthen our partnership and both shape and showcase research efforts with these key universities. A few exciting areas of research include:

- Ocean wave power, underwater wireless communication and underwater drone technology to support more autonomous and greener ships—University of California, Berkeley
- The potential for robotics and artificial intelligence to create more efficient and safer ships—University of Michigan
- Additive manufacturing, underwater wet welding and digital manufacturing—Colorado School of Mines
- Blockchain applications in supply chain, global maritime logistics and environmental compliance—State University of New York Maritime College
- Biologically-inspired engineering, soft robotics and deformable structures in fluid environments; and 4D printing, a cutting-edge technology in which a 3D-printed structure can change based on different environments—Massachusetts Institute of Technology (MIT)
- New technology applications for sustainability supporting decarbonization targets for 2030 and beyond—Webb Institute

ABS supports 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 Maritime College; ABS Chair of Engineering at California Maritime Academy; ABS Chair of Metallurgical and Materials Engineering at Colorado School of Mines; ABS Chair in Ocean Engineering at University of California at Berkeley; ABS Chair of Marine and Offshore Design Performance at University of Michigan; ABS Chair of Naval Architecture at Massachusetts Institute of Technology; ABS Chair in Naval Architecture and Marine Engineering at the Webb Institute.

ASPIRE PROGRAM

ABS is as committed to encouraging the personal development of its employees as it is to supporting students at educational institutions around the world. One in-house effort to cultivate the talents of its employees is the Aspire program. Through Aspire, newly hired graduates take an active role on the ABS team, working alongside professionals from more than 60 countries. Through rotations in the Engineering, Survey and Technology groups, Aspire employees develop broad-based knowledge of the marine and offshore industries as well as supporting marine, offshore and additional business departments. Upon program completion, graduates are placed throughout the organization to support ongoing projects. Since the program's founding, 72 employees have completed the rotational development course. Aspire participants bring diverse backgrounds and skill sets to ABS, including data analytics, naval architecture, ocean engineering and mechanical engineering to support the marine and offshore industries and the future of ABS.





SAFETY LEADERSHIP | DRIVING SUSTAINABILITY

DIGITAL INNOVATION



A DIGITAL FOUNDATION FOR A SAFE AND SUSTAINABLE FUTURE

The digital revolution is sending ripples of change through the most critical aspects of business operations in industries around the world. In the marine and offshore sectors, this digital journey is at a relatively early stage. As a result, there are many competing visions both of industry's digital future and the digital transformation that such a future requires of its stakeholders.

Amid the predictions, one thing seems clear: as digital technologies become a cornerstone of business operations, they will also become a cornerstone of safety and sustainability initiatives, and of the risk and reliability solutions that support them.

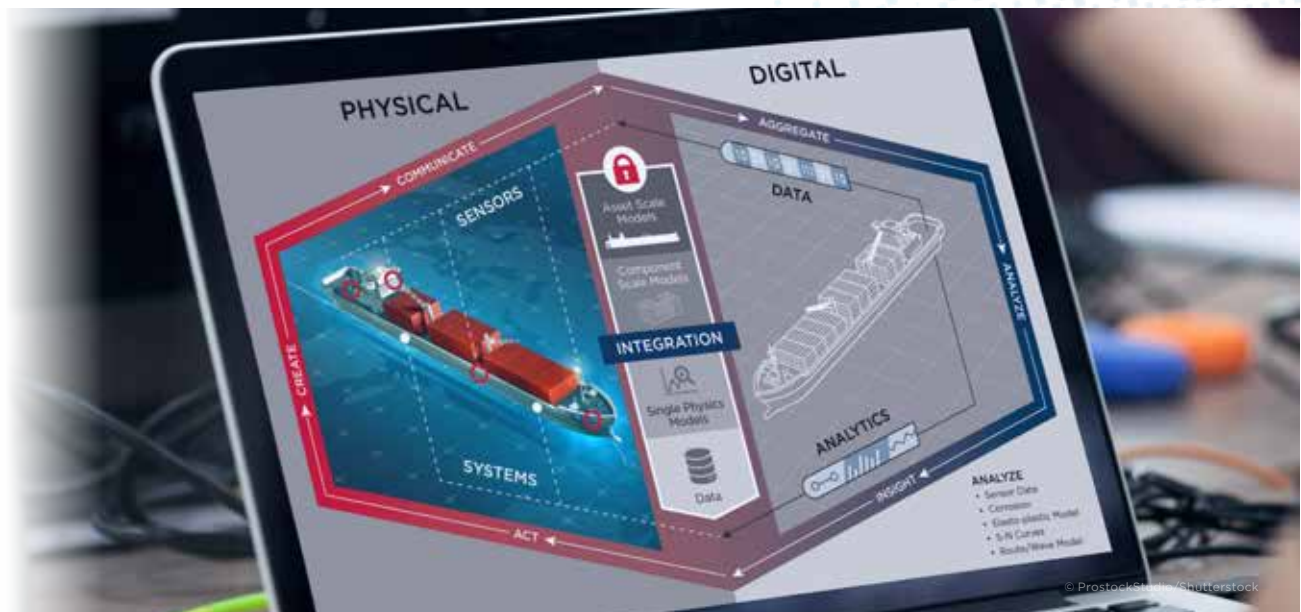
The industry sustainability challenge is significant, requiring fundamental technological advances to meet the regulatory targets of a low-carbon economy, as well as the asset management needs of the future. Digital technologies will be key enablers, not only in meeting radical decarbonization objectives—but also in bringing forth the innovation on which industry progress and sustainability depend—and finally in advancing the sciences of risk and reliability that give us confidence to develop unprecedented concepts into the products and processes to meet this extraordinary challenge.

To reap the full operational, safety and sustainability benefits that digitalization can bring, companies must align their digital strategies with their business goals. Just as no strategy is complete without provision for protection, mitigation and remediation of unwanted events, so no digital strategy is complete without giving serious consideration to cyber security.

Cyber threats are invisible, persistent, unpredictable and potentially devastating. For this reason, every computer or device that connects to the internet needs a reliable and resilient cyber security system to protect it.

As the industry leader in maritime cyber security, ABS is advancing its groundbreaking cyber risk methodology and mitigation strategies, empowering the industry to effectively measure and manage cyber risk. The ABS FCI Cyber Risk™ methodology—incorporated into a powerful shared dashboard—calculates a cyber risk index and provides clients an actionable report detailing risk mitigation strategies. The dashboard provides an instant and holistic picture, illustrating the degree of cyber risk across assets, operations and critical suppliers.





One simple premise underpins our digital vision: to support clients from initial design through operations and maintenance to the end of an asset's service life. Using this framework, we can develop and deploy technologies that make a life-cycle viewpoint on data a practical reality.

The life-cycle view on data may be most apparent in the development of asset management and risk and reliability solutions. ABS consistently demonstrated industry-leading performance in these areas throughout 2018: from its work with offshore asset owners and drilling contractors to validate data accuracy from operational technology (OT) on smart rigs, to digital transformation projects built on the ABS Nautical Systems (NS) Software, to ABS Group projects that leveraged data analytics to monitor and improve operational safety.

NS emerged as a critical piece of the puzzle joining asset management, reliability and sustainability, with the release of its latest software edition and a new business intelligence module. The many, far-reaching and ever-expanding regulatory regimes affecting maritime industries can present a significant compliance challenge to the owners and operators of marine assets, a challenge in which noncompliance can bring severe and costly penalties. This means that, going forward, compliance management will be a crucial element of operational sustainability, which is why NS developed a set of tools offering complete capabilities to plan, execute and document all compliance work processes.

ABS Advanced Solutions continued crafting innovative solutions to technical and operational problems for numerous types of assets at all stages of their life cycle, including enterprise asset management and cyber resilience projects.

ABS Group continued delivering technical services and risk and reliability solutions to enhance the safety and maintainability of assets and operations globally, through comprehensive engineering and risk management solutions, performance optimization, integrity management and reliability services, resulting in safer, more reliable assets and operations around the world.

Our history of safety-driven cutting-edge development truly distinguishes ABS in the industry, particularly our decades-long record of introducing disruptive technology change into the industries we serve—no other class organization can claim such a legacy.

The future will challenge everyone in new and varied ways, but by integrating digital and other new technologies with our profound dedication to safety, we will continue to bring groundbreaking developments to our clients and to industry—part of the digitally transformed, safe and sustainable future that we envision both for ourselves and for everyone.

CYBER SECURITY: THE CORNERSTONE OF OUR DIGITAL FUTURE

As stakeholders in the marine and offshore industries contend with extreme emissions and efficiency targets mandated for 2030 and 2050, while simultaneously pursuing both near- and longer-term strategic business objectives, they must necessarily place increasingly stringent performance demands on marine and offshore assets.

Advanced analytics, data-driven decision-making, augmented reality and other tools of the digital revolution are core capabilities which will enable those stakeholders and their assets to meet new requirements essential to participation in the low-carbon, high-efficiency economy that is slowly coming into existence. For physical assets, this future demands increasingly adaptive risk and reliability solutions, and for digital assets, it requires constant advancement in computing and digital technologies and, therefore, unyielding vigilance in cyber security—a challenging task because cyber threats are formless, intangible, unpredictable and potentially, devastating.

For this reason, cyber security is the safety foundation of sustainability in the digital age and should be at the heart of any digitalization program. Yet, too often, business leaders view cyber security as a technical matter requiring technical solutions—when the reality is that it requires a holistic solution—a continuously self-improving regime combining hardware, software and guidance for employees on safe cyber practices.

Our approach to cyber security is underpinned by dedication to technology development in the service of safety. Animated by this dedication, we have developed industry-specific guidance and services to measure and mitigate cyber risk that have made us leaders in the maritime industry's cyber vanguard. In 2018, ABS announced a truly groundbreaking advance in the field of understanding and mitigating cyber risk: our proprietary FCI Cyber Risk™ method.

ABS joined forces with the Stevens Institute of Technology to develop a new formula for calculating cyber risk. Until now, cyber risk in the maritime industry has typically been conceived of as “risk = threat x vulnerability x consequence.” This conceptual formulation, whose elements are not measurable, undermines any efforts to engineer a solution or calculate a resolution. The FCI methodology was developed following a two-year research contract with the Maritime Security Center—a U.S. Department of Homeland Security Center of Excellence—led by Stevens Institute of Technology and including the U.S. Department of Defense.

The FCI method replaces these traditional elements with ‘functions, connections and identities’, terms that refer to items that are countable, observable and easily understandable: ‘functions’ represent systems that a cyber-attack would seek to compromise; ‘connections’ represent how the functions communicate and where their potential points of attack are; and ‘identities’ represent the people or devices that interact with the functions. The FCI method is incorporated into a powerful dashboard, providing a comprehensive shared view and giving asset owners a clear understanding of the degree of cyber risk across assets, operations and critical suppliers. The solution enables operators and owners to gain a deep understanding of their cyber risk—as well as pinpointing remediation efforts and illustrating return on investment of cyber risk mitigation strategies over time.

We believe this approach is the missing link in maritime industry cyber security. By employing a strategy that considers all the risk elements and generates a relative risk contribution rating, we have made the subject easier to understand and easier to action. As a result, companies from across the shipping industry are adopting the ABS FCI approach to gain critical insights into the relative risk positions of their assets and organization.





THE SMART EVOLUTION

In the past year, advances in connectivity, data processing and sensor technologies accelerated the industry's digital evolution, while individual companies struggled to digest both the disruptive changes brought by those advances and the unending challenge of complying with increasingly complex, far-reaching regulations.

Taken together, disruptive technologies and evolving regulations—and their economic consequences—form one of the great challenges to industry sustainability.

These are early days in the journey from smart to semi-autonomous to autonomous assets, but in terms of providing industry guidance, ABS has already taken the lead by connecting the smart journey with sustainability.

In 2018, ABS introduced one of the building blocks of the smart journey, releasing comprehensive guidance for the marine and offshore industries on a goal-based framework for data-driven decision-making using smart technology. The *ABS Guidance Notes on Smart Function Implementation* supports data infrastructure development, enabling health and performance monitoring and augmented vessel operations, ultimately leading to better-informed decisions regarding fast-moving environmental requirements. The Guidance Notes sets an actionable framework in which owners, operators and equipment manufacturers can take smart steps today in preparation for an environmentally sustainable tomorrow.

Smart technologies provide real-time data on the condition of structures and machinery and apply advanced analytic techniques to identify trends and anomalies—providing early indicators to avoid potential failures and vessel downtime. The Guidance Notes are the cornerstone of the ABS smart series and are followed by an actionable guide designed to improve data acquisition, processing and analysis and the basis for a condition-based class (CBC) approach.

CONDITION-BASED CLASS

Classification began to experience a revolutionary shift in delivery of primary services, in large part thanks to a progressive alignment of digital technologies with business goals, practices and procedures.

Advances in hardware, software and analytical technologies are enabling significant shifts in maintenance strategy—from traditional corrective maintenance to preventive maintenance, and from preventive to condition-based maintenance (CBM).

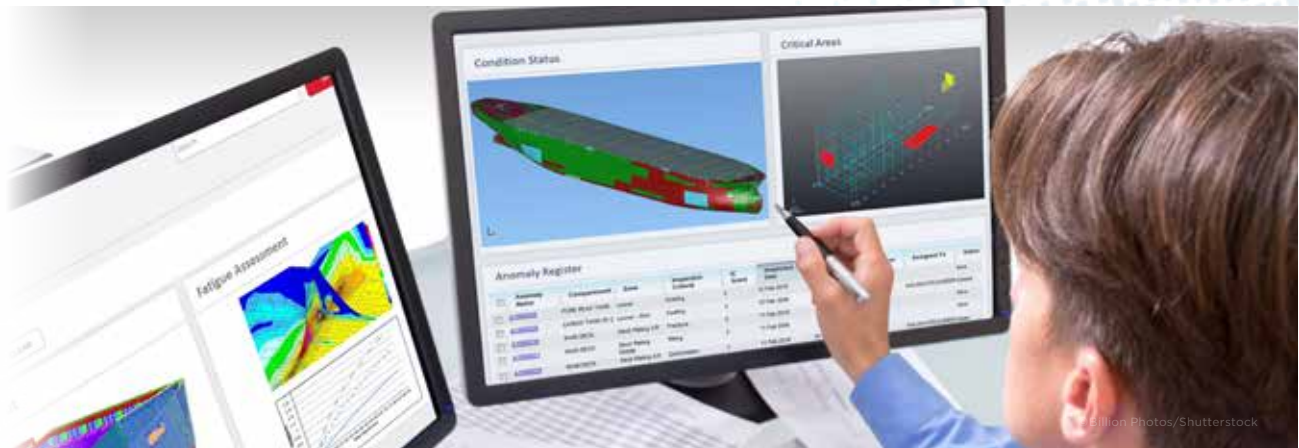
In CBM, data gathered from machinery, control systems and sensors mounted throughout the vessel is used to continuously monitor the condition of equipment and structures and generate maintenance plans based specifically on their condition, rather than generic calendar-based programs suggested by their manufacturers. CBM provides the capability to detect emerging failures, enabling development of optimal repair/replacement strategies and overall asset life extension.

CBC takes advantage of sensor data, generated to monitor structural and equipment status, allowing ABS specialists to evaluate indicators of asset performance or lifespan, and modify class surveys accordingly. CBC enables customized survey planning, tailored to a specific asset and focused on the conditions and structures meriting the most attention—resulting in increased efficiency in the classification process while maintaining overall risk and safety metrics.

The migration to CBC is a phased journey. First, vessel maintenance cycle is aligned with the classification cycle, replacing calendar-based schedules with condition-based processes. Then, data is gathered from multiple sources and cleansed, allowing relevant data analysis. The third phase is developing models that use machine learning algorithms for predictive maintenance based on anomaly detection.

In the CBC paradigm, class surveys become more targeted and less intrusive, improving the overall experience for operators through more uptime and more days at sea while ensuring the traditional, high safety standards for classed assets remain in place—bringing greater efficiency to the entire process of keeping assets in class.





CBC PILOT PROGRAM WITH THE MILITARY SEALIFT COMMAND

Our two-year project with the U.S. Navy's Military Sealift Command (MSC) is set to deliver the maritime industry's first-ever bow-to-stern CBC asset management program. The objective is a landmark advancement in the classification industry—enabling the move from purely calendar-based surveys to an entirely CBC model—using digital solutions to increase MSC's operational availability and flexibility.

ABS is collecting data throughout the project from sensors installed throughout the hull and all classed machinery aboard three MSC vessels: USNS *Spearhead*, an expeditionary fast transport craft; USNS *Amelia Earhart*, a dry cargo/ammunition vessel; and USNS *Pomeroy*, a large ro/ro vessel.

To establish precise baseline conditions for the project, ABS performed in-depth survey assessments of structures and built digital twins for each vessel. Through our proprietary advanced analytics, the digital twins detect abnormal behavior in vessel structure or machinery and provide early warning of developing problems, thus allowing mitigation of issues before they occur.

The endless stream of data generated by each digital twin enables ABS to continually refine its understanding of the vessel. This vessel-wide intelligence gives ABS and MSC a holistic view of the entire vessel's structural health and onboard equipment performance—continually improving predictive maintenance capabilities.

"Integrating condition-based maintenance into the survey model is the future of class, and we are delivering it today," said ABS Chairman, President and CEO, Christopher J. Wiernicki. "The ABS condition-based class solution helps MSC target critical areas for repair, prioritize maintenance requirements, and more efficiently schedule and use resources to improve availability. The project objectives are to reduce downtime, provide greater operational flexibility, allow ships to remain in service longer and meet mission demands, while also meeting class requirements."

ABS is working in an unprecedented degree of integration with both MSC and vendors to share data and enrich the digital picture of each vessel.

"We are pleased to have ABS as a trusted partner in this digital journey. Through the condition-based maintenance program, we are working with ABS to achieve a heightened level of vessel readiness, leveraging data in altogether new ways. The program will provide a data platform to support timely decisions as well as enhanced planning of vessel overhaul and repair periods."

ANDREW BUSK
DIRECTOR,
MSC ENGINEERING

REMOTE SURVEYS

In 2018, ABS introduced Remote Surveys as part of its ongoing commitment to drive safety performance and productivity for clients using digital technologies. Offering easy direct access to our global network of surveyors, ABS Remote Survey delivers a new option for smart and safe surveying.

A survey is completed remotely based on a review of visual and technical information, such as video from hull inspection robots or photographs of minor damage and repair provided by the vessel.

Remote Survey takes ABS responsiveness to an even higher level, saving clients' time and money and giving operators greater flexibility and efficiency. This is the latest safety step in the ABS Mission to promote the security of life and property and preserve the natural environment.

The following are available for ABS Remote Survey:

- Continuous Machinery Survey
- Tailshaft Survey Extension
- Minor Damage Survey
- Rectification for Outstanding Class Recommendations/Statutory Deficiencies
- Remote Underwater Examination of Offshore Units
- Change of Owners
- Extension of Survey
- Permits to Proceed Subchapter M
- Special Survey of Hull (RIT-based)

“We’re eager to use this new remote survey capability as it will increase efficiency of our operations. This means our units can receive support from an ABS surveyor from any location in the world. We expect the option to conduct an Underwater Inspection in Lieu of Drydocking (UWILD) remotely will reduce the logistical expenses of a UWILD significantly.”

SACHIN MEHRA
VP ASSET MANAGEMENT,
ENSCO





e-CERTIFICATES

ABS introduced e-Certificates, continuously available, tamper-proof, independently verifiable and secure digital equivalents of traditional ABS paper certificates. e-Certificates are now available to the entire ABS-classed fleet, subject to flag Administration authorization. e-Certificates are accessed via the ABS online secure database, so clients can access the latest certificates at any time and from anywhere in the world.

Fully compliant with International Maritime Organization's (IMO) Guidelines, ABS e-Certificates reduce administrative burdens, cut onboard clutter and simplify port State, flag State and third-party validation. The authenticity, originality and traceability of the e-Certificates are easily verified through the ABS Validation Portal, available for any third parties that need to confirm the information contained in the e-Certificates.

The ABS e-Certificate system allows a simultaneous, vessel-wide view of all applicable certificates, rather than requiring the user to look up each certificate individually.

SURVEYS ASSISTED BY ARTIFICIAL INTELLIGENCE

One thrilling aspect of ABS' digital vision is equipping drone-mounted cameras with a unique new technology that allows semi-automated analysis of marine and offshore structures. The end-game is making surveys and inspections quicker, cheaper, more comprehensive and far safer for the surveyors and onboard personnel involved.

The groundbreaking technology behind this vision is the subject of a three-year collaboration between ABS, Singapore Polytechnic University and the Singapore Maritime Institute, the goal of which is to develop a vision-based coating inspection and assessment system that employs deep machine learning techniques—enabling automated assessment of coating breakdown and corrosion. These joint partners are currently working on a unique algorithm that can identify and analyze minute deteriorations in marine coatings.

The most recent product produced by the partnership is a smartphone application of the technology, currently undergoing on-site beta testing by our surveyors.



NAUTICAL SYSTEMS

The many, far-reaching and ever-expanding regulatory regimes affecting the marine and offshore industries present a significant compliance challenge to asset owners and operators, a challenge in which noncompliance can bring severe and costly penalties. As a result, compliance management is a crucial element of operational sustainability.

ABS developed a set of tools offering complete capabilities to plan, execute and document all compliance work processes. In January, we delivered a major release of our ABS Nautical Systems (NS) Enterprise fleet management software and a new business intelligence module, NS Insight. Along with updates and evolutions to its well-known NS Voyage Manager, NS Autologger and NS Health, Safety, Quality, and Environmental (HSQE) Manager modules, the system also offers the industry's most comprehensive compliance solution for many regulatory mandates, including the EU's MRV, the U.S. Coast Guard's Subchapter M and IMO's Data Collection Services (DCS).

NOTABLE NS IMPLEMENTATIONS AND AWARDS

CROSBY TUGS SELECTS NS WORKBOAT SOFTWARE FOR SUB M COMPLIANCE

In 2018, Crosby Tugs selected the ABS Nautical Systems (NS) Workboat mobile compliance software to enable compliance with Subchapter M regulatory requirements. Crosby adopted NS Workboat across its fleet of tugboats, to record compliance data and generate safety reports on tablets or smartphones while crew carry out routine operations. Crosby leveraged NS Workboat pre-built ISM data sets including: planned maintenance jobs; meeting, inspection and drill jobs; and the inspected equipment list; to rapidly implement its Subchapter M compliance plan. NS Workboat provided a hub for all compliance-based data and the fleet calendar view for improved compliance plan tracking and management.

“Our team at Crosby was searching for a complete software system for our Subchapter M compliance. The NS workboat system was a perfect fit for us. We are excited to work with this software going forward.”

WADE SAVOY
CORPORATE DIRECTOR,
QHSE,
CROSBY TUGS



TOPAZ EMBRACES THE DIGITAL FUTURE

Topaz Energy and Marine is an owner/operator of approximately 120 offshore support vessels (OSVs), active primarily in the Caspian, MENA (Middle East-North Africa) and West Africa regions. In the maritime industry and particularly the OSV sector, digitization is still in its earliest stages. However, in 2014, Topaz knew it needed to embark on its digital evolution to continue to deliver superior service to the energy industry.

Topaz built its data strategy on ABS NS Enterprise software as well as upgrading and implementing V-Sat communications on board its core fleet. The NS solutions autonomously creates a dashboard for benchmarking and more informed decision-making for Topaz and its clients

Topaz is now reaping the rewards of data analytics and digital technologies – notably, higher efficiency and better performance aboard its vessels. Specific improvements include using real-time data to improve decision-making for Topaz and its clients; improved maintenance planning and reduced downtime, improved compliance through automation, quality assessment and feedback, and greater accountability and ownership across the organization.

“Any digital initiative will fail without the proper prerequisites in place. You have to decide what you are after – operational excellence, cost control, asset management, customer satisfaction, or improved sales – and then determine key performance indicators (KPIs) and their specific enabling technologies, and build a structure around them. The NS Enterprise software is a core technology to connect our diverse fleet.”

KRIS VEDAT
HEAD OF IT,
TOPAZ ENERGY AND MARINE

RAWABI VALLIANZ OFFSHORE SERVICES IMPLEMENTS NS FLEET MANAGEMENT SOFTWARE

Rawabi Vallianz Offshore Services (RVOS) completed implementation of the ABS Nautical Systems (NS) fleet management software across its fleet of 44 offshore support vessels (OSVs).

RVOS, part of Rawabi Holdings, used NS software to deliver operational insights to continuously improve client services. RVOS objectives for NS implementation were improving operational efficiency and fostering an enhanced safety culture for its fleet; the NS software, Maintenance, Purchasing, Crewing, Document Management and HSQE modules have improved standardization of RVOS operational processes across the board.

Real-time data captured in the NS software suite enabled RVOS to make more definitive and smarter operational decisions, allowing them to demonstrate continuous improvements in operational efficiency to their clients, while also providing accurately detailed operating records.



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“By introducing ABS NS to our fleet and key modules within our operating system, we envision this advanced technology will ensure success for our clients and our internal stakeholders. This comprehensive solution allows the company to grow by leaps and bounds, while ensuring standardization in our processes for efficient and effective mobilization of our resources.”

OSSAMA AL-MUHTASEB
GENERAL MANAGER,
RAWABI VALLIANZ

ABS GROUP—MANAGING RISK WITH INNOVATIVE DATA TECHNIQUES

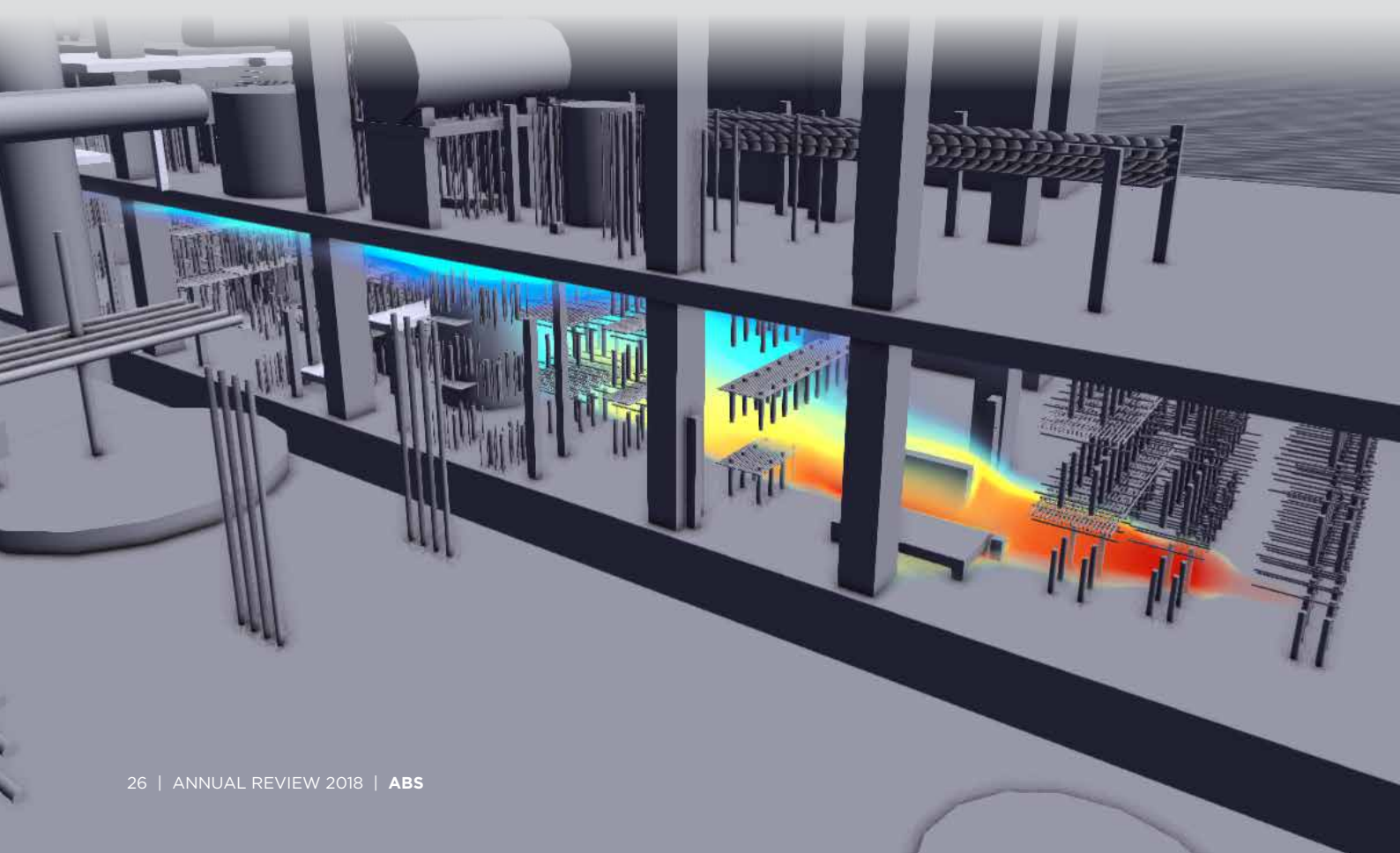
Business analytics are becoming commonplace in the government and private sectors, for which organizations are using historical performance data and predictive modeling to support a wide range of operational needs.

With the rise of data science, ABS Group's risk experts are seizing opportunities to use machine learning and big data techniques to extract and apply data to improve their risk predictions. The results are risk analysis solutions that generate higher quality information in both scope and certainty.

Performance management related to safety is not new, but risk management solutions integrating key performance indicators; incident and near miss data; modeling results; and subjective inputs from the workforce are propelling organizations to the next level. Modern data science techniques are capable of extracting, integrating, and analyzing previously inaccessible and siloed data. Monitoring safety culture and ultimately predicting safety performance are no longer impossible tasks. Taking full advantage of these technologies is the vision for the future of risk management.

In 2018, ABS Group supported organizations in building innovative digital platforms that use data to monitor, analyze and manage various types of operational risk. ABS Group worked with both commercial and government clients to develop data-driven risk models that generate key information about the possibility of unwanted outcomes, intuitively visualize their risk profile, and help apply valuable insights to improve operational safety and efficiency.

Addressing challenges in the era of the Fourth Industrial Revolution requires more creative and innovative ways of problem-solving. ABS Group continued to build on its next-generation risk analysis toolkit which uses techniques from multiple disciplines to solve our clients' operational challenges. In response, we built cloud-based digital platforms and data analytics solutions that leveraged statistics, probabilistic risk assessments, economic modeling, geospatial analysis, simulations, machine learning and workforce surveys.



A fundamental key to leveraging data and digital solutions is high-quality, reliable data. Data quality and data management are foundational to data analytics solutions that can provide significant improvements to safety, cost savings, and sustainable performance across a range of market sectors. Looking ahead, ABS Group will continue to develop new data analysis and data management solutions that enhance risk-based decision-making to reinforce a culture of health, safety, quality and environmental leadership.

As organizations leverage artificial intelligence, machine learning, and emerging data analytics techniques for risk management, these innovative data techniques are helping us achieve sustainable “drive to zero” process safety and HSE performance, superior quality and sustained reliability.



MAKING A DIFFERENCE IN PUBLIC SECTOR SAFETY AND SECURITY

ABS Group's digital capabilities are enhancing safety and driving sustainability by:

- Developing an innovative hybrid machine learning and geospatial modeling tool to help a government agency reduce building inspections (60-70 percent workload reduction) after a flood disaster.
- Implementing geospatial rail solutions to help class I railroad and short line railroad operators choose the lowest risk routes for HAZMAT shipments.
- Modeling the risk of maritime HAZMAT routes to help port communities understand where along a vessel's route neighboring populations may be affected, so that they can better deploy their resources to mitigate risk.
- Creating terrorism risk models for multiple government agencies to help them better understand their risk profile to support the development of sound security policy and optimize the allocation of security forces.
- Advancing a data-driven risk methodology, tool, and process to prioritize safety inspections of HAZMAT shippers and package manufacturers.
- Developing a cloud-based digital platform with enhanced data analytics to extract insights into companies' safety culture.



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GLOBAL MARINE



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MARINE DIRECTION IN CHALLENGING TIMES

Uneven and sometimes volatile performance marred the slow recovery of shipping markets in 2018, but improvement in the global economy and commodity pricing was sufficient to stimulate increased activity in most major sectors.

At the same time, the industry reached a high-water mark in terms of its engagement with environmental regulations and the many varied challenges in the evolving regulatory landscape. Preparations continued for compliance with the 2020 sulfur cap, the U.S. Coast Guard moved towards enforcement of its ballast water discharge rules, and the experience-building phase continued for the IMO Ballast Water Management (BWM) Convention. The IMO also presented the industry with one of the most difficult tasks in modern shipping history, when in April it adopted a radical plan for decarbonization of the shipping industry. This plan proposes to bring marine emissions reductions in line with the goals of the Paris Climate Agreement, and, in so doing, raises significant challenges for the industry going forward.

ABS, meanwhile, working across the spectrum of established and emerging regulatory requirements, combined its core classification expertise with novel services and technology solutions to provide industry-leading guidance for navigating these and other challenges. Throughout the year we helped our clients, and the industry, by fostering innovation, participating in development of groundbreaking technologies, encouraging digital transformation and guiding the way to true sustainability.

As we continued our safety leadership in the shipping industry in 2018, our core dedication to safety remained the driver and the foundation of all our achievements, our innovation, and our longstanding commitment to provide practical, safe and sustainable solutions to complex challenges.



SAFETY

- ABS unveiled e-Certificates, the latest development in its ABS FutureClass™ program, to provide continuously available, tamper-proof, verifiable and secure digital certificates. Fully compliant with IMO Guidelines, the ABS e-Certificate system uniquely allows a simultaneous, vessel-wide view of all applicable certificates.
- As part of its commitment to drive improved safety performance and productivity using digital technology, ABS introduced Remote Surveys, a revolutionary service that makes use of advanced remote inspection equipment such as drones and wearable technology. Augmenting the traditional survey process with remote survey technology will reduce vessel downtime and increase efficiency and flexibility in vessel maintenance.
- Reflecting the growing need for effective tools to counter cyber risk, ABS announced development of a groundbreaking methodology to provide a calculated risk index for vessels, fleets and facilities. Unlike qualitative cyber risk assessments, the FCI Cyber Risk™ model quantifies cyber security risk and gives all stakeholders an actionable strategy to implement across the supply chain.
- ABS and shipyard Hyundai Heavy Industries (HHI) collaborated to develop cyber security requirements for the first ABS Cyber Security-Ready (CS-Ready) Notation, awarded to a very large crude carrier (VLCC). HHI implemented vessel requirements at its yard and ABS examined the cyber-readiness of the critical control systems including management, navigation and communication.



SHIP TECHNOLOGY

- Supporting a consistent approach in the maritime sector, ABS published *Guidance Notes on Additive Manufacturing* for marine and offshore assets. 3D printing has potential to introduce new efficiencies by shrinking spare part lead times. Central to the guidance is aid for manufacturers in creating repeatable, reliable results.
- Reflecting the shift to new sources of auxiliary and propulsive power, ABS published the *Guide for Direct Current (DC) Power Distribution Systems for Marine and Offshore Applications* (DC Power Guide) to support safe application of hybrid technologies. The latest in a series of publications on hybrid electric power systems, including the *ABS Guide for Use of Lithium Batteries in the Marine and Offshore Industries* and the *ABS Guide for Use of Supercapacitors in the Marine and Offshore Industries*, the DC Power Guide sets out requirements for design, installation, testing and survey of DC power distribution.
- Crowley Maritime subsidiary Jensen Maritime and ABS completed a pilot project using 3D computer-aided design models to support classification plan review. By eliminating the need to submit 2D drawings, the initiative is expected to achieve time savings of up to 25 percent and reduce the designer's approval costs.
- ABS introduced ABS CHEM, a program designed to help chemical tanker owners determine if vessel characteristics match cargo criteria. ABS CHEM uniquely allows shipowners to obtain preliminary cargo approval with no interruption to scheduling and loading operations while an addendum is sought.

WITH EYES ON 2030 AND BEYOND, ABS CONNECTS DIGITIZATION AND SUSTAINABILITY

Laying the foundation for the adoption of smart functionality, ABS published comprehensive guidance providing the marine and offshore industries with a goal-based framework for data-driven decision-making based on smart technology. The ABS *Guidance Notes on Smart Function Implementation* support the development of data infrastructure, allowing health and performance monitoring and augmented vessel operations, enabling more informed decisions in support of fast-moving operational and regulatory requirements.

The guidance sets an actionable framework for owners, operators and equipment manufacturers to take smart steps today in preparation for an environmentally sustainable future. Smart technologies use advanced analytical techniques to identify data trends and anomalies providing early indicators to avoid potential failures and vessel downtime. By implementing smart monitoring, vessel and operational data can be leveraged to assist and augment day-to-day operations, forming the foundation for increased autonomy in operation.

The Guidance Notes form the cornerstone of the ABS 'Smart Series' and will be followed by guidance designed to improve data acquisition, processing and analysis and the basis for a condition-based class approach.



ABS BRINGS TOGETHER INDUSTRY TITANS TO DISCUSS THE FUTURE OF LNG

To mark the start of the biannual Posidonia event in Athens, Greece, ABS brought together the leaders in LNG shipping to debate the future of technology, operations and LNG's potential as a transport fuel.

Chairman and Chief Executive Officer of Angelicoussis Shipping Group John Angelicoussis; Executive Chairman of GasLog Ltd. Peter Livanos; Chairman of Dynacom Tanker Management Ltd. George Prokopiou; and Chairman Emeritus of Poten and Partners Michael Tusiani joined ABS Chairman, President and CEO Christopher J. Wiernicki for a two-hour discussion: *The Future of LNG Shipping: What Matters Most?* held at the Stavros Niarchos Foundation Cultural Center.

The panelists offered valuable insights to a packed room on a wide range of issues from the business case for investing in LNG to the impact of shale gas, the prospects for charter and spot rates and future technology trends.

GAS SOLUTIONS

2018 saw ABS continue to provide industry leadership and guidance for LNG carriers, floating structures and systems, gas fuel equipment and systems, and for compliance with new regulatory and statutory requirements.

- ABS supported the first conversion of a slow-speed marine diesel engine to Ethane as a fuel for Navigator Gas, which partnered with MAN Energy Solutions and systems supplier TGE to complete the conversion of *Navigator Aurora's* main engine from LNG to Ethane.
- ABS continued to foster innovation in LNG vessel design, classing *Diamond Gas Orchid*, the world's first 'Sayarigo STaGE' LNG carrier for Diamond LNG Shipping. The innovative design introduces significant improvements in carrying capacity and fuel performance, incorporating a more efficient hull structure and innovative hybrid propulsion.
- *Containerships Nord*, the first of four ABS-classed LNG fueled 1,400 TEU feeder containerships, was delivered by Wenchong Shipyard to Containerships Oy and completed its first LNG bunkering at Rotterdam. The remaining three vessels are scheduled for delivery in the first half of 2019.
- ABS signed a joint development program (JDP) with Probunkers to provide technical support for a fleet of LNG bunker vessels. ABS is working with Probunkers to provide regulatory guidance, define applicable rules and standards, identify technical and operational challenges and advise on technology solutions.



COMPLIANCE AND ENVIRONMENTAL SUSTAINABILITY

Aiding industry preparation for compliance with the 2020 global sulfur cap, ABS released several publications to complement its program of workshops and presentations.

- ABS updated its Advisory on Exhaust Gas Scrubber Systems, providing deeper insights into their installation and operational considerations for existing vessels. The Advisory provides background on available scrubber types and technologies along with information on installation and operational challenges during construction and retrofitting.
- ABS issued the Advisory on Marine Fuel Oil to provide owners and operators with industry-leading guidance on the considerations and challenges with the marine fuels that can comply with the 2020 global sulfur cap requirements.
- Leading Greek shipping industry stakeholders joined ABS for a workshop on drafting 2020 sulfur limit ship implementation plans. Intended to help shipping companies and crew ready their vessels for compliance with the January 2020 deadline, the workshop identified risks associated with vessel design and operations, including a HAZID study.
- ABS continued to provide guidance on the IMO Polar Code, based on the regulation and on operational feedback. This guidance requires the operator to demonstrate a firm understanding of the environment in which the ship will be operating, and to comply with the Code's mandatory Operational Assessment. Additionally, the guidance forms the basis for the mandatory Polar Waters Operation Manual.
- MEPC 72 adopted the Initial IMO Strategy on Reduction of Greenhouse Gas (GHG) Emissions from Ships, the first milestone on the journey to developing a comprehensive strategy for reducing marine GHG emissions. The strategy is intended to drive change by providing greater confidence to the industry and sending a strong signal to stimulate investment in the development of alternative fuels and new technologies.

ABS-LED WORKSHOP FOR MAERSK LINE IDENTIFIES HAZARDS HAVING AN IMPACT ON CONTAINERSHIP SAFETY

Leading containership operator Maersk Line selected ABS to lead a workshop on identifying and evaluating potential hazards posed by stowage of dangerous cargoes on containerships.

The workshop assembled industry stakeholders to conduct a comprehensive Hazard Identification (HAZID) study to better understand key risks associated with cargo. The workshop identified hazards associated with dangerous goods stowage on a range of containership designs, many which are not fully addressed by the International Maritime Dangerous Goods (IMDG) Code. The outcome included recommendations to improve stowage planning and hazard mitigation, leading to better management of risks.

The risks associated with cargo carried on ships can have serious impact on the safety of the crew, and the ship itself, if not properly identified and managed. ABS is continuously looking for ways to expand safety in the marine industry. Workshops like this one leverage knowledge from the industry and provide the opportunity to refine ABS Rules and Guides and consider new guidance.



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ABS JOINS PROJECT TO BRING ‘GAME-CHANGING’ SPACE TECHNOLOGY TO LNG AS FUEL

ABS joined OceanFinance and Scorpius Space Launch Company (SSL) in the SPACE TECH4SEA project to adapt composite technologies first developed for the space industry to LNG containment systems.

The project, which has attracted more than €1m of funding from the European Union, applies composite technology to fuel tanks with the goal of encouraging LNG fueled newbuilds and retrofits by cutting costs, reducing weight and increasing the vessels’ cargo capacity.

ABS is at the forefront of innovation in LNG shipping and its use as marine fuel and believes the use of composite technology has the potential to change the game for LNG as fuel, substantially lowering the barriers to entry.

The three-year project will adapt SSL’s PRESSURMAXX composite tanks for marine applications using composite carbon fiber technology to develop ultralight, compact tanks, making LNG as fuel feasible for a broader range of marine vessels.



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- The MEPC 73 meeting adopted a resolution to prohibit carriage of noncompliant fuel oil for combustion, propulsion or operation on board a ship after January 1, 2020. The prohibition does not apply to ships employing an alternative abatement arrangement such as an approved exhaust gas cleaning system, known as scrubbers.

- ABS published the new *Guide for the Classification Notation Underwater Noise* in 2018 supporting environmentally-friendly ship design and operation to reduce radiated underwater noise. This Guide sets forth requirements for the optional underwater noise class notation as well as the process and criteria to obtain the notation. IMO issued MEPC.1/Circ.833 *Guidelines for the Reduction of Underwater Noise from Commercial Shipping to Address Adverse Impacts on Marine Life*. The European Union developed EU Marine Strategic Framework Directive, 2008/56/EC to address concerns about the underwater noise pollution affecting marine life and habitats. Additional initiatives are encouraging quieter shipping, for example, reduced port entry fees have been implemented for vessels carrying underwater noise reduction measures.



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- With the challenges faced by the industry to meet the Energy Efficiency Design Index (EEDI) Phase 3 targets, entering into force in 2025, wind-assisted propulsion will potentially become an important part of the overall energy efficiency solution for tankers, bulkers and other large ships. In 2018, ABS and MARIN launched a joint industry project (JIP) to develop procedures to assess and compare expected performance of various wind-assisted propulsion technologies—and to develop guidelines related to the strength, stability, mechanical and other features for safe operation of these technologies.
- ABS enhanced its Added Resistance in Wave software, supporting adherence to the IMO Minimum Propulsion Power (MPP) and various government regulations, covering greenhouse gas (GHG) emissions and EEDI related to making ships more efficient to reduce emissions.

EDGE ANALYTICS AND REMOTE INSPECTION TECHNOLOGY TRANSFORM TANK INTEGRITY ASSESSMENT

In 2018, ABS began development of edge analytics, used with remote inspections, to assess tank integrity. Combining drones with edge analytics, human tank entry can be avoided, and time spent reviewing drone footage is drastically reduced. Edge analytics uses Artificial Intelligence to automatically detect, tag and measure coating breakdown and other structural deficiencies. This increases safety and eliminates time spent preparing the tank for human entry, and much of the drydock discovery phase, as well as providing a better estimate of steel renewal and paint work to be performed.



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GLOBAL OFFSHORE



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GLOBAL OFFSHORE

From the very beginning of the offshore industry, owners and operators have relied on ABS to provide the classification services and technical assistance that has helped nearly every major offshore technology make it safely out to sea.

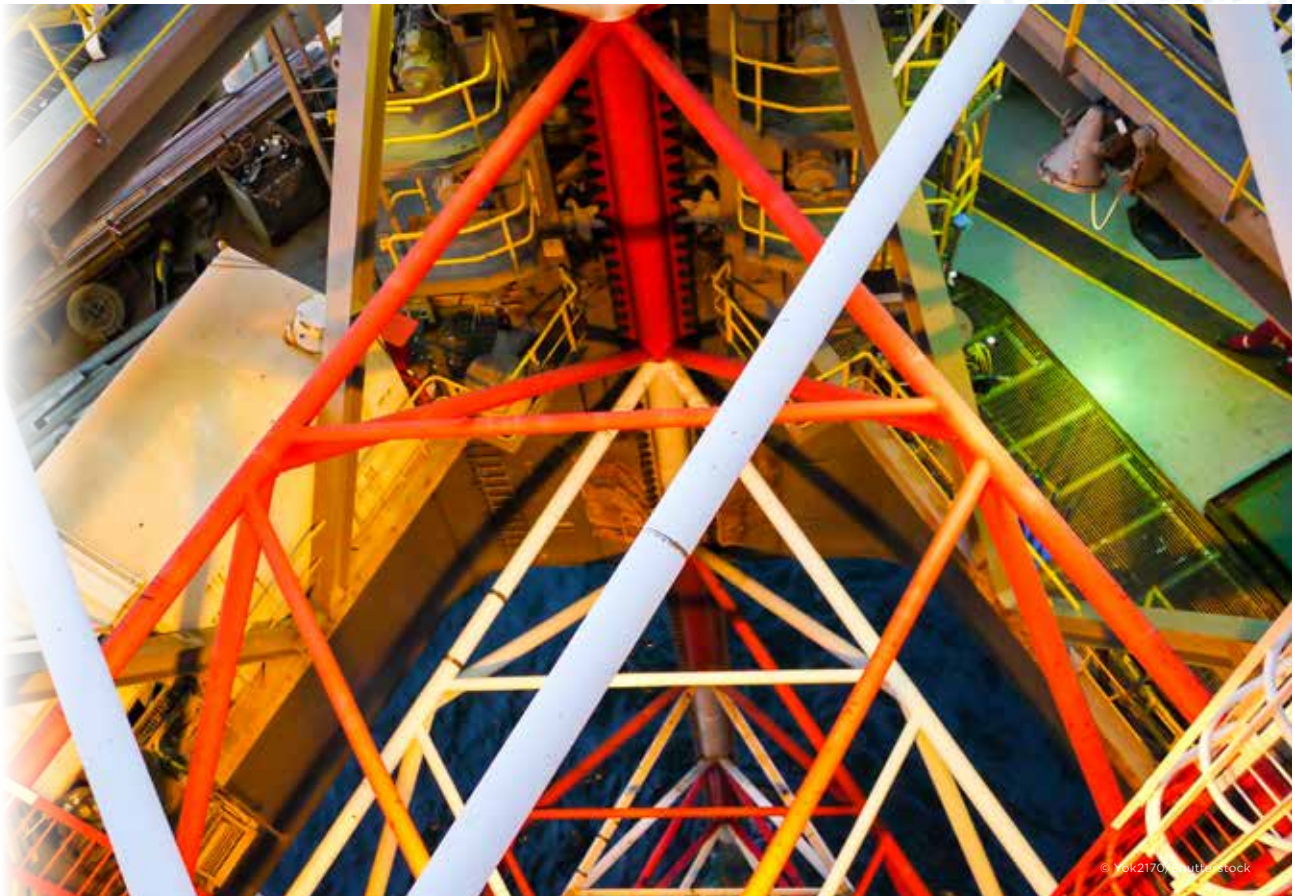
In just a few years, the offshore industry will celebrate its 75th anniversary. Ever since the first rigs were erected out of sight of land, ABS has stood shoulder-to-shoulder with offshore pioneers and producers as they continually advanced outwards and into the depths in their quest to unlock the energy treasure chest that lies beneath the ocean floor.

ABS earned its place as the number one class organization for the offshore sector by providing the technical support that has facilitated nearly every major offshore innovation in history make it safely out to sea. ABS maintained its position as the classification leader for offshore oil and gas in 2018 through significant achievements in diverse areas including smart technologies, managed pressure drilling and hybrid power systems.

This is more than the expression of a proud technology legacy; it is an active participation in a constant, evolving contest that pits daring innovation against dangerous environments with energy as the prize.

Industry activity picked up during the year amid stabilizing oil prices, but markets remained challenging. Owners and operators sought ABS assistance in getting more out of their assets through increased utilization, life extension and conversion, and in preparing for new business via reactivation and other technology investments that increase operational efficiencies. Throughout 2018, ABS addressed a broad spectrum of issues, leveraging its varied expertise to help clients improve operational efficiency and operate safely in many challenging environments.





EXPLORATION

ABS remained the industry leader in the drillship, self-elevating mobile offshore drilling unit (MODU), and semisubmersible MODU markets in 2018, helping clients improve machinery, system and structural safety and collaborating with industry to identify potential safety issues for working assets.

Offshore exploration was marked by low rig utilization and low day rates in 2018. Still, industry forged ahead in many areas with ABS assistance as it awaited recovery.

- ABS awarded the world's first Managed Pressure Drilling (MPD)-Ready Notation to Ocean Rig for its ABS-classed deepwater drillships *Corcovado* and *Mykonos*. The MPD-Ready™ notation attests that the necessary provisions are in place to integrate equipment needed for MPD operations and is based on the *ABS Guide for the Classification and Certification of Managed Pressure Drilling Systems*, the industry's only standalone guide providing specific requirements for MPD systems, subsystems, and equipment in offshore applications for drilling in complex deepwater wells.
- ABS issued the ABS MPD™ notation to Seadrill's *West Capricorn*, a 6th generation ultra-deepwater semisubmersible operating in the Gulf of Mexico (GOM), the first column stabilized drilling unit to receive the ABS MPD™ notation complete with the Maltese Cross, which denotes survey attendance throughout the process, from vendor fabrication to on-board installation. Seadrill previously attained the ABS MPD™ notation, for two drillships in its fleet, the *West Capella* and *West Tellus*.
- ABS published the updated *Guidance Notes on Air Gap and Wave Impact Analysis for Semi-submersibles* in 2018, to address the industry's call for more technical guidance after a serious incident on a semi-submersible in the North Sea. The updated guidance was developed based on in-depth knowledge acquired in an active joint technology initiative with owners and operators—to determine the structural strength required for units to endure high and low wave impacts. The research was conducted over a 10-year period, supporting extensive industry review of the updated Guidance Notes.

LEADING FLOATING WIND MARKET SUPPORT

In 2018, ABS remained at the forefront of technology assistance to the growing floating offshore wind power industry, working with designers and operators to identify risk and provide data-driven risk and reliability solutions for these installations. To date, ABS has been instrumental in formulating global standards for wind platforms, notably working with the International Electrical Commission on standards for the design and fabrication of floating wind installations. As co-chair of the floating group, ABS is collaborating to develop the American Wind Energy Association's Offshore Compliance Recommended Practices, the U.S. standard for offshore wind farms.

In 2018, ABS supported the refurbishment and relocation of the WindFloat I floating wind power plant from Portugal to Scotland, helping the installation become operational within nine months. ABS was also awarded the class contract for the next phase of the Kincardine wind farm development consisting of 5 floating offshore wind turbines supporting 50 MW, scheduled for completion in 2020.

ABS granted approval in principle (AIP) to SBM Offshore for its TLP based floating offshore wind turbine design. The approved design is developed to a technology maturity level of a Front End Engineering Design (FEED) for all relevant extreme and fatigue load cases, using detailed wind and met-ocean conditions for a site offshore France.

ABS also granted approval in principle (AIP) to Neptune for its 178-m wind turbine transport vessel design, capable of moving full-length welded towers and large turbine parts for units to 50 MW, which will be completed in 2020.



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GE AWARDED SERVICE PROVIDER RECOGNITION IN CONDITION-BASED MAINTENANCE

In 2018, ABS awarded General Electric Marine Solutions with Service Provider Recognition for its data analytics-informed solution, Seastream Insight, which provides health and performance monitoring of rig equipment through use of a digital twin. This solution enables condition-based maintenance on ABS-classed rigs, within an ABS Preventative Maintenance Program. By comparing real-time data with its digital twin, it can predict equipment degradation and avoid potential equipment failure, giving early warnings and suggested corrective actions. It is the first such solution recognized by ABS for a third-party service provider.

In October, ABS introduced its *Guidance Notes on Smart Function Implementation*, which offers the marine and offshore industries comprehensive guidance towards a goal-based framework enabling data-driven decision-making based on smart technology, and outlines data infrastructure requirements that facilitate machinery health and performance monitoring. The first in a series of planned publications on smart technology, it sets an actionable framework for owners, operators and equipment manufacturers to take smart steps today in preparation for an efficient and environmentally sustainable future.



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- ABS awarded Sembcorp Marine the industry's first Cybersecurity-Ready (CS-Ready) Notation to its Pacific Class 400 jackup rig. Sembcorp collaborated with ABS in development of the notation by providing a test bed and user feedback. The industry leading ABS FCI Cyber Risk™ model is used in applying the notation. ABS cyber security experts investigated the cyber-readiness of the critical control systems including drilling control systems, electrical power generating and distribution system, vessel management systems, and safety critical systems such as fire detection.
- ABS hosted the first annual Drilling Contractor's Forum, gathering industry leaders to discuss safe implementation of hybrid power systems, maximizing value of digitized assets, emerging inspection technologies and other topics based on feedback from the ABS MODU technical committee.
- In 2018, ABS helped Diamond Offshore evaluate its dropped object prevention program, assessing its processes and procedures to identify opportunities for improvement, leveraging the *ABS Guide for Prevention of Dropped Objects on Offshore Units and Installations* (DOPP Guide). The Guide includes a program of requirements and best practices to protect personnel, assets and working environments from dropped object incidents. ABS provides the industry's only prevention guidance regarding this issue.

TECHNICAL REVIEW AND VERIFICATION FOR FIRST HYBRID-POWER OFFSHORE SUPPORT VESSEL

The ABS *Guide for Use of Lithium Batteries in the Marine and Offshore Industries* establishes safety guidelines for owners, operators, shipyards, designers, and manufacturers for installation and operation of assets using lithium battery power systems.

In 2018, ABS classed the world's first OSV to operate using hybrid power, awarding its lithium-ion battery power system notation to SEACOR Marine for its OSV *Maya*, which is currently operating offshore Mexico. ABS completed key reviews and verifications to the battery integration project, including:

- Review and approval of test reports, specifications, and safety features
- Review and approval of structural documentation on battery containers
- Witnessing testing of the converters that transform battery voltage to ship system voltage
- Review of technical documentation for structural, electrical, HVAC and safety systems, and testing of batteries, convertors, transformers and HVAC units
- Review of technical documentation for installation of containers on board including stability calculations and structural and electrical drawings
- Review of modifications to switchboard drawings for the hybrid system

The vessel was converted in May 2018 at Bollinger Shipyards in Morgan City, Louisiana, and the integration of the lithium-ion battery system was completed and made operational within 90 days, including all approvals. The hybrid power system reduced the vessel's average fuel consumption by 20%, as a result of which SEACOR converted three further vessels with plans to convert an additional six.



SUPERCAPACITOR GUIDE AND HYBRID POWER ADVISORY

Underscoring our position at the forefront of technology, ABS published its *Guide for Use of Supercapacitors in the Marine and Offshore Industries*, a landmark document that defines requirements for design, construction and installation of supercapacitors. ABS also issued the ABS Advisory on Hybrid Electric Power Systems, which evaluates advantages and disadvantages, challenges, and level of readiness for the primary hybrid electrical power systems and components suited for marine and offshore applications.





KEY DELIVERIES AND AWARDS

- OOS Energy, a subsidiary of OOS International, took delivery of ABS-classed drillship *Tiger 1*, constructed at Shanghai Shipyard Industries to ABS class standards. OOS Energy will operate the *Tiger 1* drillship for Pemex, a moored drillship capable of working in water depths up to 5,000 feet with a maximum drilling depth of 31,500 feet.
- Two newbuild ABS-classed jackup rigs, the *SMS Mariam* and the *SMS Faith* were delivered to Selective Marine Services. The rigs were constructed at the China Merchants Heavy Industry Company (CHMI) Shipyard and are operated by GustoMSC, an NOV company.
- ABS was selected by Japan Drilling Company (JDC) to class its *Hakuryo-14* jackup rig at delivery. It was constructed by PPL Shipyard, a subsidiary of Sembcorp Marine. Pertamina hired the rig for drilling in the Mahakam Block, offshore Indonesia.
- Borr Drilling took delivery of the ABS-classed *Natt* jackup rig, constructed by PPL Shipyard, a subsidiary of Sembcorp Marine. First exploration and production (E&P) hired the *Natt* independent leg cantilever rig for drilling operations in offshore Nigeria.
- International Maritime Industries Company (IMI), selected ABS to class a newbuild jackup design, the LJ43, for the first two rigs of a planned 20-vessel order, for delivery to Aramco Rowan Offshore (ARO). The LJ43 design is a collaboration between GustoMSC and Lamprell; it incorporates a high capacity cantilever design featuring an innovative blowout preventer (BOP) handling system, which is intended to increase uptime for operations in the Middle East.

ABS AND KEPPEL PARTNER ON INDUSTRY'S FIRST SMART RIG

ABS and Keppel FELS, a wholly-owned subsidiary of Keppel Offshore & Marine, worked in a joint development project (JDP) to integrate smart functions towards delivery of the first newbuild smart rig. Working with Keppel, ABS refined its methodology to verify and validate smart functions, supporting a more data-centric approach to survey after construction and ultimately assisting rig owners to move to a rig-specific condition-based class (CBC) approach.

The rig collects data from a range of sensor technology monitoring machinery and structural health to improve asset performance. The rich stream of data will allow ABS to derive data-driven insights to focus surveys on areas that need attention, while Keppel looks to transform the efficiency, safety and operability of the rig.

ABS introduced *ABS Guidance Notes on Smart Function Implementation*, comprehensive guidance providing the marine and offshore industries with a goal-based framework to enable data-driven decision making based on smart technology.

“This rig is equipped with our proprietary RigCare Solution - which encompasses a suite of digital services in close collaboration with ABS and partners to support the rig’s life-cycle needs. RigCare Solution will significantly transform the efficiency, safety and operability of the rig. We greatly appreciate the support from ABS in this JDP.”

TAN LEONG PENG
EXECUTIVE DIRECTOR,
OFFSHORE,
KEPPEL OFFSHORE & MARINE



PRODUCTION

Offshore industry activity picked up during the year. However, in large part due to continuing onshore shale production, the offshore production sector remained challenging.

- SBM awarded ABS the classification contract for the floating production storage and offloading (FPSO) *Liza Unity*. Operated for ExxonMobil, it is one of the world's largest floating production facilities for the Stabroek block, offshore Guyana. The FPSO will be designed to produce 220,000 barrels of oil per day (BOPD), will have associated gas treatment capacity of 400 million cubic feet per day (cfpd) and water injection capacity of 250,000 barrels per day. The FPSO will be spread moored in water depth of about 1,600 meters and will be able to store around 2 million barrels of crude oil.
- ABS was awarded class of the FPSO platform for the Layang field in offshore Malaysia. Yinson is undertaking conversion and operation of the VLCC for JX Nippon.
- ABS was awarded the class contract for the *Hai Yang Shi You 121* floating storage and offloading (FSO) in Lufeng field 13-2, by China Merchant Heavy Industry (CMHI), which it is constructing for the China National Offshore Oil Company (CNOOC). When completed, the vessel will have storage capacity of about 800,000 barrels.
- ABS received the class contract for the LLOG semisubmersible for King's Quay development in the Green Canyon Area in the GOM. The semisubmersible, constructed by Hyundai Heavy Industries (HHI), will be installed in 5,000 feet of water, and is designed to handle 80,000 BOPD, 200 million cfpd of gas and 40,000 BPD of produced water.
- ABS was selected to class a floating storage and regasification unit (FSRU) for BOTAS, Turkey's oil and gas pipeline operator. The 170,000 m³ FSRU will be built at Korea's Hyundai Heavy Industries shipyard.
- ABS granted approval in principle (AIP) to a new FPSO design by HHI. The barge shaped hull design features a two-million-barrel capacity, a 25-year lifetime without drydocking, and structural reinforcement to support topsides installation.



- ABS also granted an AIP to HHI's deepwater floating liquefied natural gas (FLNG) hull design, which the builder expects can be constructed for less than half the cost of a conventional FLNG hull. It is based on LNG carrier designs and, like the FPSO, features structural reinforcements to take topside module loads and a hull designed for a 25-year operating life without drydocking.
- ABS engaged with industry in various projects providing policies and procedures on asset data collection and its use, enabling a more proactive approach to life extension assessments for aging assets.
- Integrating digitization and life extension, ABS contracted with Shell, SBM Offshore and Rio de Janeiro Federal University (UFRJ) to develop what is being called a 'life extension meter.' The project involves developing analytical models representing FPI structural profiles enabling owners to develop planned and predictive maintenance strategies and life extension programs.

SUBSEA

- The China National Offshore Oil Company (CNOOC) awarded ABS a contract to provide classification for its expanding subsea activities in China, along with performance standards for moorings, risers and sulfur cap emissions. ABS also won a contract with the China Classification Society (CCS) to provide joint certification services to CNOOC for offshore fixed platforms, subsea pipelines and systems in China's Lufeng Four field.
- ABS issued the industry's first "Concept Verified" Statement of Maturity to Stress Engineering Services Inc. for its riser condition-based monitoring (CBM) services program, and to LaserStream LLP for its bore-erosion measurement and inspection system, BEMIS™. This is the second of five technology qualification stages to be completed by Stress and LaserStream for their new technologies that support structural integrity evaluation and maintenance assessments of drilling risers. The "Concept Verified" stage follows requirements outlined in the ABS *Guidance Notes on Qualifying New Technologies*, which uses a five-step systems engineering approach to evaluate new technologies for incremental risks from concept stage to operational maturity.



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- ABS issued a *Subsea Processing System Advisory* in 2018 to help industry evaluate subsea processing systems. The Advisory provides an overview of the available technologies, maturity levels, challenges and future trends.
- The ABS subsea group presented a paper, *Life Extension of Deepwater Risers Used for a Spar Application in Gulf of Mexico*, which specifically addresses configuration of the steel catenary risers (SCRs) and top tensioned risers (TTRs) used for Spar platforms, and profiles a data-driven, integrity centric approach for life extension of deepwater risers.

OFFSHORE SUPPORT VESSELS

ABS remained the industry leader in the offshore support vessel (OSV) market in 2018, and demand edged up three percent, as marginally higher day rates tempted units out of layup, a growing reactivation trend that included vessels in service less than 15 years. Because reactivating OSVs and MODUs can be a lengthy, complicated process, ABS introduced its Drilling Vessel Layup and Reactivation Service, which provides development plans that quantify budgets and timelines for layup and reactivation of these offshore assets. The service helps owners identify the strategic steps required for layup and reactivation, providing owners with an effective and efficient approach to meeting class-reactivation requirements.

- Offshore asset deliveries for 2018 included 68 OSVs, 16 self-elevating non-drilling units, and two single point mooring (SPM) systems.
- ABS signed a contract with Sapura Offshore for 13 SPMs to be built by SBM Malaysia, a contract with Hengtong Huaxi Offshore Engineering for two self-elevating units (SEUs) to be built by Nantong Yahua Shipbuilding Group, and a contract with Woenn Jinn Harbor Engineering for a cable layer to be built by DDW-Paxocean Shipyard.

Looking beyond the energy sector, ABS expanded its work by providing services to vessels and facilities associated with offshore fish farms, classing vessels that transport live fish off the Chinese coast and agreeing to provide classification services to vessels and a fish farm scheduled to complete construction in 2019. To assist this sector, ABS developed its *Guide for Building and Classing Offshore Fish Farming Installations* covering harvesting, transportation, processing and delivery of live fish.

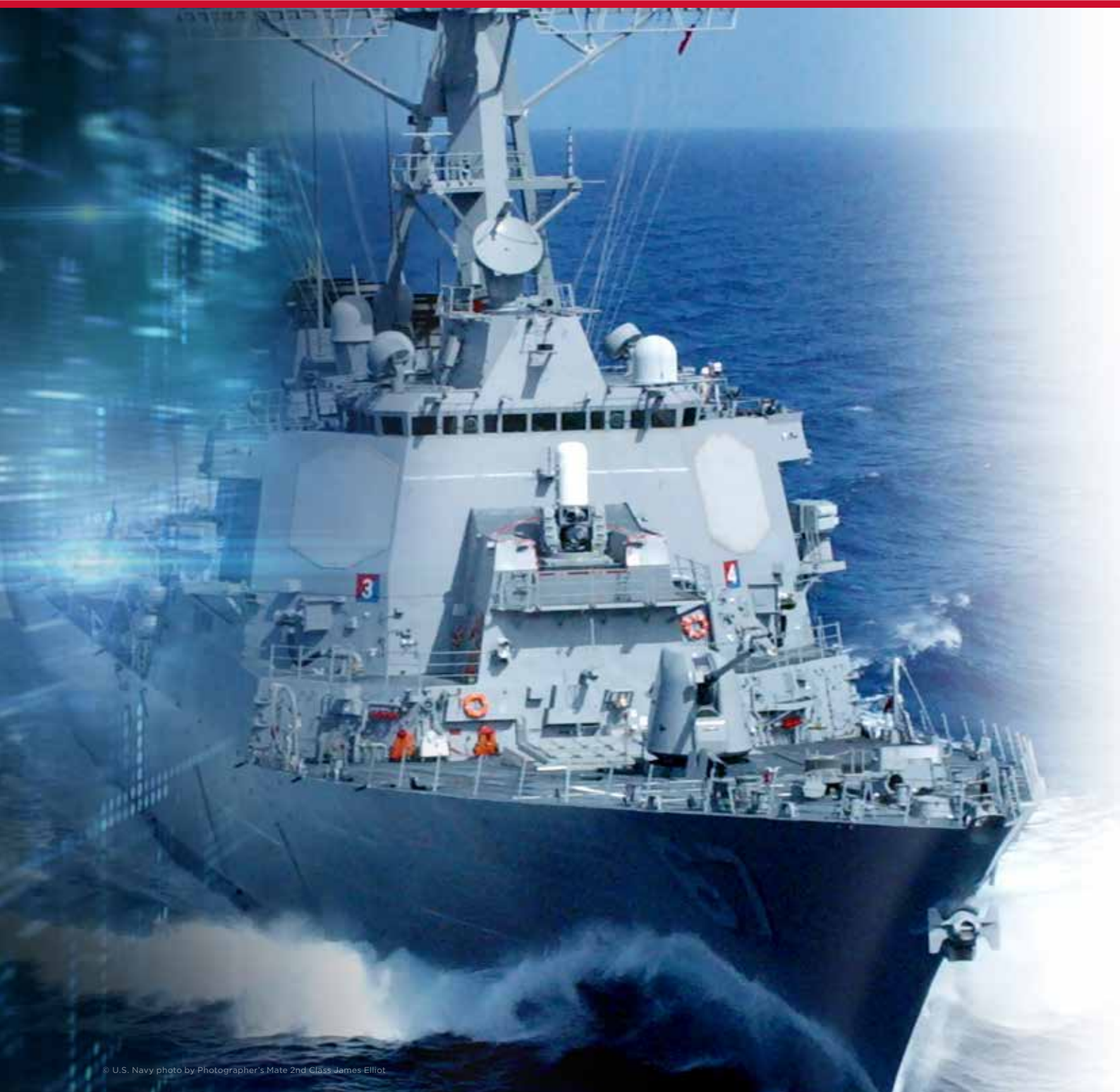


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SAFETY LEADERSHIP | DRIVING SUSTAINABILITY

GLOBAL GOVERNMENT



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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 bonds between ABS and the U.S. government were forged in the smoke and fire of the First World War, 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 nearly 100 years, ABS has been the official classification organization of the United States and, under U.S. law, the only classification organization authorized to class U.S. government vessels. There are nearly 200 government-related ABS-classed vessels in the U.S. alone. Today ABS continues to provide leading classification services supporting the U.S. Coast Guard, Navy and other government shipowners in uninterrupted global force projection, law enforcement, research, survey and logistic operations.

ABS works on behalf of the U.S. government to provide steadfast support for its required safety regimes.

- The ABS-classed, NASSCO built, USNS *Hershel “Woody” Williams* (T-ESB-4) was delivered and entered service with Military Sealift Command (MSC). The T-ESB-4 vessel was built based on the Alaska-class oil tanker design to augment the Navy’s fleet of maritime sealift and amphibious warships supporting a variety of maritime based missions including Special Operations Force, Airborne Mine Counter Measures operations, humanitarian support, and command and control of traditional military missions.
- Austal USA delivered the ABS-classed Expeditionary Fast Transport (EPF) ship USNS *Burlington* (EPF 10) to the U.S. Navy’s MSC. The EPF program provides the Navy with a high-speed intra-theater transport capability. The 338-foot long *Burlington* is an aluminum catamaran capable of transporting 600 tons, 1,200 nautical miles at an average speed of 35 knots and is designed to operate in austere ports and waterways adding flexibility to U.S. warfighters worldwide. The ship’s flight deck supports flight operations for a wide variety of manned and unmanned aircraft.
- ABS was awarded a two-year contract by the U.S. Navy’s MSC to deliver the maritime industry’s first CBC asset management program. The objective of the joint project is developing digital solutions to increase MSC’s operational availability as well as enabling the move from calendar-based surveys to a CBC model. ABS is collecting data throughout the project from sensors installed throughout the hull and all classed machinery aboard three MSC vessels: USNS *Spearhead*, an expeditionary fast transport craft; USNS *Amelia Earhart*, a dry cargo/ammunition vessel; and USNS *Pomeroy*, a large ro/ro vessel.





© U.S. Navy photo by Photographer's Mate 2nd Class James Elliot

- ABS was awarded the class contract by VT Halter Marine Inc., for the first of four auxiliary personnel lighter—small APL(S) craft for the U. S. Navy. APL(S) Barracks Craft (berthing barges) house crewmembers when ships are under repair or modification. The Navy's APL(S) are mobile and are easily towed to support changing fleet requirements; they also offer potential use for humanitarian missions and other temporary assignments.
- ABS was awarded the class contract by Gulf Island Fabrication, Inc. through its subsidiary Gulf Island Shipyards, LLC, for a towing, salvage and rescue ship (T-ATS) with the U.S. Navy with an option for seven additional vessels.
- ABS was awarded the class contract by Vigor Shipyard in Ketchikan for two new ferries for the Alaska Highway System. The first of these ferries, the *M/V Tazlina*, was delivered in 2018, the second, the *M/V Hubbard*, is slated for delivery in 2019. The ferries were designed and constructed in-state as a part of an initiative to develop the local Alaska shipbuilding industry.
- ABS is under contract to develop a U.S. government cyber notation to the specific requirements of the U.S. Navy's MSC to validate its cyber resilience program.

SUPPORTING INTERNATIONAL GOVERNMENTS

ABS continued to grow and develop its global partnerships in 2018, expanding the breadth and depth of its work with international governments.

- ABS was awarded a contract by the Canadian Coast Guard to provide classification and certification services for its existing fleet of 114 vessels and future vessel acquisitions, building on its 2017 Non-Combatant Class Society (NCCS) classification contract award by the Canadian Department of National Defense for the Royal Canadian Navy's non-combatant vessel fleet. ABS will survey the Canadian Coast Guard vessels under the Delegation of Statutory Inspection Program (DSIP) to verify compliance with the Canada Shipping Act and its regulations and issue all vessels the required Canadian Maritime documents under the authority of the Minister of Transport.
- ABS was awarded an inspection services contract for seven ferries by the New Brunswick Department of Transportation and Infrastructure. These services build on the strong relationship ABS has developed with Transport Canada (TC) and its extensive experience with TC regulations, and particularly with Transport Canada Marine Safety and Security (TCMSS) implementation of the Delegated Statutory Inspection Program (DSIP).
- ABS classed the newly converted LNG fueled ferry, *Spirit of British Columbia* representing a significant environmental milestone for BC Ferries' fleet. The *Spirit of British Columbia* was the first to undergo conversion while its sister vessel, the *Spirit of Vancouver Island*, also to be ABS-classed, is expected to complete conversion during the spring of 2019. These vessels are the largest ships in the BC Ferries fleet with a capacity to carry 2,100 passengers and crew and 358 automobile equivalents.
- ABS was awarded a contract for classification during construction by SAFE Boats International for eight, SAFE 35 Multi-Mission interceptors, High-Speed Craft for delivery to the Hong Kong Police Force.

SAFETY LEADERSHIP | DRIVING SUSTAINABILITY

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SAFETY LEADERSHIP | DRIVING SUSTAINABILITY

ABS GROUP OF COMPANIES, INC.

ABS Group of Companies, Inc. (ABS Group), through its operating companies, provides risk-based engineering, safety, performance and certification solutions to support operational excellence in the industrial and government sectors. The organization's technical advisory services deliver value to global markets including the aerospace, automotive, critical infrastructure, manufacturing, marine, oil and gas, petrochemical, pharmaceutical and process industries.



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ABS GROUP OF COMPANIES, INC.

To sustain leadership in risk, reliability and integrity management, ABS Group positioned itself competitively in 2018 through a range of technical and advisory services including process safety management, asset integrity management and performance optimization, and management systems certification.

ADVANCING SAFETY, INTEGRITY AND RISK MANAGEMENT SOLUTIONS FOR OPERATIONAL EXCELLENCE

Sustainability and diligence are inextricably intertwined. The practices, processes, standards and technologies that help companies achieve sustainability must be diligently maintained and continuously improved if sustainability is to be upheld and become a company's steady-state condition. Two critical elements in achieving and maintaining sustainable operations are risk mitigation and regulatory compliance.

For nearly 50 years, ABS Group has continued to set standards of excellence in risk-based process safety, asset integrity and regulatory compliance management for commercial and government clients. As a recognized industry leader and trusted risk advisor, ABS Group delivers technical services to support the safety and reliability of high-performance assets and operations globally.

In 2018, ABS Group helped clients in the aerospace, alternative energy, automotive, chemical, industrial manufacturing, marine, oil and gas, pharmaceutical and government sectors develop new tools, techniques and methods of problem-solving that help reduce business risk and improve performance across the full asset life-cycle and value chain.





Solutions that contributed to the ABS Group 2018 achievements included:

- Improving global safety culture and performance to protect asset owners' license to operate, facilitate regulatory compliance and drive operational excellence
- Addressing strategic asset integrity management through more data-driven, technically robust and integrated solutions aligned with reliability and optimization strategies
- Certifying the management systems of companies in new markets to the latest international standards, including the first international airport system and first healthcare system certified to the ISO 55001 Asset Management Standard
- Sharing best practices and lessons learned to help asset owners improve effectiveness and efficiency and plan for long-term success

Globally, ABS Group continued to provide key technical safety and risk management services in 2018, including risk-based inspection, damage mechanism assessment/review, equipment certification, reliability engineering, incident investigation/root cause analysis and data management for industrial facilities. One standout success was achieved by our data analytics team when it played a key role in developing a rapid natural disaster damage assessment tool for the U.S. Federal Emergency Management Agency (FEMA), and received the agency's annual innovation award.

At ABS Group, the enduring focus of our technical engineering and risk advisors is helping clients improve their operational efficiency and effectiveness, with process safety management (PSM) and health, safety, quality and environment leadership driving this strategy.

REDUCING COSTS WITH COMPREHENSIVE ASSET LIFE-CYCLE MANAGEMENT

In many industries, diligence is the key not only to sustainability, but also to survival. This is especially true for the oil, gas, chemical and other process industries, which must maintain the highest levels of safety, integrity and reliability in order to protect stakeholder value and preserve their organizational license to operate.

Throughout 2018, ABS Group provided essential assistance to companies in these and other markets through a full suite of technical solutions that enable greater process and performance efficiencies throughout the asset life-cycle. Core services focused on adding value through the adoption of new technologies and the application of data insights that help clients improve asset integrity management (AIM) programs and achieve better asset performance for long-term profitability.

Our integrated technical engineering, safety, and risk management services helped industrial and government clients reduce inspection and maintenance costs for critical infrastructure and global facilities ranging from aging petroleum refineries to newbuild LNG export facilities. ABS Group provided comprehensive AIM solutions to help midstream businesses improve fixed equipment and piping inspection programs, develop risk-based inspection and corrosion mitigation programs, and apply cost-effective maintenance and data management strategies.

Building on our nearly 50 years of accumulated knowledge and experience solving mechanical integrity issues for pressure equipment owners and operators, ABS Group began assisting one of the largest energy infrastructure companies in North America with establishing an AIM program for its new LNG terminal. The scope of work included performing damage mechanism assessments, developing risk-based inspection plans and identifying condition monitoring location placement. The work has resulted in significant cost savings due to more technically based and robust determination of inspection and nondestructive evaluation (NDE) requirements.

ABS Group also strengthened its American Society of Mechanical Engineers (ASME) Authorized Inspection Agency services in Europe in 2018 to support U.K.-based clients in pressure equipment certification and regulatory compliance. As a member of the Pressure Vessel Manufacturers Association, ABS Group continued to provide multidisciplinary consulting and engineering capabilities in project certification, verification, quality assurance and inspection for clients globally.





Photo courtesy of the Greater Houston Community Foundation

MITIGATING PUBLIC RISK THROUGH INNOVATIVE DATA TECHNIQUES

Unprecedented rainfall and flash flooding in several metropolitan areas of the United States during the last few years resulted in some of the costliest natural disasters in the nation's history. In response, government agencies sought to apply data-driven solutions to aid the relief efforts and damage assessments that follow such disasters. In 2018 ABS Group responded to this call with innovative data techniques that helped a government agency reduce inspection costs and improve its structural damage assessment process to expedite recovery activities.

In the wake of a flooding event, communities participating in the U.S. National Flood Insurance Program (NFIP) are required to undergo inspection by local floodplain administrators, who determine whether structures within the flood areas are to be considered "substantially damaged". Since efficiency, speed and transparency are critical during large-scale disaster recovery, ABS Group helped develop a rapid response machine learning tool to predict damage levels. Our data analytics and data management solution helped regional agency officials complete timely damage determinations and reduce unnecessary costs associated with the inspection process.

ABS Group also conducted a root cause investigation of flooding in New Orleans that occurred in August 2017. Our team evaluated the performance of equipment and personnel through data analysis, interviews and inspections; analyzed pumping and power equipment maintenance system implementation and funding; and developed causal factors and root causes which led to the flooding. The comprehensive evaluation provided extensive recommendations for city management to reduce the potential for damage from natural disasters and man-made hazards.

Industrial facilities around the world also benefited from our risk-based approach and expertise, which helped many organizations improve scale inspections, timeliness of delivery, consistency in data management and transparency in documentation processes.

Facilities that must contend with unique risks stemming from natural hazards often turn to ABS Group for assistance, due to its decades of experience in this specialized area of risk management. ABS Group was selected by a state water district to analyze the performance of its facility under seismic loads, and to develop seismic retrofit and building improvements to mitigate seismic risks. The design solution, completed in 2018, provides improvements that include strengthening of existing concrete structures and application of advanced engineering services combining risk-based engineering, seismic assessments and state-of-the-art nonlinear time history structural analyses. For this elegant solution, the Advanced Engineering division of ABS Group was awarded the 2018 St. Louis Council of Construction Consumers Best Practice Award for a structural renovation project.

2018 saw ABS Group continue to expand its cyber capabilities for clients in the government sector. The Space and Naval Warfare Systems Command (SPAWAR) Systems Center Atlantic awarded a contract to ABS Group and a consortium of technology companies to provide an understanding of the full-risk picture of cyber threats to naval operations, and to develop risk-informed mitigation strategies. ABSG Consulting Inc. (ABS Consulting), a subsidiary of ABS Group, will provide cyber risk and security support services to SPAWAR. The ABS Consulting scope of work will include engineering-based risk assessment, strategic planning and advanced analytics support to determine cyber mission risk vulnerability and marine navigation control system effectiveness onboard U.S. vessels.

This long-term commitment to developing a comprehensive cyber-risk management solution underscores ABS Group's place as a leading technical services provider and reaffirms its reputation for expertise, earned through nearly five decades of service to the maritime industry.





SETTING GLOBAL FIRSTS IN ASSET MANAGEMENT SYSTEMS CERTIFICATION

At ABS Group, we are committed to environmental safety, quality and care while helping organizations minimize their risk exposure, improve operational efficiency and promote safer, more reliable and compliant assets.

ABS Quality Evaluations, Inc. (ABS QE), the management systems certification subsidiary of ABS Group, remained a global leader in 2018, providing accredited management system audits and training for a number of focus areas including quality, environmental and corporate social responsibility, as well as market segments including aerospace, automotive and chemicals.

The key standard in asset management is ISO 55001:2014, which establishes international requirements for best practices. Compliance with ISO 55001 demonstrates that organizations are striving for a culture of proactive, continual improvement in managing assets with improved control of day-to-day activities and business efficiencies, reduction of risk-related costs, compliance in regulatory activities and reduced failure rates with an overall improvement in financial performance.

Throughout 2018 ABS QE continued to be a global leader in asset management services, as the only certification body accredited by the ANSI-ASQ National Accreditation Board (ANAB) to certify organizations to ISO 55001. ABS QE set two global milestones during the year by awarding the first ISO 55001 certification to a healthcare system, as well as to the busiest international airport system (based on passenger boarding). In 2018, ISO 45001 replaced OHSAS 18001 as the leading standard for occupational health and safety. This is the first global standard addressing workplace risk management to prevent injuries, ill health and fatalities, and supporting safer working environments for continuous improvement of occupational health and safety performance. In addition to helping clients transition from OHSAS 18001 to the new ISO 45001 standard, ABS QE developed a webinar series to assist organizations in understanding the new ISO 45001 standard requirements.

ABS QE successfully helped clients around the world meet the deadline for transition to the latest international standards, and delivered significant organic revenue growth for the year driven by transition audits related to the ISO 9001:2015 quality management standard, ISO 14001:2015 environmental management standard, AS9100D:2016 aerospace quality management system standard and IATF 16949:2016 automotive quality standard.

EAM SYSTEMS: OPTIMIZING ASSET PERFORMANCE AND RELIABILITY

The role of the reliability and maintenance engineer remains a critical one in the digital era, as knowledge and experience provide the critical link between data analysis and insight-driven action. Our reliability engineers developed solutions in 2018 addressing the Industrial Internet of Things (IIoT), predictive and prescriptive analytics, artificial intelligence and root cause analysis using machine learning for better optimization of enterprise asset management (EAM) systems and processes.

2018 saw ABS Group provide global EAM and reliability engineering solutions to many industries, including agribusiness, life sciences, facilities, manufacturing, education, utilities and renewable energy. Through its asset performance optimization (APO) service line, ABS Group helps clients in diverse markets reduce maintenance costs, manage physical assets, upgrade systems and optimize business processes for improved asset performance, increased uptime and reduced life-cycle costs.

As the reliability and maintenance industry continued to face the challenge of adapting to an ever-expanding range of tools and techniques on the market, the APO team focused on providing a greater understanding and awareness on how to practically update EAM systems and improve the effectiveness and efficiency of EAM processes in the era of the Fourth Industrial Revolution.

The APO service line continued to leverage experience gained from hundreds of EAM system implementations and provided value to clients by applying a risk-based approach to maintenance. Value-added activities in 2018 included developing more accurate master asset lists, performing spare parts and root cause analyses, and ranking asset criticality to determine priority and requirements for asset maintenance to maximize the return on investment.

A major area of continued focus in 2018 was facilities management for industrial manufacturers in the pharmaceutical, food and agriculture industries, as well as universities and other public sector enterprises. To control the increasing complexity of assets found in a single industrial plant, on an educational institution's campus, or across global manufacturing sites, EAM systems have become more mobile, responsive and predictive in managing asset data. ABS Group helped facility managers improve maintenance scheduling, with a more complete risk understanding, and applied robust, data-driven EAM solutions to improve asset management for more reliable operations.



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