WHITE PAPER

AUTONOMOUS SHIPS AND SAFETY AT SEA

ONE SEA
Autonomous maritime ecosystem

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Foreword

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Advances in connectivity and digital technologies are transforming all aspects of life today, and most notably, through the recent months of global pandemic. In a marine context, and combined with advances in ship autonomy, they are also having a dramatic impact on global shipping with major implications for the future.

I am proud to say that amongst the membership of the One Sea alliance, we have some of the world's most distinguished marine automation technology innovators and enablers. Independently, our members will affirm that in principle there are few technological constraints on the potentially autonomous ships of the future. In the years ahead, they envisage autonomous ships making a significant contribution to raising industry productivity, enhancing sustainability and improving the conditions of those working at sea.

Perhaps less fully appreciated is the direct and powerful contributions autonomous ship technologies are and will make to enhancing maritime safety. The purpose of this publication is to examine the safety gains for shipping being achieved and expected, in order to drive the wider consultative process without delay.

All of us realise that technology depends on a robust regulatory framework and, as technology pioneers cooperating in our autonomous shipping ecosystem, we have considerable knowledge and expertise to offer as new rules and regulations are drawn up.

After all, where 'autonomy' includes the greater use of automated systems in deep-sea and coastal trades, remote control systems to improve tug and port service vessel safety in busy port areas, or fully autonomous systems for short-haul crossings between two points, the vessels concerned will continue to be manned. Indeed, far from posing a threat to seafarers' jobs, such solutions will demand new skill sets of seagoing personnel. And to reflect these developments, it is fair to say that a new regulatory framework is now urgently required.

One Sea members spearheading new initiatives in ship autonomy in Europe and Asia are engaging not only with national maritime authorities in the development of specific projects within their jurisdictions, but also at an international level in the development of this global regulatory framework.

Introduction

Global shipping is facing at least three decades of momentous change as it adapts to Industry 4.0 and an unprecedented transition to carbon-free fuels that have not yet even been developed for marine applications.

Industry 4.0 neatly describes the challenges faced by shipowners and operators today. It represents the combination of new digital technologies which offer scope for significant efficiency gains, increased transparency and thus improved decision making, and the adoption of operational automation and potentially autonomous ships in the future.

At first sight, the link between the marine fuels of tomorrow and ship autonomy seems remote. But it's not. None of the fuels currently under consideration, as shipping's decarbonisation drive gathers pace, are as energy-intense as the hydrocarbons used today. Not only will new fuels be several times more expensive, but in most cases they will also require more storage space on board ship, more frequent bunkering, and more rigorous safety standards and handling procedures.

With no action, shipping's new sources of power will have a significant impact on ship operating efficiency. Higher costs, less space on board ship for revenue-generating cargo, more time to load fuel… these will all have an impact on productivity.

This is one reason the work of One Sea and its members is so essential. While the end goal may be to facilitate autonomous maritime logistics, the waypoints will establish new systems and procedures, based on the internet-of-things, all of which can contribute to efficiency gains. Individually, the impact may be marginal, but taken together, they have the potential to generate significant contributions to shipping's climate-related profile.

Another reason, and one which has perhaps been misunderstood, relates to the safety of those working at sea. Indeed, according to One Sea member Kongsberg, autonomous ship technology provides a focus for "removing humans from hazardous working environments onboard vessels, reducing the likelihood of human error by introducing smarter systems that are highly automated and autonomous to various degrees, (and) improving the internal and external situational awareness".

One Sea is a high-profile collaboration of stakeholders including shipping companies, technology developers and enablers, autonomy experts, satellite communications providers, and IT specialists. Its aim is to assist in the development of safe autonomous systems in global shipping that could lead towards an effective operational maritime ecosystem by 2025.

We also aim to expand our membership, particularly in Asia and the Americas, because we believe that collaboration involving as many stakeholders as possible is essential as global shipping faces the challenges of digitalisation and the development of autonomous systems. As a priority, we also seek to engage in constructive and purposeful dialogue with the regulators, insurers, representatives of maritime labour, training establishments, flag administrations and classification societies who can help shape the future of autonomous shipping for the satisfaction of all.

The One Sea ecosystem plans to set the course for new industrial standards. In doing so, we invite all stakeholders to participate fully in the development of these standards based on their likely consequences for marine safety, as well as for facilitating new business models, reducing shipping's carbon footprint, and opening new commercial opportunities.

1 | Today's safety framework

We sometimes envisage the world's seas populated by autonomous vessels, operating in a coordinated network alongside traditional vessels manned by seafarers. But in the real world, experts across most of shipping's skill sets believe this scenario is still some years ahead.

That is not to say, however, that we should not embark on the voyage. Every digital advance, every autonomous development offers potential to raise safety standards, improve efficiency, and improve the life and working conditions of millions of seafarers. Potential benefits include a reduced risk of human error, improved safety of life at sea, more shipboard capacity for cargo and/or fuel, and improved productivity.

In a topical instance, a recent Tradewinds article revealed that the ultra large container ship, Ever Given, which caused one of shipping's highest-profile accidents when she grounded and blocked the Suez Canal, actually had two pilots on board at the time. Interviewed by the newspaper, Capt. John Dolan, Standard Club's Deputy Director of Loss Prevention and head of the International Group of P&I Clubs' subcommittee on pilot safety, said that vessel monitoring technology could play a role in reducing accidents and aid the sometimes poor communication between ship masters and pilots.

Shipping's regulatory regime is structured on several levels. They range from international conventions negotiated, drafted, adopted and ratified by the IMO and its 174 members, to national jurisdictions, flag authorities, and regional regulations applying to access channels, the waters of ports, harbours, fjords and estuaries.

Apart from the pace of autonomous development, which has accelerated, the backdrop has not changed much since the Standard Club's Senior Claims Director, Heather Maxwell, wrote in the P&I club's Technology Bulletin[1] in 2018. Referring to international trade by sea, she stated: "The predicted degrees of ship automation and the timeframes to implementation can vary dramatically, but the simple fact is that the current legal framework lacks the basic language required to account for autonomous ships in any capacity."

Maxwell highlighted some of the principles enshrined in shipping's legal framework today. From a practical point of view, in Article 94.4 of the UN Convention on the Law of the Sea 1982, ships are required to have a master who is "in charge" at all times. Meanwhile, the IMO's Convention on the International Regulations for Preventing Collisions at Sea 1972 (COLREGS) provides navigation instructions for ships to follow to prevent collisions.

But she pointed out that the instructions only apply when 'one ship can be observed visually from the other'. Rule 5 (Lookout), she explained, insists above all on perception and judgement to assess the 'special circumstances' and to make a full appraisal of the risk of collision. "Whilst it is feasible that ships remotely operated or monitored from ashore could satisfy these conditions, it is difficult to see how a fully autonomous ship ever could," she wrote.

Turning to the International Convention for the Safety of Life at Sea (SOLAS), minimum standards of safety at sea are set out, including an obligation for masters to assist a ship or person in distress. "Regulation V/33 explicitly requires masters to deviate to save life," she noted. "In some cases, autonomous ships may be better at responding to distress signals, but sometimes there can be no substitute for visual identification.

Maxwell concluded by pointing out that not only will international regulations framed by the IMO have to be overhauled, but so too will individual countries' own shipping legislation. According to the UN, she noted that the Law of the Sea Convention 1982 was implemented as an update to the centuries-old freedom-of-the-seas doctrine in order to account for 'the technological changes that had altered man's relationship to the oceans'.

Now is the time to re-evaluate our relationship once again, she declared.

1 Standard Club Technology Bulletin, September 2018

2 | Cyber security

The digital revolution has come upon global shipping so quickly that it is no great surprise that cyber security systems have not necessarily kept pace with progress. At various online webinars and presentations recently, experts have warned that an approach based broadly on compliance with newly introduced IMO cyber regulations, rather than active threat risk management, simply will not be adequate.

Speaking recently at a maritime cyber security webinar[2], Ben Densham, Chief Technology Officer of Nettitude, a cyber security consultancy and Lloyd's Register subsidiary, revealed the gap between the approach of many shipping companies and those of its many other clients in sectors such as financial services, health care and aviation. He pointed to the increase in cyberattacks since the onset of the pandemic, and the fact that new technologies are opening up "shipping's attack service".

Cyber security, Densham noted, is affected by factors including, but not limited to connectivity, artificial intelligence, situational awareness, sensors, digital health management, energy management and the environment, and the adoption of digital twin technology. A clear understanding of how data is transferred is absolutely essential, he said, pointing out that the cyber challenge is bigger for existing ships than it is for new vessels that are built for purpose.

This, he explained, is because the digital transformation of vessels in operation today tends to take place one stage at a time – incorporating monitored components from different original equipment manufacturers who have their own security systems. The absence of a holistic approach to cyber security is prone to result in weak links in the cyber protection armoury. In contrast, a newly designed vessel with autonomous capabilities, such as Yara Birkeland, would have been developed with a holistic approach to cyber security in mind.

Densham noted that the complacency amongst some ship operators is not universal. Some shipping companies, he said, had adopted rigorous cyber security strategies. And separately, one major container line is known to employ a team of hacking specialists, working round the clock to identify weak points in their system.

However, following a realisation of the scale of the SolarWinds cyber breach and industry-specific cyberattacks on companies including the world's largest container lines, port authorities, and even the IMO itself, cyber safety is right at the top of the agenda.

Thought to have been carried out by state hackers, the SolarWinds attack offers a wake-up call for the shipping industry, partly because it highlights how unprepared many companies and organisations are to prevent, detect and respond to cyber threats. However, many of those attacked already had sophisticated cyber security systems in place that were not based merely on regulatory compliance, but featured active threat detection and management. SolarWinds' customers include 425 of US Fortune 500 companies, the top ten US telecommunications companies, the top ten US accounting firms, all branches of the US Military, the Pentagon, the State Department, as well as many academic institutions around the world.

At session 101 of the IMO's Maritime Safety Committee, in June 2019, approved Interim Guidelines for Maritime Autonomous Surface Ship (MASS) trials were agreed, with a view to ensuring that trials of systems are conducted safely, securely, and with due regard for protection of the environment. A series of recommendations regarding best practice were also set out. Specifically, on cyber security, the Guidelines say: "Appropriate steps should be taken to ensure sufficient cyber risk management of the systems and infrastructure used when conducting MASS trials."

2 Sixth MASWRG Conference: MASS Regulation – Unlocking the Future of MASS

3 | Owner/operator views

The complex business of international shipping is populated by thousands of shipping companies ranging from those with just a few vessels to vast corporations with hundreds of ships across a variety of sectors. It is no surprise, therefore, that there are many different views on the application of smart technology across this industrial sector.

At one end of the spectrum, there are the progressive innovators anxious to adopt the latest technologies – including sensor fusion, artificial intelligence, machine learning, clever algorithms – or at least try them out in real life aboard their vessels. It is these owners who will be first in the adoption of autonomous technologies in the future.

It is also these pioneers who will demonstrate the ways in which digital systems and advances in autonomy can assist in raising ship safety. These are the companies for which BIMCO's drafting committee, aided by London law firm HFW, completed the industry's first standard contract for the operation of autonomous vessels, published in 2021.

Commenting on the initiative, leader of the HFW team, Gudmund Bernitz, said: "BIMCO and the drafting committee are facing an interesting challenge with creating this standard contract, in that there are currently no autonomous ships actually in operation. In fact, fully-autonomous shipping is likely still several years away. Many of the provisions are therefore having to be based on assumptions and expectations, and will continue to be refined and adapted over time as automation projects start to go live across the industry, to ensure that the standard contract continues to meet the needs of this emerging technology."

However, the vast majority of owners and operators are keen to embrace the automation of certain procedures – electronic chart display and information systems (ECDIS) are a case in point – but view autonomy with some caution. Many believe that it will first be adopted in some inshore and harbour applications, where companies including ABB, Keppel Singmarine Pte Ltd, Kongsberg Maritime, ST Engineering, Svitzer and Wärtsilä, for example, are all actively engaged in a range of autonomous tug experiments and trials.

In a deep ocean context, there is more scepticism, based primarily on the reality of shipping's existing regulatory and safety framework and Conventions, developed by the IMO over many decades; change at the IMO is a drawn out process.

At the same time, some concede that discrete autonomous technologies – those that aid human situational awareness, for example – can have a major impact on maritime safety generally. Experts point specifically to the high incidence of pilot-related accidents and those involving service and support vessels operating in harsh conditions.

Where attitudes are concerned, one key will be keeping the distinction between automated systems and full-blown autonomy firmly in mind. Dr Kalevi Tervo, ABB Marine & Ports' Corporate Executive Engineer and Global Program Manager, has observed: "Mathematical models can be designed to enable a conventional automation system to handle more complex tasks. An automation system becomes an autonomous system when you start to automate human capabilities such as perception, understanding and decision-making."

"As a practical example, an autonomous navigation system would support the human operator to identify the other ship, interpret any potential threat and change course to prevent a collision," Dr Tervo added. "Even when the level of automation increases, we will always need competent crew working alongside the technology".

It is nonetheless widely accepted that automation, real-time connectivity, sensors, the cloud, data analysis and remote monitoring will have a growing impact on the maritime sector and that their adoption is likely to accelerate further as the sector wrestles with decarbonisation.

Sensing, tracking, simultaneous real-time monitoring on ship and shore, artificial intelligence, machine learning, virtual engineering and augmented reality are just some of the technologies that now facilitate new strategies in ship operation. They enable component condition and performance monitoring, voyage optimisation, just-in-time arrival, and entirely new strategies for maintenance of components on board.

Ultimately, some ships will be equipped for autonomous operation in which systems can not only be programmed but will also be capable of 'thinking for themselves'. In other words, they will be able to identify potential hazards or obstacles to achieving a certain aim and, in light of that, take a different approach or strategy. (Please find more on this in *The role of the human in decision-making, Section 4*)

None of these new technologies would have been possible without the pioneering endeavours in ship autonomy undertaken by One Sea members, amongst others. As noted above, changes to shipping's safety and regulatory systems, necessary for the adoption of some more far-reaching autonomous technologies, are customarily slow. The success of trials of various autonomous applications that are being undertaken today suggests that, where ship safety is concerned, there may not – in fact – be a moment to lose.

4 | The role of the human in decision-making

Over recent decades, shipowners and operators have scrutinised vessel operating costs to identify any conceivable opportunity where savings may be possible. Many of these costs, if not fixed, are relatively constant – vessel insurance, for example, surveys and drydocking.

But manning is one major cost centre where there is much more flexibility. Provided that the Minimum Safe Manning requirements of a ship's registry are met, managers have a degree of flexibility over a ship's complement, both above and below deck. Substantial reductions in crew numbers have taken place, therefore, to the point where further cuts are not practical in many instances, and there are concerns over the welfare of seafarers who live for weeks with minimal social interaction.

It cannot be a surprise, therefore, if many seagoing personnel - and particularly older ones - view the steady advance of digital technologies and, in the future, higher levels of autonomy as a pending threat to employment. They fear another round of job losses and more stressful working lives in the 24/7 shipboard environment.

Yet many experts in the field suggest that these views are misplaced. Digital development, more automation, and ultimately autonomous operation in some applications, promise to improve the quality of seafarers' lives. And, far from proving dispensable, their role as part of a new ship management framework will be more important than ever.

ABB Marine & Ports' Dr Kalevi Tervo pointed out that although autonomous systems can mimic certain cognitive processes, their abilities so far are limited to specific tasks such as navigating a ship or controlling industrial machinery. However, a fully autonomous system for a general purpose would apply human-like creativity and judgement to solve any number of problems, he said, including unfamiliar ones. "We're now at the stage where human capabilities and experience in combination with intelligent technology is able to do a better job together than any one of the two could do alone," he said.

Nevertheless, the role of seafarers, their required skill sets, and even the location of their employment are likely to change significantly. Experts suggest that there will be a reduced requirement for conventional able seamen and, in the engine room, wipers and greasers. The nature of their work will change too, with new demand for multi-skilled troubleshooting personnel on board some ships and at the ports and terminals they serve.

Set in a maritime context, the adoption of digital systems for administration and day-to-day operations management provide early examples of automated processes that have a significant impact in the industry. Examples include digital maintenance management, remote surveys, shore management centres manned by experts, and various software systems designed to support operational efficiency including voyage performance, weather routeing, speed and consumption.

Further into the future, master mariners and navigators are likely to be required at shoreside control centres, monitoring the safe passage of autonomous vessels in coastal waters. In the event of a major incident such as an allision, collision or a ship threatened with being overwhelmed by the elements, safety rules will be required to formalise procedures for manual intervention or control.

5 | Insurance implications

There are some aspects of commercial ship operation which must be considered urgently in response to accelerating digital developments and advances in autonomy. One concerns the requirement to have effective asset insurance in place at all times.

Marine insurance is sometimes viewed as one of the less transparent sectors of commercial ship operation but it is, nevertheless, essential. For financial covenants not to be breached, for ships to be able physically to trade, and to meet ship registry and classification requirements, commercial vessels require valid marine insurance relating both to hull and machinery, and third-party liabilities covered by protection and indemnity (P&I) insurances.

One Sea has already identified some of the challenges relating to the development of robust insurance cover for ships with varying degrees of autonomy, and some of these are set out below. However, in our view, this is a critical safety issue and in relation to One Sea's drive to develop stakeholder dialogue, the engagement of representatives from the marine insurance industry is now pressing, both for those in the vanguard of new technology, as well as those who will underwrite the related risks.

5.1 Hull and machinery cover

Most ship operators today assume that their hull and machinery insurance policies are sufficient to provide insurance cover for their assets in the event of a physical event such as a collision, grounding or, in the worst case, a total loss. However, in a digital context, this has not yet been put to the test and could yet prove that existing policies require modification if they are intended for assets with varying level of autonomy.

This is because most hull and machinery policies exclude cyber risk cover through the Institute Cyber Attack Exclusion Clause 380, as follows:

> *1.1 Subject only to clause 1.2 below* [which relates to risks of war, civil war, revolution, rebellion, insurrection, or civil strife and is not relevant to this paper]*, in no case shall this insurance cover loss damage liability or expense directly or indirectly caused by or contributed to by or arising from the use or operation, as a means of inflicting harm, or any computer, computer system, computer software programme, malicious code, computer virus of process or any other electronic system.*

There are, however, specialist cyber-risk policies available in the London market although these are understood usually to be tailored to meet certain specific cyber risks, rather than a more general cover-all policy. This relatively young branch of marine insurance has a short track record and actuaries therefore have limited data on which to base their risk assessments. It is understood, therefore, that the policies are expensive.

It would seem, however, that traditional hull and machinery insurance policies are not fit for the purpose of insuring autonomous ships. Without valid insurance, however, ship operation is not possible. Both class and ship registration are invalidated and any finance relating to a specific asset is contingent upon valid insurance. In physical terms, a ship is unable to operate, prevented from entering coastal waters, channels and port areas.

Therefore, it is evident that a robust appraisal of autonomous ships' insurance requirements must be undertaken, possibly leading to a new type of policy or, at least, major revisions to existing ones.

5.2 P&I cover

Potentially far more complicated is the issue of P&I liability insurance which covers risks including cargo liabilities, crew claims, damage to third-party property including fixed and floating objects, collision liabilities not covered by hull and machinery insurance including pollution-related costs, apportioned by the degree of fault, and wreck removal.

Since P&I Clubs are owned by their shipowner members, it is clearly in their interest to minimise the volume and quantum of claims. Therefore, risk assessment and loss prevention are an essential part of their operation. What are the risks, and how can they be managed and minimised?

However, P&I insurance is not a precise science. The assessment of risk and the prevention of losses rely on history, data, and in some cases, legal precedent. Terms like "seaworthiness", "good seamanship" and "best practice" may sound loose, but they have been well-defined over the years. A huge body of case law has established the clear interpretation of statutory regulations including the International Convention for the Safety of Life at Sea (SOLAS), the International Convention for the Prevention of Pollution from Ships, the International Convention for Preventing Collisions at Sea (COLREGs), and the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW).

Although each P&I Club has its own rules, there are also rules embodied in the Hague Visby Rules, brought into English law by the Carriage of Goods by Sea Act 1971, to define

the right and obligations of parties to a voyage, also specifying maximum exclusions of liability. P&I Clubs also provide their liability insurance cover on the basis of a ship's "seaworthiness", which includes have a competent and fully manned crew on board.

The IMO is currently conducting a detailed analysis of the principal codes that cover the safe operation of ships with the aim of producing a gap analysis for autonomous vessels. However, as we know, the IMO's procedural wheels turn slowly, and experts say that there is no chance that the IMO's deliberations can match the exponential acceleration in shipping's digital and autonomous technology development.

Experts in loss prevention at P&I Clubs highlight emphasise that many of the risks they cover relate to human beings. In their absence, therefore, a whole tranche of potential risks could well disappear. However, new and potentially unquantifiable risks could develop, and they identify several key areas of concern relating to the new risk assessment requirements that would be required. We have noted some of these here, although these are examples and the list is not exhaustive.

Loading and cargo monitoring during voyage – under the Hague Visby Rules, a carrier commits to his counterparty to transport cargoes with care. This includes, but is not limited to, the safe loading or cargo at origin, the monitoring and carriage throughout a voyage, and safe discharge at destination

Attitude to risk – the identification and assessment of risk by a seafarer on board ship is likely to differ markedly from that of a remote operator sitting many miles away in a comfortable shoreside control centre.

Training competence – so far, there is no requirement to have seafarers directly involved in the operation of autonomous vessels. This has not yet been considered in relation to the STCW. The Convention could be modified by the addition of another chapter, for example, but this would take time.

Physical risk to shoreside control centre – the safety and security of the control centre is paramount, both in a cyber and also a physical context

Other issues identified by P&I risk assessment and loss prevention experts include:

Remote control centre jurisdiction;

Definition of "good seamanship" as referenced in the IMO's COLREGS;

Seaworthiness and its definition under Hague Visby Rules;

Apportionment of liability in the event of an accident.

6 | Classification

Longstanding principles of ship classification are being carefully assessed to see whether they are fit for the purpose of classifying assets incorporating varying levels of autonomy. However, assuring the quality and safety of an asset that has not existed before is a completely new challenge.

As noted by One Sea member MacGregor: "We are systematically working on the development of autonomous technologies that will further contribute to raising safety and efficiency standards. However, it is not one isolated development that will secure this safer, more efficient environment but many smaller advances that will be integrated together, with this process being critically dependent on stakeholder collaborations. The success of partial or fully autonomous operations will rely on greater connectivity between systems. The important part will be to standardise connection protocols so that a system, comprising a number of components, can work effectively together."

Tony Boylen is a Principal Specialist, Assurance of Autonomy, at Lloyd's Register. In a recent article[3], he explained that projects involving different levels of autonomy must be broken down into separate elements for the assurance process, before allowing an entire project to be viewed holistically and assured as one complete system.

The assurance process is a formidable task and must be undertaken at various levels, Boylen explained, from the original equipment manufacturers shipowners and operators offering and adopting new technologies, to the regulators and flag states who require classification society approvals and validations. Then, ultimately, there is the IMO which will have the final say on how far automation is allowed to take over and/or support decision-making at sea.

Boylen also highlighted the scale of the assurance task. He explained it like this: if someone said, I give you my word that this person can be trusted 99.99% of undertake this task, you'd probably feel confident. "However, in a million lines of software code, 99.99% means that one hundred lines could be wrong. That's not good enough."

Image: Wärtsilä

3 www.lr.org/en/insights/articles/the-rapid-pace-of-autonomous-technology-applications-in-shipping

The assurance process is almost certainly requiring classification societies to re-think their risk assessment protocols to gauge whether they are suitable for the certification of autonomous technologies and the assets in which they are installed. New ways of working are evident.

Japan's ClassNK, for example, recently announced a joint project with Sompo Japan Insurance to carry out research into risk assessment systems for autonomous ships. The classification society will collaborate with the insurer and its marine underwriters, as well as Sompo Risk Management Inc, a group subsidiary, that has established expertise in the risk assessment of the practical applications of autonomous vehicles. The research project started in February, with results due to be published in 2022.

Writing recently in The Maritime Executive, Matthieu de Tugny, Executive Vice President of the Marine and Offshore Division, Bureau Veritas, suggested that autonomous shipping is less likely to go mainstream but much higher levels of autonomy and remote control are to be expected in shipboard operations generally.

ABS Senior Vice President, Global Engineering and Technology, Patrick Ryan, has said that autonomous technology is gradually reshaping the maritime industry, bringing benefits such as increased operational efficiency, less human error, reduced emissions, increased safety, and lower operating costs. Speaking on the launch of new guidance[4] on autonomy, he said that the phases between automation and fully fledged autonomous functionality had been categorised by the classification society in a Smart to Autonomous framework.

April 2021 saw the launch of the Maritime Technologies Forum (MTF), with the stated aim of bridging "the gap between technology knowledge and the regulatory process". Founding members of the forum include American Bureau of Shipping (ABS), DNV, Japan's Maritime Bureau, Ministry of Land, Infrastructure, Transport and Tourism (MLIT), Lloyd's Register (LR), Nippon Kaiji Kyokai (ClassNK), the Norwegian Maritime Authority (NMA), and the UK's Maritime and Coastguard Agency (MCA).

"The regulatory framework for the development and use of new technology must remain up to date to ensure advances assure the safety of people, assets and the environment", the new grouping said. "By bringing together expertise to offer guidance and advice on technical and regulatory challenges, the MTF will support the shipping industry and the International Maritime Organization (IMO) to navigate and embrace the impact of these changes." Key focus areas include energy efficiency, alternative fuels and increasing levels of autonomy.

The One Sea Alliance welcomes the launch of the MTF and offers its full cooperation in working towards bridging the gap between technology and regulation, also expressing its willingness to offer any contribution requested in relation to ship safety.

4 ABS Advisory on Autonomous Functionality

7 | Next steps

One Sea has participated in the regulatory efforts of IMO and flag states around the world, by informing them of the current status of developments and the consequences of their decisions. One Sea will continue to support regulators at both national and international levels. It is in everybody's best interest that rules that are developed cover the safe operation, management and maintenance of autonomous ships. The rules must cover all systems onboard as well as manning-related issues. One must also not forget shore-based procedures that will become even more important in the wake of these new technologies.

We invite all actors in the field to engage and collaborate with the other stakeholders with specific interest in the safety of autonomous ships, including ship designers, builders, insurers, owners, labour representative organisations, classification societies, connectivity providers, regulatory authorities, and flag states. Collaboration is the key to finding solutions that will be both safe and satisfactory to all parties.

The work done at national and international standards organisations aims at the development of common technical standards in support of integrated and coherent criteria. One Sea will continue to engage and collaborate in these endeavours. It is crucial that international harmonised safety rules covering autonomous ships are developed.

The backbone of the process is the focus on the application, testing and verification of digital and autonomous technologies that promote and encourage safer working practices and ease the administrative workload of seagoing personnel. The information exchange and cooperation between those doing the testing and those that create regulations and standards will enable the development of safety rules in shipping.

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