Legal and regulatory challenges for a new European waterborne transport system

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Advanced, Efficient and Green Intermodal Systems

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Executive summary

This executive summary provides an overview of the key points discussed in the report on the legal and regulatory challenges associated with introducing a new European waterborne transport system, as developed under the AEGIS project. The report emphasizes the importance of transitioning to waterborne transport for sustainability, reducing CO_2 emissions, improving energy efficiency, and mitigating road congestion. However, it also highlights the legal and regulatory hurdles that arise due to the technological and logistical innovations required for such a transition.

The AEGIS concept proposes a holistic approach to waterborne transportation, considering it as a system rather than independent modes. This approach presents challenges in terms of rulemaking, as it involves not only navigation laws but also regulations concerning ship design, terminal operations, and port development. Additionally, the differences in legal regimes between offshore and inland navigation further complicate establishing consistent communication between the two.

The focus of the report is primarily on advanced ships equipped with remote control or full autonomy for navigation and cargo handling, which are the core of the AEGIS project. It identifies the legal challenges associated with these advanced ships and discusses the various stages involved in implementing the new waterborne transport system, ranging from system design to cargo handling and terminal expansion. Special attention is given to the role of lawmakers and regulators in facilitating the transition of cargo from road to sea when autonomous vessels are involved.

To overcome the identified legal and regulatory challenges, the report suggests two approaches: regulating specific matters or adopting new interpretations of existing concepts. However, the report does not delve into specific legislation but instead provides an overview of challenges applicable in different European contexts, drawing inspiration from the experiences of stakeholders in the AEGIS project use cases. It highlights that authorities are approaching these challenges from a public policy perspective, aiming to create favourable conditions that indirectly incentivize stakeholders to transition to a more efficient and environmentally sustainable system.

The recommendations put forward in the report focus on stakeholders accumulating best practices within the existing framework, which will evolve over time to accommodate a wider variety of industrial practices as they develop. By collaborating and researching extensively, organizations such as the CCNR, CESNI, and the IMO are making significant strides in addressing legal challenges and shaping the future of autonomous vessels in the maritime industry.

In conclusion, this executive summary provides a condensed overview of the report's findings on the legal and regulatory challenges for a new European waterborne transport system. It highlights the importance of transitioning to waterborne transport for sustainability goals while acknowledging the complexities and hurdles involved. By adopting appropriate regulations and interpretations and fostering collaboration among stakeholders, the proposed transport system can pave the way for a more efficient and environmentally sustainable future.

Definitions and abbreviations

AAWA	Advanced Autonomous Waterborne Applications Initiative
AEGIS	Advanced Efficient and Green Intermodal Systems project
AIS	Automatic Identification System
AIS	Automatic Identification Systems
BIMCO	Baltic and International Maritime Council.
CCNR	Central Commission for Navigation on the Rhine
CEF	Connecting Europe Facility
CEF-T	Connecting Europe Facility for Transport
CEMT	European Conference of Ministers of Transport
CESNI	European Committee for drawing up Standards in the field of Inland Navigation
CLECAT	European Association for Forwarding, Transport, Logistics and Customs Services
CLIA	Cruise Lines International Association.
CMR	Convention on the Contract for the International Carriage of Goods by Road
COLREG	Convention on the International Regulations for Preventing Collisions at Sea
DMA	Danish Maritime Authority
EC	European Commission
ECSA	European Community Shipowners' Associations
EEA	European Express Association
EFIP	European Federation of Inland Ports
EMSWe	European Maritime Single Window environment
ESN	European Short Sea Network
ESPO	European Sea Ports Organisation
ESR	Effort Sharing Regulation
ETC	European Transport Corridors
ETD	Energy Transition Directive
ETS	Emissions Trading Scheme
EU	European Union
EUDA	European Dredging Association
FAL	Facilitation of International Maritime Traffic Convention
FEPORT	Federation of European Private Port Companies and Terminals
GHG	Greenhouse Gas
GNS	Good Navigation Status
GSIS	Global Integrated Shipping Information System
HFO	Heavy Fuel Oil
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
ICS	International Chamber of Shipping
ICT	Information And Communications Technology
IMO	International Maritime Organization
IPSCA	International Port Security Contractors Association
ISO	International Organization for Standardization
ISPS	International Ship and Port Facility Security
ITF	International Transport Forum
IWT	Inland Waterway Transport
LNG	Liquefied Natural Gas

LPG	Liquified Petroleum Gas
M2M	Machine-to-Machine
MARPOL	International Convention for the Prevention of Pollution from Ships
MASS	Maritime Autonomous Surface Ships
MOS	Motorways of the Seas
MRV	Monitoring, Reporting, and Verification:
MSW	Maritime Single Window
MUNIN	Maritime Unmanned Navigation through Intelligence in Networks project
NAIADES	Navigation and Inland Waterway Action and Development in Europe.
NEXUS	Next Generation Support Vessels Providing Safe And More Efficient Offshore Wind Farm Services project
NGO	Non-Governmental Organization
NOx	Nitric Oxides
OPS	Onshore Power Supply
PIANC	World Association for Waterborne Transport Infrastructure
RFNBO	Renewable fuels of non-biological origin
ROPAX	“Roll-On/Roll-Off” passenger
RORO	“Roll-On/Roll-Off” vessels
SOLAS	International Convention for the Safety of Life at Sea
SOx	Sulphur Oxides
SPC	Short-Sea Promotion Centres
SSS	Short Sea Shipping
STCW	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers
TEN-T	Trans-European Transport Network
UNCLOS	United Nations Convention on the Law of the Sea
UPEI	Union of the European Independent Fuel Suppliers

1 Introduction

The development of a new European waterborne transport system responds to imperatives of sustainability, as identified by the European Union lawmakers. Shifting to transport by water is expected to reduce CO_2 emissions, increase energy efficiency and reduce road congestion. But notwithstanding such public policy objectives, the underlying technological and logistical innovation that render the transition possible encounters legal and regulatory challenges.

This Deliverable is part of the overall contribution of a work package dedicated to providing policy support to the introduction of such an innovative waterborne transport system (WP6), as designed in the AEGIS project. This report will not consider issues of public policy, which are the overarching political objectives that could eventually also encourage or constrain the introduction of the AEGIS concept, but that are not impacting on rights and obligations of the relevant actors [1].

The AEGIS concept looks at waterborne transportation as a system, and not as a patch of independent alternative modes. Yet this holistic approach makes it all more complicated from the standpoint of rulemaking, for one must not just consider laws and regulations applicable to navigation, but also to ship design, terminal operations and even port development. Another issue pertains to the difference in legal regimes applicable to offshore navigation and inland navigation, and how a waterborne system requires a consistent communication between both regimes.

In this report the focus is placed on the advent of *advanced* ships, and not so much on the environmental or energy law associated with their means of propulsion. The proposed concept of the AEGIS project indeed seeks to introduce ships with remote control or full autonomy, and that represents the core of the legal challenges identified during the project. Advanced ships are therefore defined, for the remit of this report, as ships that introduce autonomous navigation and that facilitate autonomous cargo handling.

After introducing the methodology (2.2) and the AEGIS use-cases (2.3), the following sections focus on the various stages of implementing this new waterborne transport system: from systems design all the way to cargo handling and terminal expansion. The objective is to illustrate how law makers and regulators are playing and should play an essential role in ensuring the transition of cargo from road to sea, when this depends on the implementation of autonomous vessels.

2 Methodology

Legal and regulatory challenges are here understood as potential constraints – either by inadequate wording or by omission – in the applicable legal framework that play a role in the introduction of the proposed new waterborne transport system.

AEGIS is based on three use-cases where different components of the system are conceptualized and approached in geographic and thematic isolation. However, this report, very much like the project itself, adopts a systematic approach to transport systems. The idea is that the AEGIS concept is adaptable to other regions as well, allowing it to spread all over Europe. Thus, although the data stems from national and local experiences, the challenges are framed as they would exist regardless of location but within a European context. While Work Package 6 analysed the proposed AEGIS concept as a system of waterborne transport, each element of the system was conceptualized for a scenario and worked within a respect use-case. From a legal and regulatory perspective, each country has its own challenges; however, from the perspective of the AEGIS project, the focus is on how to achieve a European-wide system and thus national specific issues are not central in the analysis. Still, the necessity for a detailed description of the use-cases in this Deliverable (Section 2.3) by comparison to other reports [2] has to do with the fact that public policy analysis is focused on supporting modal shift in general, while regulatory issues are more closely related to the actual product or service being introduced into the market.

The Annexes to this Deliverable provide an overview of the relevant legal instruments and proposed regulatory changes in both SSS and IWT segments[1]. In addition to international treaties and rules and standards from international organizations, the report acknowledges EU law implementing these international instruments. National laws and municipal regulations were studied as part of the case study work, but they are not given central relevance in the report as the objective is to draw on the experience from the AEGIS use-cases for the implementation of the concept throughout Europe.

This report is partly based on desk-based research undertaken in the period between June 2019 and May 2023, including participation in events hosted by relevant organizations and other research projects[2]. The author also relied on data provided by key informants interviewed along the course of the project. They are not identified as direct sources of the output of this report since they provided leads and not conclusive legal opinions. Yet their participation is hereby acknowledged and thanked for.

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[1] For short-sea shipping, the following instruments are considered: SOLAS, CLL, International Convention on Tonnage Measurement of Ships (TMC), Standards of Training, Certification and Watchkeeping (STCW), Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGs), International Convention on Maritime Search and Rescue (SAR), Maritime Labour Convention (MLC), and the International Convention for the Prevention of Pollution from Ships (MARPOL), particularly Annex VI (Regulations for the Prevention of Air Pollution from Ships). Additionally, specific regulations and guidelines from the International Maritime Organization are considered relevant. Regarding inland waterway transport, the following instruments are considered: Police Regulations for the Navigation of the Rhine (RPNR), European Code for Inland Waterways (CEVNI), Strasbourg Convention on the limitation of liability in inland navigation (CLNI), and Convention on the collection, deposit, and reception of waste produced during navigation on the Rhine and inland waterways (CDNI). Furthermore, specific regulations and guidelines from the Central Commission for the Navigation of the Rhine are considered relevant.

[2] September 2022: the IMO Seminar on Development of a Regulatory Framework for Maritime Autonomous Surface Ships (MASS), especially Panel 4 (Regulating MASS within the framework of UNCLOS) and Panel 5 (Operating MASS: Legal issues related to communication and enforcement); October 2022 and March 2023: meetings of the EU-funded PLATINA3 project that provides coordination and support activities to promote inland waterway transport (IWT) in Europe.

3 Overview of AEGIS use-cases

The idea of AEGIS is to design a system that combines autonomous ships, smaller vessels, short sea routes and inland waterways, as well as small and medium port terminal with automated operations. The three use-cases are designed around the different types of transport scenarios [3].

UC-A is established in the coast of Norway and focuses on shortsea shipping from the big ports in Western Europe, such as Rotterdam, to the Norwegian West Coast and the hinterland distribution within the fjords. The geographical setting is important, as the redistribution of cargo is done throughout a very indented coastline with fjords, often requiring pilotage assistance. There are many small terminals in islands and isolated locations that need to be regularly serviced, creating an efficiency challenge for cargo transport operators. AEGIS proposes a concept whereby a mother vessel redistributes cargo to a daughter vessel that then brings the cargo to more isolated locations[3].

UC-B is established in existing Belgium waterways, namely the river Scheldt, and with the potential to expand to other rivers. The concept revolves around RORO barges operating in various segments of existing inland waterways linking port terminals to larger ports in the coast of Belgium (Ghent, Zeebrugge) and in the Netherlands (Rotterdam). The concept has the potential to exploit connections potentially going into France (Lille, Paris) and Germany. The goal is to allow truck trailers to be placed in an autonomous RORO barge and transported through the waterway, redistributing the cargo to local terminals along the way. To get the trailers on and off the barge, an automated guided vehicle (AGV) is expected to be used. This design would make gains in efficiency by avoiding congested roads around large city centres in the region.

UC-C is established in two distinct locations in Denmark: Aalborg Port in North Jutland, and Vordingborg Port in Zealand. This case revolves around small and medium enterprise port terminal development and how ports link with urban planning. Both cases include new shipping routes: one short-sea shipping route linking the port of Aalborg to the coast of Sweden, and the other linking the port of Vordingborg to inland waterways in Germany and Poland[4]. This case serves to discuss the impact of the AEGIS concept on terminal cargo handling operations, namely by analysing land-sea interactions and conflicts of interest with stakeholders who are not involved in navigation but still have vested interests in the development of the waterfront. This case also enables a discussion on energy storage and supply, as ports become energy hubs to support the EU policy for “green transition” [4].

[3] The concept of the mother vessel is to transport cargo from the European West coast along the Norwegian west coast. The distribution into the hinterland will be accomplished by the daughter vessels. The cargo transhipment will be carried out at locations (ports on islands or near the coast) by a transhipment from mother vessel to port and from port to daughter vessels. The direct ship-to-ship-transportation is possible but is not part of the specific scenario in UC-A. Here, the concept would use Hitra. Transhipment could hypothetically be done with two autonomous cranes from the mother vessel, without relying on unloading at the terminal, while the mother vessel is moored to the quay and the daughter vessel is moored to the mother vessel. Yet in the final definition of the use-case design concept, it was proposed that the mother and daughter vessels will operate independent of each other, where the cargo will be unloaded to the terminal and then loaded onto the mother/daughter when applicable. The direct loading/unloading between the two ships has been examined as a deliverable in AEGIS WP3, but it is concluded in the use case to not go for this solution-Also, while these vessels are container carriers, the smaller ones being container barges; In the end barges were left out as the solution for use case A, but rather standard vessels (60 and 100 TEUs capacity).

[4] The project’s two vessel concepts are relevant for this use-case: the RORO vessel for a Aalborg and a multipurpose vessel for Vordingborg; some of the UC-A-Vessels, meaning the big and small mother vessels as well as the daughter vessels (for the Limfjord) could also call on these ports ; the RORO vessels of UC-B are not applicable since those concepts were only designed for inland waterway and not short sea transportation.

A range of technological innovations is proposed in the AEGIS project: autonomous navigation and remote-control operation of vessels, autonomous cargo handling at port and on board (ship-to-ship loading), and alternative low and zero emission propulsion concepts, namely methanol and electricity [5]. It is around these innovations that specific regulatory challenges arise, and thus the technology itself guides the structure of this report, going from systems design, to ship engineering, all the way through to navigation and port operations.

4 Digital system development & maintenance

Before entering the execution of autonomous navigation, it is important to consider challenges associated with the design, installation, supervision, and maintenance of digital navigation systems. This task is performed by system suppliers, also known as technology providers. In AEGIS, the design of such systems includes the programming of various levels of autonomy, which would allow a ship to recognize its surroundings and to respond to that input by adopting pre-programmed behaviour. In other cases, that may signify relaying the navigation to a remote operation centre, which will remotely operate the vessel temporarily or permanently.

The main legal challenge for the system supplier is the responsibility for malfunctioning, and the obligations regarding maintenance and continuous threat assessment [6]. The issue of cyber risks associated with the implementation of AEGIS falls partly under this scope, for the systems may not be open source, and thus the supplier is the sole person capable of repairing and updating the digital system once a problem is identified. These problems may include failure of the software, the hardware and fail-safe mechanisms, violation of the operational design domain, loss of connection, data quality, computational complexity, lack of updates, and cyber-attack. All of these will be added risks with the increased implementation of autonomous technology.

The response to this challenge may include the development of certification schemes for software. This sort of scheme would provide some legal security to the relationship between system supplier and system operator. In the case of tort liability (responsibility), the general framework of products liability would apply (as it is the case already for any software). Standard-setting organizations would also face liability, for example when negligence is found in certification of software. Joint tort liability may be the response, for example to face cybersecurity risks which are partly digital system flaw and partly user negligence.

The successful implementation of advanced digital technology and automation in the proposed waterborne transport system depends on the legal certainty with respect to liability in case of malfunction. The system used in autonomous vessels can be considered either a product or a service; its defects may generate liability. Unclarity with respect to this issue is a legal challenge, for it may deter relevant actors from implementing existing technology. This is particularly evident when components of the autonomous ship are using Artificial Intelligence (AI).

The 2018 evaluation report of the EU Product Liability Directive identified several shortcomings in relation to digital technologies in general and to AI in particular [7]. The EU Commission's proposed directive on liability for AI concerns civil law liability in tort for damages caused by an AI system [8]. The proposed directive sets out common rules concerning presentation of documentation related to high-risk AI systems to make it possible for a plaintiff to substantiate a potential claim for damages. Further, the proposed directive introduces common rules for the burden of proof in case of culpable damages caused by an AI system. Member States will have some margin of interpretation when integrating this directive, which may affect the introduction of the proposed waterborne system in some regions [8].

A final note regarding digital system maintenance relates to the issue of cybersecurity. On national and transnational levels, the matters of cybersecurity primarily concern criminal matters. The fragmentation of national criminal laws (substantive and procedural) is a challenge, pending their harmonization across the EU. Diversity of national laws is one of the main reasons of the global cybercrime vulnerabilities, as such diversity does not allow for the development of a single legislative response to the global phenomenon [9]. A certain threshold must exist to ensure that the technology provider is not deemed negligent in the design of the system so as to ensure that any criminal activity does not exploit a vulnerability that could have been prevented by exercising due professional diligence.

A final note is due to the impending change in business models brought about by AEGIS. The complexity of manufacturing autonomous ships is expected to lead to a different role for shipyards. This may lead to a different type of contract being established between actors, a service instead of transmission of property. The manufacturer would become a service provider to the client, and the operator would thus not own the ship. The shipbuilder would represent a network of actors providing services and products, and possibly remain responsible for the development of the software and most technologically advanced parts.

5 Registration, classification and certification

Ship registration, ship classification, and ship certification are all different concepts in the shipping industry with different legal implications. Ship registration refers to the process of registering a ship with a national flag state. This involves complying with the requirements of the flag state in terms of ownership, management, and operation of the ship. A registered ship is entitled to fly the flag of the country of registration and is subject to the laws and regulations of that country. Ship classification refers to the assessment of a ship's structural and mechanical integrity, as well as its safety and environmental performance, by a classification society. A classification society is an independent organization authorized by the flag state to perform this function. The classification society issues a class certificate to the ship if it meets the required standards. Ship certification refers to the issuance of certificates by the flag state or other recognized organizations, which attest to the ship's compliance with international conventions and regulations governing safety, security, and environmental protection.

Aside from the digital infrastructure governing the ship, the proposed new waterborne transport system also introduces drastic physical changes to vessels which may affect manoeuvrability, namely the removal of the ship’s bridge and the installation of sensors for either remote control or autonomous navigation. Furthermore, the AEGIS concept designs introduce alternative propulsion systems aimed at contributing to reducing shipping emissions. This includes potentially different possibilities: electrical batteries, methanol, or hydrogen, as alternative propulsion systems are part of the objectives of the project. The goal of these alternative designs is to contribute to the decarbonization of shipping industry, in alignment with EU policy, and to ensure efficiency gains.

International law requires that every ship be registered in a country, called its flag state; any seagoing ship is thus subject to the law of its registration state, the flag state. The state of registry is responsible for complying with international rules and standards on seaworthiness. It is at the stage of registration that most legal challenges associated with the new vessel types proposed by AEGIS may emerge, for it is when the classification of an object as a ship is determined. This varies greatly from country to country, even within the EU [10].

The matter of registration in inland shipping presents unique challenges due to the presence of varying technical requirements. To establish harmonized conditions for issuing inland navigation certificates for inland waterway vessels, all Member States have adopted uniform technical requirements, resulting in simplified regulations and increased safety standards [11]. This approach fosters a deeper and more equitable internal market. The European Standards laying down Technical Requirements for Inland Navigation vessels (ES-TRIN standards), developed by the European Committee for drawing up Standards in Inland Navigation (CESNI), an international body created in the framework of the Central Commission for the Navigation of the Rhine (CCNR), serve as the basis for establishing these requirements. Both EU legislation and the legislative framework of the CCNR refer to these standards and their updates. As a result, Union inland navigation certificates verifying that all types of crafts comply with the revised technical requirements are valid on all EU inland waterways, including the Rhine, while Rhine certificates are valid on all EU inland waterways.

To facilitate the effective implementation of safety requirements for vessels, a dedicated database called the European Hull Database (EHDB) ensures the availability of information on vessels and certificates. The EHDB enables Member State authorities to access information necessary for ensuring vessel safety.

There are situations where derogations from technical requirements may be authorized. For example, the EU Commission authorized Germany to derogate from technical requirements for the use of fuel cell technology with methanol as fuel for passenger vessels [12]. Derogations like these may be necessary to test new vessel designs before consolidating a new legal regime that encompasses all limitations of the current framework. It is expected that such exceptions will be granted regularly to enable innovation in vessel design while ensuring safety standards are maintained.

The challenges at this level relate to the recognition of new vessel types as at least equally safe for navigation; EU Member States are currently committing to temporary project-specific derogations to allow for testing of prototypes, but it is questionable whether this approach is sustainable at a larger scale. This is a matter of expediency, as regulators do not have shipping automation high in the agenda and thus delay the creation of agile administrative procedures, deterring the industry from investing in new vessel types.

6 Insurance and risk management

The issue of insurance is of relevance because the AEGIS concept introduces new types of risk to the waterborne venture. The digitalization of various processes, from navigation to remote controlling to cargo transfer, all the way through to terminal operations may remove some risks, but it creates additional ones. This was already briefly mentioned when discussing challenges proper of digital system development and maintenance. Additionally, cyber threats affect the fair presentation of risk and the concept of seaworthiness.

All vessels must comply with the IMO regulatory framework aiming to safeguard shipping from current and emerging cyber threats and vulnerabilities and includes functional elements that support effective cyber risk management [13]. The goal of maritime cyber risk management is to support safe and secure shipping, which is operationally resilient to cyber risks[5]. The effectiveness of cyber risk management will need continuous updates and cyber protection will have to be considered by shipping companies' loss prevention departments. Cyber risk management must be considered by marine underwriters as material information in relation to MASS. Depending on the degree of automation, cyber security measures will specifically impact on the MASS' safety [14].

Under UK law, "Before a contract of insurance is entered into, the insured must make to the insurer a fair presentation of the risk." This means that a policyholder must disclose every 'material circumstance' which it knows or ought to know. A "material circumstance" is defined as one that "would influence the judgement of a prudent insurer in determining whether to take the risk and, if so, on what terms." To comply with the duty of fair presentation of the risk, the shipowner will have to disclose the cyber risk management programme in place for MASS, to obtain an effective marine insurance policy. The approach to cyber risk management provides a foundation for better understanding and managing cyber risks, thus enabling a risk management approach to address cyberthreats and vulnerabilities[6].

The 2023 Version of the Nordic Marine Insurance Plan, which was launched at the beginning of October 2022, can be utilised as a reference to analyse this challenge[7]. The Nordic Plan is a collaboration between insurers and shipowners, and attempts are made by insurers to facilitate insurance solutions to avoid uninsured risk exposure. Marine cover is accordingly based upon the "all risks" concept.

The EU Operational Guidelines on trials of Maritime Autonomous Surface Ships (MASS) are also pertinent to insurers, as they provide clarity on the roles of authorities and applicants and offer

[5] MSC-FAL.1/CIRC.3/REV.1. For the purpose of the *Guidelines on Maritime Cyber Risk Management*, cyber risk management means the process of identifying, analysing, assessing, and communicating a cyber-related risk and accepting, avoiding, transferring, or mitigating it to an acceptable level, considering costs and benefits of actions taken to stakeholders.

[6] For detailed guidance on cyber risk management, users of these Guidelines should also refer to Member Governments' and Flag Administrations' requirements, as well as relevant international and industry standards and best practices. Additional guidance and standards may include, but are not limited to: .1 The Guidelines on Cyber Security Onboard Ships produced and supported by ICS, IUMI, BIMCO, OCIMF, INTERTANKO, INTERCARGO, InterManager, WSC and SYBAss. .2 Consolidated IACS Recommendation on cyber resilience (Rec 166). .3 ISO/IEC 27001 standard on Information technology – Security techniques – Information security management systems – Requirements. Published jointly by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). .4 United States National Institute of Standards and Technology's Framework for Improving Critical Infrastructure Cybersecurity (the NIST Framework).

[7] The Nordic Marine Insurance Plan is a collaboration between The Nordic Association of Marine Insurers (Cefor), Danish Shipping, the Finnish Shipowners' Association, the Norwegian Shipowners' Association, and the Swedish Shipowners' Association. The Plan is regularly updated every 4 years.

guidance on what to consider in their assessments, including risk assessments. These guidelines adopt a goal-based approach, whenever possible, to ensure that trials are conducted with at least the same level of safety, security, and environmental protection provided by the relevant IMO instruments. The guidelines provide a framework for the overall process of establishing test areas for MASS, granting authorizations for MASS system trials in these areas, and performing such tests. By following these guidelines, insurers can ensure that they meet the necessary safety and environmental standards for insuring MASS trials [15].

According to existing literature, there is a lack of clarity regarding how insurance markets are adapting to the evolving concept of seaworthiness for MASS. If the operational technology of MASS is capable of achieving the same outcomes as traditional manned vessels, it may be necessary to update the implied warranty of seaworthiness for MASS with regard to the number of crew on board. However, the incorporation of contractual remedies in insurance policies remains at the discretion of underwriters, who may choose to maintain their position on this matter. Therefore, the way in which insurance markets will address the issue of seaworthiness for MASS remains uncertain [16]. Despite the uncertainty surrounding the issue of seaworthiness for MASS, a prudent underwriter can still conduct a thorough risk evaluation based on the standard terms that are currently available in the insurance market. By doing so, insurance cover can be tailored to adequately respond to the needs arising from the construction of MASS. Therefore, while the insurance industry may face challenges in adapting to the evolving concept of seaworthiness for MASS, prudent underwriting practices can ensure that the risks associated with these vessels are adequately evaluated and managed.

7 Autonomous transportation

The AEGIS concept comprises vessels with varying degrees of autonomy designed for navigation in two distinct settings: internal/coastal waters and inland waterways. Different legal challenges arise depending on the location of navigation. As specified in the vessel types for the AEGIS use cases, there is a degree of complementarity between ships with higher or lower levels of autonomy. This means that different options may apply, and the concept facilitates a seamless transition between different autonomy levels. The diagram below provides a summary of the different levels of autonomy for each degree, with levels 1-2 involving human presence on board and levels 3-4 operating without any human presence.

	Level of autonomy	*Human presence*	*Operational control*	*Human role*
Degree 1	Ship with automated processes and decision support	Yes	Seafarers are on board to operate and control shipboard systems and functions. Some operations may be automated and at times be unsupervised but with seafarers on board ready to take control	Supervision and operation
Degree 2	Remotely-controlled with seafarers on board	Yes	The ship is controlled and operated from another location. Seafarers are available on board to take control and to operate the shipboard systems and functions	Backup to manoeuvre, supervise the systems
Degree 3	Remotely-controlled without seafarers on board	No	The ship is controlled and operated from another location. There are no seafarers on board	Monitoring and remote control
Degree 4	Fully autonomous	No	The operating system of the ship is able to make decisions and determines actions by itself	Monitoring and emergency management

Figure 1: Degree of navigation autonomy according to IMO

In the case of short sea shipping: the mother vessel in operation along the Norwegian west coast (UC-A) would have a low to medium level autonomy (1-2 according to the IMO) and be autonomy-ready; the daughter vessels 1-2-3 would have a higher autonomy level (3-4 according to the IMO). The RORO vessel in operation within the Kattegat/Skagerrak region, departing from Aalborg (UC-C) and the multi-purpose (combined SSS and Inland) in operation in the Baltic Sea would both have a low to medium autonomy level. Both vessel concepts include a bridge for operating the vessel by a crew on board within the first duration of their service time. In the second phase due to higher autonomy manoeuvring, it becomes possible to remove the bridge, since it will be no longer needed for an operating crew. The vessels then will be operated by Remote Control Centres on land.

In the case of inland waterways: there are two scenarios for a RORO barge operation; scenario 1 is Rotterdam – Ghent, direct route (no stops) and scenario 2 is Ghent – Paris, milk route (multiple stops). The autonomy levels of the three developed vessels for the UC-B (CEMT-Class II, IV, VI) have an autonomy level of 3-4; they are expected to have swappable electric batteries. Setup is based around the same overall conceptual idea of mother-daughter as UCA.

Importantly, the AEGIS concept features only two vessels above 5000 GT, which are the mother vessel for UC-A (1100 TEU/ 10900 GT) and the RORO vessel for UC-C/ Aalborg (5700 GT). One vessel in UC-B is 4700 GT. All other vessels are well below 5000 GT.

7.1 Offshore navigation

Regulation of offshore shipping (including short-sea shipping) is the remit of the IMO. This UN specialized agency has been conducting regulatory scoping exercises to identify and resolve legal challenges brough along by the introduction of MASS. Aside from challenges with the definition of ship and crew, there are also separate but equally relevant challenges concerning jurisdiction over ships and the insurance over navigation incidents [17].

7.1.1 Definition

Maritime Autonomous Surface Ship (MASS) refers to a type of vessel that operates on the surface of the water without a crew onboard, utilizing autonomous systems for navigation, operation, and control. MASS vessels are designed to perform various tasks, such as oceanographic research, surveillance, cargo transportation, and even military operations. These ships are equipped with advanced sensors, communication systems, and artificial intelligence technologies to enable autonomous operation.

Continuously Unmanned Ship (CUS) refers to a specific type of MASS that remains unmanned at all times during its operation. It operates autonomously, relying on its onboard systems to navigate, avoid obstacles, and perform its designated tasks without human intervention. CUS vessels are designed to operate for extended periods without the need for crew rotation or onboard human presence.

Periodically Unmanned Bridge (PUB) refers to a configuration where the bridge or control centre of a ship is unmanned during specific periods of operation. While the ship itself may have a crew onboard, the bridge or control centre is periodically unmanned, relying on automation and remote monitoring systems to ensure the ship's safe operation. During unmanned periods, the ship's systems are monitored from a shore-based or remote-control centre.

Periodically Unmanned Ship (PUS) refers to a type of vessel where the entire ship, including the bridge and other areas, is periodically unmanned. Similar to PUB, PUS relies on automation and remote monitoring systems during unmanned periods. However, unlike CUS, which remains unmanned at all times, PUS vessels may have a crew onboard during certain periods or for specific tasks, with unmanned periods scheduled for maintenance, refuelling, or other purposes.

Autonomy Assisted Bridge (AAB) refers to a bridge or control centre that is equipped with advanced autonomous systems to assist human operators in the ship's navigation and operation. The AAB configuration combines human expertise with artificial intelligence and automation technologies to enhance decision-making, optimize operations, and improve overall safety. It allows human operators to have real-time information, intelligent recommendations, and automation support while maintaining ultimate control and responsibility over the ship's actions.

These concepts reflect various levels of autonomy and unmanned operation in maritime vessels, with each configuration offering different benefits and considerations based on the specific requirements and objectives of the ship's mission.

The definition of offshore autonomous operations has been the subject of debate. The Maritime Safety Committee IMO has conducted a regulatory scoping exercise to evaluate how MASS could be regulated, by analysing relevant ship safety treaties[8].

The exercise considered varying degrees of autonomy, including crewed ships with automated processes and decision support (Degree One), remotely controlled ships with seafarers on board (Degree Two), remotely controlled ships without seafarers on board (Degree Three), and fully autonomous ships (Degree Four). The Committee recognized that the best way forward to address MASS in the IMO regulatory framework could be through the development of a goal-based MASS instrument, such as a "MASS Code," that includes goals, functional requirements, and corresponding regulations suitable for all four degrees of autonomy, and that addresses the gaps and themes identified by the regulatory scoping exercise. The Committee invited Member States to propose ways to achieve the best way forward at a future session of the MSC.

To introduce MASS operations safely and effectively in the regulatory framework, the IMO conducted a regulatory scoping exercise. The exercise identified four key areas that require policy decisions before addressing individual instruments.

Firstly, there is a need to clarify the meaning of terms such as master, crew, or responsible person in several instruments. The role and responsibility of the master, particularly for degrees of autonomy Three and Four, where personnel on the shore side might control the ship, are potential gaps that require addressing.

Secondly, the functional and operational requirements of the remote-control station/centre and monitoring need to be addressed. These are new concepts to be implemented in IMO instruments and are identified as a common theme and potential gap in several instruments.

Thirdly, the scoping exercise identified the possible designation of a remote operator as a seafarer as a common theme and potential gap in several instruments. Qualifications, responsibilities, and the role of the remote operator as a seafarer are complex issues that need addressing.

Lastly, the matter of a glossary should be considered after the regulatory scoping exercise has been completed, together with information from the International Organization for Standardization (ISO) concerning new standards.

[8] The MSC's regulatory scoping exercise, as approved by the Committee, can be found in the report of MSC 103 (MSC 103/21/Add.1, annex 8) and circular MSC.1/Circ.1638 (Outcome of the Regulatory Scoping Exercise for the use of Maritime Autonomous Surface Ships (MASS)).

In step 2, views were expressed to re-evaluate the degrees of autonomy, taking into account the lessons learned during the regulatory scoping exercise. New definitions were proposed in several places, which require further consideration and decision-making.

The deployment of the offshore side of AEGIS poses significant legal and regulatory challenges, given its reliance on autonomous navigation. While each state has the freedom to adopt rules and standards for their own vessels, it is crucial to establish shipping standards from a universal perspective to ensure fair competition and avoid disrupting trade. The IMO plays a key role in this regard, striving to establish universal shipping standards that are applicable across jurisdictions. As such, addressing the legal and regulatory challenges posed by autonomous navigation is essential for the successful deployment of the offshore side of AEGIS, and requires a collaborative effort by all relevant stakeholders.

7.1.2 Jurisdiction over ships

Under the United Nations Convention on the Law of the Sea, ships fall under the jurisdiction of the flag state, which has various responsibilities. The flag state is authorized to register any class of ship (UNCLOS art. 91), granting registered ships navigation rights regardless of their class[9]. However, the coastal state also has the authority to determine specific navigational and passage rights, while the port state can regulate port entry conditions and conduct inspections under port state control.

The AEGIS concept raises legal concerns with regard to the law of the sea. To exercise due diligence over a ship, the flag state must have effective jurisdiction and control over administrative, technical, and social matters[10]. However, the current terms for exercising this duty do not fully account for the specifics of MASS navigation.

The UNCLOS requires the flag state to take measures "as are necessary" to ensure safety at sea[11]. Some of these obligations are of particular importance for the proposed AEGIS design, which disrupt existing practices, namely the following:

- To ensure ships are in the charge of properly qualified masters and officers[12]
- To ensure ships are crewed in accordance with their class[13]
- To ensure the master and crew are conversant/required to comply with international safety, collisions avoidance, pollution prevention, radio communications rules[14]
- To ensure conformity with generally accepted international regulations, procedures and practices and take steps to secure their observance[15]
- To require master to offer assistance to persons in distress at sea[16]

[9] UNCLOS art 90.

[10] UNCLOS art 94.

[11] UNCLOS art 94(2)(b) and art 94(3)

[12] UNCLOS art 94(b)

[13] UNCLOS art 94(4)(b) and art 94(3)(b)

[14] UNCLOS art 94(4)(c)

[15] UNCLOS art 94(5)

[16] UNCLOS art 98

- To ensure compliance with international rules and standards and provide for effective enforcement, including to prevent operation of ships not in compliance with manning requirements[17]

The default template for ensuring safety in the UNCLOS requires the presence and action of humans. Removing humans from the ship, or from the bridge, raises legal interpretation issues. For example, the interpretation of the requirement to carry onboard “charts, nautical publications and navigational equipment and instruments as are appropriate for the safe navigation of the ship” may be interpreted quite differently if the ship is designed to be fully autonomous[18]. Likewise, the flag state may interpret the duty of ensuring “that each ship is in the charge of a master and officers who possess appropriate qualifications” differently than originally designed[19]. The qualification requirements could well indeed be interpreted as extending to shore-based personnel in case of remote-control operations centres[20]. The interpretative stretch is much larger if one considers navigation based on an autonomous system, whereby an artificial intelligence is involved in decision-making (e.g. to avoid collision at sea). In this case, one could suggest that programmers must be qualified mariners.

The crewing of the vessel is another concern of the flag state[21]. The determination of what crew is under international law is expected to change if it is temporary, not in charge of the steering, or consisting of a shore-based team. The requirement of maintaining radio communications is also one that needs to be interpreted anew in view of the proposed concept[22]. The AEGIS transport system would reduce or eliminate the need for onboard steering at sea, but there may be advantages for keeping crew on board for emergency purposes, maintenance or for mooring. In the case of UNCLOS requirements.

Another challenge proper of offshore navigation is the duty to render assistance. As per international law, “every State shall require the master of a ship flying its flag” to render assistance to persons in distress or to other ships after collision[23]. Without humans on board, it becomes a legal challenge to interpret the scope of this obligation, as the practical fulfilment of its terms becomes quasi-impossible in case of remote control (unless there is someone on board for that matter) and impossible in case of autonomous navigation. The SOLAS convention requires the master to render assistance up to the capabilities of ship and crew[24]. Consequently, if the master cannot provide assistance, they must notify the MRCC, and they are thereby relieved of their responsibility. Autonomous ships will be equipped

[17] UNCLOS art 211-217

[18] UNCLOS art 94(a)

[19] UNCLOS art 94(4)(b)

[20] UNCLOS art 94(4)(b) and 94(4)(c)

[21] UNCLOS art 94(4)(b)

[22] UNCLOS art 94(4)(c)

[23] UNCLOS art 98

[24] SOLAS Regulation 33(1): Distress situations: obligations and procedures The master of a ship at sea which is in a position to be able to provide assistance on receiving information from any source that persons are in distress at sea, is bound to proceed with all speed to their assistance, if possible informing them or the search and rescue service that the ship is doing so. This obligation to provide assistance applies regardless of the nationality or status of such persons or the circumstances in which they are found. If the ship receiving the distress alert is unable or, in the special circumstances of the case, considers it unreasonable or unnecessary to proceed to their assistance, the master must enter in the log-book the reason for failing to proceed to the assistance of the persons in distress, taking into account the recommendation of the Organization, to inform the appropriate search and rescue service accordingly.

with advanced sensor and communication technology and can serve as a "commander on the scene," with RCC personnel trained in such operations. It may also be possible to equip the ship with systems to assist in such situations. However, the effectiveness of such systems remains to be demonstrated.

The AEGIS concept designs encompass various degrees of autonomy, including scenarios where no humans are present on board the vessel. However, when humans are completely absent even from remote control operating centres, flag states face jurisdictional difficulties in overseeing the actions of the master and crew. In the case of remote control, individuals serving as a surrogate for the master and crew (assuming the availability of personnel to deploy in the event of malfunctions) are likely to be situated on land, rather than onboard the vessel. Consequently, the flag state's authority to enforce jurisdiction could be limited by the jurisdiction of the state where the remote-control centre is located. To address this issue, guidelines for international cooperation may need to be established to ensure compliance with applicable safety standards.

From a coastal state perspective, sovereignty is enjoyed over internal waters and port waters. In the territorial sea, the sovereignty of the coastal state is subject to the regime of innocent passage[25]. In what respect to MASS, this means that the coastal state may not apply design, construction, manning or equipment standards “unless they are giving effect to generally accepted international rules or standards”[26]. One challenge with respect to this in the AEGIS context is whether the coastal state may require crew on board even if the ship is in compliance with such generally accepted standards (e.g. in heavy traffic areas). Further to that, special requirements exist in straits: therein a coastal state likely cannot impose manning requirements; safety regulation in straits focuses on sea lanes and traffic separation schemes[27]. Such regulations must be non-discriminatory, which means that the regulator state cannot exclude vessels based on nationality for example, or on specific technical standards.

From the perspective of a port state, Maritime Autonomous Surface Ships (MASS) present significant challenges. Compliance is typically verified by a control officer who conducts an inspection of the vessel, which may involve conducting interviews and requesting specific documentation or access to certain areas of the ship. The designated contact person onboard is also informed of any findings, including irregularities that may require repair at a shipyard. However, this process is predicated on the presence of an individual onboard the vessel. This assumption raises questions about how port state control officers would interact with a remote-control operator or an individual responsible for the autonomous systems on board, which may prove impractical and potentially lead to confusion. Therefore, it is essential to implement appropriate procedures to ensure that inspections are not hampered by the autonomous nature of the vessel's navigation systems.

7.1.3 Vessel traffic service

Coastal states bear the responsibility of ensuring safe navigation in their coastal waters, which includes providing adequate traffic control measures and appropriate markings to complement a ship's seaworthiness requirements. Nevertheless, the increasing digitalization and automation in navigation pose challenges to the liability regime in the event of a shipwreck. Overcoming these challenges is crucial to ensuring safe and secure navigation in coastal waters [18].

[25] UNCLOS art 21

[26] UNCLOS art 21(2)

[27] UNCLOS art 41-42

VTS systems are located on the shore and provide ships with various types of information, such as the positions of other vessels or warnings about meteorological hazards. They can also manage traffic in ports or waterways. When ships enter a VTS area, they report to the authorities via radio and can be tracked by the VTS control centre. Ships must monitor a specific frequency for navigational warnings and may receive direct contact from the VTS operator in case of an incident or to receive advice on when to proceed in regulated traffic flow areas. Governments can establish VTS where they see fit, based on the volume of traffic or level of risk. IALA develops standards and recommendations related to the establishment and operation of VTS systems to promote global harmonization[28].

Typically, VTS integrates information from various sources such as radar, AIS, and closed-circuit television circuits in a command-and-control room. AIS transponders enable ships to provide automatic position, identification, and other information to both other ships and coastal authorities. SOLAS, specifically regulation V/19, establishes navigational equipment requirements for ships based on their type. As part of a revised new chapter V in 2000, the IMO made it mandatory for all ships to carry AISs capable of providing automatic information about the ship to other ships and coastal authorities.

To establish regulations for the deployment of MASS and related infrastructure on Marine Aids to Navigation, including VTS, it is necessary to consider both the technological and regulatory aspects of MASS operations. Here, the regulatory challenge lies in defining the terms of the responsibility of coastal state authorities to provide vessel traffic services, and the potential impact on the liability regime in case of maritime casualties.

It is worth discussing whether UNCLOS's obligation to protect navigational aids, facilities, and installations[29]. Since coastal states have a duty to ensure that their traffic control systems are capable of safeguarding navigation in merchant fairways and must be prepared to interact with traffic and respond to any situation that arises, the liability for a maritime casualty may be limited if that maritime casualty was caused by coastal state negligence[30]. Yet it is debatable whether VTS can be considered an aid to navigation and whether their failure truly limits the liability of the ship owner. One indication that VTS may be considered aids to navigation is found in the IALA Navguide, which defines aids to navigation as "devices, systems, or services, external to vessels, designed and operated to enhance the safe and efficient navigation of individual vessels and/or vessel traffic"[31]. This definition potentially includes VTS.

As VTS operations become increasingly automated, it is necessary to reassess the concept of fairway maintenance and how VTS can contribute to shipping accidents. Moreover, there may be implications for liability regarding environmental damage. Those who fail to meet their obligations and contribute

[28] IALA is a non-profit, international technical association. Established in 1957, it gathers together Marine Aids to Navigation authorities, manufacturers, consultants, and scientific and training institutes from all parts of the world and offers them the opportunity to exchange and compare their experiences and achievements.

[29] The coastal State may adopt laws and regulations, in conformity with the provisions of this Convention and other rules of international law, relating to innocent passage through the territorial sea, in respect of the protection of navigational aids and facilities and other. See UNCLOS art 21(1)(a)

[30] The registered owner shall be liable for the costs of locating, marking and removing the wreck unless the registered owner proves that the maritime casualty that caused the wreck: was wholly caused by the negligence or other wrongful act of any Government or other authority responsible for the maintenance of lights or other navigational aids in the exercise of that function. See *Nairobi International Convention on the Removal of Wrecks, 2007, article 10, 1.*

[31] IALA Standard S1040 – Vessel Traffic Services.

to an increased risk of pollution may be held liable. Therefore, coastal state authorities should ensure that they fulfil their responsibilities as vessel traffic service providers and are equipped to handle any traffic situation, including potential changes in liability in the event of maritime casualties. It is crucial for them to be prepared to interact with traffic and respond to any incidents that may occur.

In situations where communication between the ship's remote-controlled system and VTS is disrupted, coastal states may require VTS to establish plans to take over control of MASS to ensure safety of life at sea and environmental protection. However, in such circumstances, new regulations are needed to establish the legal relationship between VTS and MASS. This issue is not expected to be directly resolved by the IMO, as its primary focus is on ships rather than coastal services. Coastal state legislation, potentially harmonized under IALA, could address this issue. IALA includes VTS and pilotage as aids to navigation in its recommendations, which could be included in the strict liability of fairway maintenance[32]. Pilotage, although relevant in this matter, is not considered an aid to navigation (see specifics below).

AEGIS ships, as MASS, heavily rely on coastal state's VTS for navigation and collision avoidance, distinguishing them from traditional ships that rely on human operators for these functions. In the case of AEGIS ships, VTS serves as the "eyes" of the vessel, providing crucial information about the surrounding environment and other vessels in the area. However, this dependence on VTS introduces new risks that did not exist before, such as potential reduced situational awareness due to technical failures or cyber-attacks on the VTS system. These risks could lead to collisions or other accidents, resulting in complex liability issues between the vessel owner and the coastal state. The liability regime for autonomous ships is still evolving, and it is important to consider the legal implications of MASS operations in relation to VTS systems. As noted above, this requires coastal states to legislate so that there is legal security for operators in situations of malfunction.

7.1.4 Pilotage

Another issue that may affect the implementation of the AEGIS concept offshore relates to pilotage, namely in areas where that is necessary (e.g. in Norwegian fjords). This refers to activities related to the navigation of vessels in which the pilot acts as an advisor to the master of the vessel and as an expert on the local waters and their navigation. Remote pilotage is an act of pilotage that is performed by a licensed pilot who is not physically present on the ship being piloted. In some European ports, this service is available to ships when severe weather conditions prevent pilots from boarding at the regular boarding point. Under these circumstances, certain ships may be remotely guided to calmer waters, where a pilot can board, with the help of radio instructions from a shore-based pilot who monitors the ship's progress using radar. The service is only offered to ships that meet certain length and draft requirements, and all parties involved, including the master, the pilot, and the port authority, must agree that remote pilotage can be safely carried out. This service is not intended to replace regular piloting but is rather a backup solution used when the ship would otherwise have to wait for better weather conditions [19]. Pilotage regulations differ not only across countries, but also across individual ports. If a pilot assumes complete remote control over the operation of an autonomous vessel, there

[32] For example, when the MV Karen Danielsen collided with the Big Belt Bridge in Denmark, investigations focused on the role of VTS. Karen Danielsen Collision with the Great Belt West Bridge: The joint Bahamas Maritime Authorities & Danish Division for Investigation of Maritime Accidents report. Danish Maritime Authority (3 March 2005).

arises a legal challenge in determining who should be held liable for any potential negligence. The issue of liability must be addressed prior to allowing autonomous ships to enter foreign ports [20].

7.2 Inland navigation

Inland navigation follows a different type of legal setting, and thus requires a separate set of legal supporting tools (see Annexes for specifics). Unlike the seas which are governed by an international legal framework with global application, each inland waterway is embedded in its own legal regime, determined by the riparian states. The AEGIS concept proposes three vessel concepts with adapted size to fit the existing inland waterways (rivers, canals), i.e. CEMT class VI, IV, and II (Classification of European Inland Waterways). One challenge that is not applicable to AEGIS is when inland ships seek to leave the inland waterway into the sea; such ships would need to be type approved also under the IMO, and thus be registered accordingly. CESNI has issued the European Standard laying down technical requirements for Inland Navigation vessels (ES-TRIN)[33]. A regulatory gap analysis was already conducted in the literature [21]; for the AEGIS concept, the same gaps persist and thus a brief overview is necessary.

7.2.1 Definitions

In 2018, following the Mannheim Declaration, the competent ministers of the Central Commission for Navigation on the Rhine (CCNR) Member States urged the CCNR to promote the development of digitalisation, automation, and other advanced technologies to enhance the competitiveness, safety, and sustainability of inland navigation. To ensure successful implementation of this initiative, the CCNR assigned the Small Navigation Committee (RN) with the responsibility for steering and coordinating work relating to automated navigation. The RN Committee addresses questions regarding automation and engages experts from various fields depending on the topic being addressed (e.g., technical, nautical, personnel, legal, etc.). Furthermore, the Small Navigation Committee is responsible for examining applications for authorisation of pilot projects. Automation is a significant change for inland navigation and will impact nearly all aspects of the industry. Therefore, the CCNR has taken a comprehensive approach that accounts for legal, ethical, and social factors. The CCNR has developed a detailed vision as a tool to steer and coordinate work to be conducted during the period spanning 2022 to 2028 and beyond, across various committees.

The CCNR developed a definition of levels of automated navigation in inland navigation to assess the need for regulatory measures[34]. The definition has been widely used by pilot projects, national authorities, and international institutions, such as the UNECE and PIANC. The CCNR extended the validity of the definition until December 31, 2022, but recognized the need to review it due to some pilot projects having difficulties assigning a single level of automation. The changes made in the 2022 edition are minor adjustments and include a clarification of some terms used, an explanatory note to provide additional information, and better consideration of the master's role in automation level 3. The subject of remote control has been removed from the definition of levels of automation, but further clarification on its relation to automation is provided in the explanatory note. The examples originally added to the definition are now included in the explanatory note. Legal requirements often

[33] This document was published on November 25th, 2022, and entered into force on January 1st, 2023.

[34] Resolution 2018-II-16 "Protocole 16 : Définition des niveaux d'automatisation en navigation intérieure"

foresee the operation of equipment by a human and at times does not explicitly allow remote control of certain operations in the vessel.

Most river-sea traffic is operated by seagoing ships. However, some specific inland vessels can make limited sea journeys between two ports of the same country if they meet certain requirements. Inland vessels cannot make international sea journeys because they do not have seagoing ship certificates. To allow inland vessels to navigate at sea, a special certificate is required as most IMO regulations for seagoing ships are not suitable for domestic trade along the coastline in restricted maritime areas. Restricted maritime areas are classified according to risk level based on wave and swell severity, risk of shipping water, exposure to strong wind, distance from shore and weather conditions. In these areas, inland vessels must be designed to withstand more severe weather conditions than pure inland vessels. Access to maritime areas is given to inland vessels taking into consideration restricted routes and limitations on wave height. There are set conditions for issuing technical certificates for inland waterway vessels in EU inland waterways, but there is currently no harmonisation in the requirements for inland vessels to navigate at sea [22]. Inland vessels at sea can be relevant when a maritime/coastal port is not well connected to the inland waterway network and is economically viable.

7.2.2 RORO vessels and multimodality

While most IWT is currently comprised of dry bulk chemical and petroleum products, as well as containers, the AEGIS inland waterway segment is aiming at creating a RORO connection. This makes trucks become part of the concept, bringing issues proper to road haulage into the scope of analysis of this report, when it normally fails to be considered when discussing IWT.

Liability issues may arise in mode-on-mode transport, where goods are carried over different modes of transportation during the same contract for carriage. The applicable legal regime in principle covers the entire voyage as long as the goods remain on the same set of wheels, but the liability of the carrier by road may be determined by a hypothetical regime prescribed by law for the carriage of goods by sea or train if certain conditions are met[35]. These conditions include that the damage must have occurred during the RORO or piggyback transportation, was not caused by the road carrier, and could only have occurred during the RORO or piggyback transportation. However, the lack of prescribed

[35] The Convention on the Contract for the International Carriage of Goods by Road covers mode-on-mode transport during a contract for the carriage of goods by road. It consists of three sentences. The first sentence ensures that the convention applies to the entire voyage as long as the goods remain on the same set of wheels: Where the vehicle containing the goods is carried over part of the journey by sea, rail, inland waterways or air, and, except where the provisions of article 14 are applicable, the goods are not unloaded from the vehicle, this Convention shall nevertheless apply to the whole of the carriage. The obvious example relates to RORO ferry transportation, very common during carriage between the UK and the Netherlands/France/Belgium or between the different Scandinavian countries. The truck (or just the trailer) carrying the goods boards the ship in Denmark and drives off again in Sweden (still carrying the goods) to resume the carriage by road. The first sentence of article 2 (1) CMR is straightforward enough; it is the second sentence that causes the problems. In spite of the (uniformity) rule in the first sentence, the second sentence then steers away from the provisions of the CMR, and instead offers an alternative set of rules when certain conditions are met: Provided that to the extent it is proved that any loss, damage or delay in delivery of the goods which occurs during the carriage by the other means of transport was not caused by act or omission of the carrier by road, but by some event which could only have occurred in the course of and by reason of the carriage by that other means of transport, the liability of the carrier by road shall be determined not by this Convention but in the manner in which the liability of the carrier by the other means of transport would have been determined if a contract for the carriage of the goods alone had been made by the sender with the carrier by the other means of transport in accordance with the conditions prescribed by law for the carriage of goods by that means of transport.

conditions for the hypothetical regime has caused problems, with different courts providing varying solutions[36].

A multimodal contract of carriage is an agreement where a carrier agrees to transport goods using multiple modes of transportation. The carrier is responsible for the goods throughout the entire journey until they are delivered to the destination. However, the European Commission has introduced a separate definition for "combined transport," which involves using at least two different modes of transportation, including an initial sea leg followed by an inland transport leg or vice versa. This distinction aims to promote environmentally friendly and efficient modes of transport for the inland portion of the journey.

The European Commission's definition of combined transport offers specific benefits and advantages to incentivize its use. These may include simplified customs procedures, reduced administrative requirements, and potentially lower charges or fees compared to traditional multimodal transport. It is important for shippers, carriers, and other stakeholders to understand these definitions and the regulatory frameworks that apply to multimodal and combined transport. Compliance with regulations and understanding the specific requirements of each mode of transport is crucial for successful operations within the European Union.

7.2.3 Interface with infrastructure

Differently than offshore navigation, IWT comprises infrastructural challenges of its own: namely bridges, locks, weirs, dams and artificial channels. Their level of autonomy and ability to interact with the proposed autonomous RORO barge concept is essential for AEGIS to succeed. The existing challenges refer to the need to create adequate rules, or adapt existing ones, to ensure the AEGIS ships are not in contravention of safety of navigation measures. They pertain to issues more generally related to the ship itself, as the risk of collision would normally be caused by the ship. However, one must consider that newly developed autonomous infrastructure could itself be the cause of legal issues. That notwithstanding, and because the AEGIS concept does not design such technical solutions, that issue falls outside the remit of this report.

[36] If a multimodal contract of carriage is not governed by an international convention, the law applicable to the contract is identified in accordance with Regulation (EC) No 593/2008 on the law applicable to contractual obligations (“Rome I”).

8 Remote operation

The new European waterborne transport system will feature a new actor, the remote operator of the vessel. There are legal consequences to removing crew and using autonomous technologies through a continuously unmanned ship that is operated by a remote-control station/centre (see definitions above 2.7.1.1.).

One of such issues is the exercise of effective jurisdiction over the remote operator of the ship. This is a distinct legal matter from exercising jurisdiction over the ship itself, as the operator is now outside the ship. It is thus impossible for the authorities of the patrolling state to question or arrest the operator when controlling the ship itself. Cooperation with the flag state is necessary, and this creates challenges from the perspective of the 'genuine link' between the vessel and the registering authority. The flag state will only have unrivalled enforcement jurisdiction if the operations or the remote-control centre are in its territory. The challenge then is to ascertain whether that link still exists if the remote-control centre is located elsewhere.

From a remote operations perspective, it is also necessary to consider the Convention on the International Regulations for Preventing Collisions at Sea. COLREGs is a regulatory convention, meaning that violations must be transformed into offences under national law. Criminal liability is almost exclusively governed by the COLREGs 1972. If the offence is serious, it may be criminal, as distinguished from regulatory, with more severe sanctions. Rule 2 covers the responsibility of the master, owner and crew to comply with the rules[37]. COLREG refers to the "ordinary practice of seamen" and "good seamanship". These are objective standards, albeit associated with vocational training. Non-compliance with COLREG is a strong indicator of fault or negligence.

[37] It says that (a) Nothing in these Rules shall exonerate any vessel, or the owner, master or crew thereof, from the consequences of any neglect to comply with COLREGs or of the neglect of any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case; and that (b) In construing and complying with COLREGs due regard shall be had to all dangers of navigation and collision and to any special circumstances, including the limitations of the vessels involved, which may make a departure from COLREGs necessary to avoid immediate danger.

9 Ship-to-ship loading

Ship-to-ship transfers normally refer to offshore bunkering activities. The novelty brought by the AEGIS concept is to create the ship-to-ship transfer of cargo, more precisely containerized cargo. For matters of navigational safety, within the proposed AEGIS concept this transfer is to be done *at berth*, and thus not offshore. That notwithstanding, the operation of this technological increment in relation to legacy methods (namely the offloading of containers onto the terminal and subsequent onloading onto another vessel) does raise some relevant legal and regulatory questions.

Classification of ships compliance with technical standards consider the issue of ship construction, design, equipment and manning, an issue subject to international standardization at the International Maritime Organisation. The crane that operates the cargo transfer is part of the vessel, and thus the transfer is an element of that ship's operations. It is so because under international law the vessel is considered a unit, and therefore the operation of an onboard crane will be deemed as part of that unit. The existence of cranes as part of ships is not itself a novelty, but the fact that this is a partly or totally automated process is a novelty. Another relative novelty is the berthing process, whereby two vessels will be moored together to facilitate the transfer of containers. The verification of crane's technical requirements and compliance with safety requirements (e.g., to avoid capsizing during operations). will have to be addressed by *certification societies*, who will have to create and verify specific technical standards for the new vessels, as well as training of crews is necessary.

Situations of accident would require anticipated certainty on whom would bear the liability to compensate for damages. Although it is speculative due to the technological gaps existing in this domain, an educated guess helps understand how these obligations would emerge. It would likely be a cascading set of private obligations, backed by public responsibility to ensure safety of navigation. At the top of the pyramid would be public authorities, namely the port state, and then the flag state. The port state would grant entry to the vessel in the port, assuming that it complies with all safety protocols as declared by the flag state. The flag state would then ask the certification society, who would then ask the surveyor, who would then ask the shipowner, who would then ask the ship operator. Depending on the level of autonomy of the ship, there might be human error involved in the mooring of the vessel. If no crew – presential or remote – is involved in either mooring or crane operations, the ship operator would contact the crane designer. It is at this level that responsibilities would become less clear, as the programmer who first designed the operation will need to assess what circumstances existed in the particular operation and whether the safety protocols set in place were duly followed by all of the parties mentioned above. It might be the case that there is an issue with the cargo, namely that it is not stored in compliance with existent standards (see IMO/ILO/UNECE Code of Practice for Packing of Cargo Transport Units. - CTU Code). Or it might be that the daughter vessel was not moored properly. Or, finally, that an act of God, to utilize insurer's jargon, led to the incident. For all these reasons, a regime of strict liability of the ship owner is to be expected.

The operation of transferring cargo autonomously will in and of itself include new risks to navigation and will thus have to be insured separately, or at least consist of a separate clause from insurance for more typical operations of the vessel. This is not a major gap to overcome for the AEGIS concept to enter the market, but it may increase costs of operation, especially at first while the ship-to-ship transfer process is considered new, and thus where more uncertainties exist. From the perspective of risk insurance, three elements are at stake: one is the damage the operation can cause to the vessel itself, the other is the damage the operation can cause to the cargo during handling, and the other is the damage the operation can cause to the barge that moors nearby, or to any other vessel. As all these potential incidents are likely to happen at a port, the actors involved are not only those associated with the transfer itself (flag states and private parties owning and operating the vessel) but also potentially the port state.

There is also to consider the important issue of customs clearance, which is usually performed when the cargo is offloaded to the dock. The problem raised by this new ship-to-ship cargo transfer at berth is to know whether there are special customs obligations associated with the operation. The concept case predicts that cargo is crossing maritime boundaries, and thus there is indeed a relevant legal situation. The obligations may vary depending on whether the goods are transported within the European Union market, or if the goods originate from non-parties to the EU free market. Although in theoretical terms this is a challenge, in practice it is to be expected that the customs clearance happens at the last terminal where the cargo is offloaded. For matter of practicality, the customs officer at the port where the ship-to-ship transfer occurs would not be capable of verifying that on board either of the vessels (and much less while the cargo is in the process of being transferred). This may thus require from the port state the need to fulfil verification obligations at other locations, namely the destination terminals. This consideration aligns with the concept of "border management modernization" which emphasizes coordinated national electronic information exchanges focused on legislation, procedures, and information and communications technology [23].

For all these reasons, it appears that the feasibility of the ship-to-ship loading in AEGIS UC-A is not threatened by legal and regulatory issues. However, the introduction of the concept still requires adaptations to be made by all relevant actors involved: 1) classifying the new vessel that includes this technology (including the drafting of applicable safety standards to be complied by the operator), 2) requiring and enforcing the liability clauses associated with this operation, 3) assessing new risks for this type of operation and insuring all parties involved, and 4) creating new customs clearance protocols to make sure they can be followed in practice and not deter or delay the transit of goods.

10 Cargo handling

The AEGIS concept introduces advanced terminal handling operations, such as autonomous reach stackers. The challenges here have to do with the potential for accidents between humans and machines, broadening the scope of the analysis to land vehicles. AEGIS proposes dedicated a port area for autonomous cargo handling operations, namely, to reduce risks for human safety. Yet while terminals are not fully automated, a transition stage exists that raises specific legal challenges. Autonomous cargo handling technology raises questions of liability in the event of accidents or damage to cargo or property. EU law holds manufacturers and importers liable for damage caused by their products [24]. However, it's unclear how liability will be assigned in cases where autonomous technology is involved. Autonomous cargo handling technology must meet safety standards to ensure that it doesn't pose a risk to people or property. EU law sets out requirements for the design and manufacture of machinery, including autonomous technology [25]. Public authorities are expected to surveil the market to ensure that products, including autonomous technology, comply with EU requirements [26]. Furthermore, autonomous cargo handling technology is vulnerable to cyber-attacks, which could result in the compromise of sensitive information or the disruption of operations. EU law requires that operators of essential services, including ports, take measures to ensure the security of their networks and information systems [27]. The legal challenges are at this level quite similar to those pointed above with respect to digital system development and maintenance, as well as with insurance and risk management. The difference is that national approaches are more possible at this level, since there is no international dimension to an activity on land. Reach stackers can pose risks to dock workers in a number of ways. For example, workers can be struck by the machinery, fall from height, or be crushed by containers that are improperly lifted or moved. Employers must comply with standards set by the EU, which requires employers to take measures to ensure the safety and health of workers, including risk assessments and providing adequate protective equipment [28].

11 SME port development

The introduction of AEGIS is expected to further the development of small and medium enterprise ports, creating challenges both on the marine front and on land.

11.1 Terminals & waterway classification

The definition of maritime zones is a matter of public international law, namely under customary law and the UNCLOS. Internal (or inland) waters are the waters on the landward side of the baseline from which the breadth of the territorial sea is measured. The coastal State has full sovereignty over its internal waters as if they were part of its land territory. The coastal state may exclude foreign flag vessels from its internal waters subject to the right of entry of vessels in distress. The right of innocent passage does not apply in internal waters. Examples of internal waters include rivers, canals, and lakes.

It is possible to have offshore inland waterways and that coastal states may be creative on how they characterize their internal waters for the purpose of navigation. The inland waterways are divided into zones. The zoning corresponds to the speed area division. There are four zones, which are defined by wave height and where zone 1 has the largest waves (maximum 2m) and zone 4 the smallest (no wind waves). It is for the Member States to determine which waters within their respective territory are classified as inland waterways and which zone each water area shall belong to. Significant wave height here refers to the average height, measured from wave valley to wave crest, of the 10% of waves with the greatest height among the total number of waves in the water area observed over a short period[38]. In practice, this means that potential for navigable waterways off the coast is relatively limited, unless states opt to deviate from this standard.

The aim of the classification of European inland waterways is to promote a uniform inland waterway network. The classification is based on the spatial dimensions of agreed ship types, of which the horizontal parameters length and width are the most important. The unloading depths and fixed point heights are particularly variable. Therefore, the tonnages given are only indicative. This classification system was adopted by the ECE as a resolution in November 1992. The classification system has been adopted by the European Conference of Ministers of Transport (ECMT). The system takes into account the social changes in Central and Eastern Europe.

The way states establish their maritime zones has an impact on actors who exercise their rights therein. The establishment of straight baselines is a way to enclose the waters as internal waters. For example, the straight baseline closes the entrance of Limfjord, a deeply penetrating waterway which, in effect, makes northern Denmark an island [29]. This however does not mean that these internal waters are deemed to be inland waterways. In practice, this means that ports are serviced different types of vessels, but, more importantly, have different rights.

Sweden recently changed the legal definition of waterways. The Swedish Transport Agency has decided on new areas for inland navigation, that is, traffic on canals, rivers and lakes - what are collectively called inland waterways. The new areas are covered by archipelago areas north of

[38] This is based on UNECE Resolution No. 61: Recommendations on Harmonized Europe-Wide Technical Requirements for Inland Navigation Vessels in United Nations. Economic Commission for Europe. Recommendations on harmonized Europe-wide technical requirements for inland navigation vessels.

Gothenburg, parts of the east coast from Kalmarsund in the south to Öregrundsgrepen in the north and the Göta Canal [30].

That is not the case in the Limfjord, leaving the Port of Aalborg unable to access EU port development funds and other funding opportunities e.g. green, high-tech or other leading development projects targeted towards inland ports in the EU, despite being a member of the European Federation of Inland Ports (EFIP). This is so because the Limfjord in the TEN-T Regulation is not classified as an "inland waterway".

11.2 Terminals & urban land planning

From a legal and regulatory perspective, port development and navigation are distinct issues that fall under the jurisdiction of national or regional administrative units. The development of ports near city centres poses a range of legal challenges related to property rights, environmental protection, and the protection of human rights. Property rights are a fundamental human right protected by law, and the development of ports may require the acquisition of land and properties from private individuals, leading to disputes overcompensation and fair treatment. The development of ports can also have significant environmental impacts, including air and water pollution, noise pollution, and habitat destruction, which can lead to legal challenges related to environmental protection and the protection of endangered species. Landscape rights can also be affected, leading to disputes over the preservation of historic buildings, cultural heritage sites, and natural landscapes. Additionally, port activities can pose risks to the health and safety of nearby residents, leading to legal challenges related to health and safety regulations and liability for damages. Proper planning and environmental impact assessments should be carried out before any port development is approved, involving consultation with local communities and stakeholders to ensure that their rights and interests are considered. Measures should be put in place to mitigate any negative impacts of port development, including measures to protect the environment, public health, and safety, and to compensate those affected by the development.

The main challenge in port development relates to property rights since expansion requires land and can impact the surrounding landscape, as well as generate noise and light pollution during terminal and berthing manoeuvres. The legality of port development plans is determined by the approval process by public authorities, as European citizens have a right of access to information, public participation in decision-making, and access to justice in environmental matters[39]. Additionally, EU law imposes specific obligations on member states regarding ports. These include ensuring security in the port perimeter [31], collecting waste from ships and cargo residues [32], and introducing liquefied natural gas and shoreside electricity infrastructure to improve port environmental practices [33]. EU law also provides for access to justice in cases involving major accidents with dangerous substances,

[39] United Nations Economic Commission for Europe (UNECE) Convention on access to information, public participation in decision-making and access to justice in environmental matters.

The Access to Environmental Information Directive is Directive 2003/4/EC of the European Parliament and of the Council of 28 January 2003 on public access to environmental information. The European Parliament &The Council Of The European Union. (2003). Directive 2003/4/EC of the European Parliament and of the Council of 28 January 2003 on public access to environmental information and repealing Council Directive 90/313/EEC. Official Journal, L 041. Brussels, 28 January 2003

The European Parliament &The Council Of The European Union. (2003). Directive 2003/35/EC of the European Parliament and of the Council of 26 May 2003 providing for public participation in respect of the drawing up of certain plans and programmes relating to the environment and amending with regard to public participation and access to justice Council Directives 85/337/EEC and 96/61/EC - Statement by the Commission. Official Journal, L 156 26. May 2003 which is particularly relevant in the context of port development, especially when ports become energy hubs with storage of explosive substances [34].

Additionally, if increased navigation is expected in certain environmentally sensitive sea areas, additional legal challenges for the development of the port relate to environmental protection, namely the existence of areas where water ecosystems are protected and where industrial development is restricted.

12 Data exchange

The introduction of advanced vessels in the maritime transport system means that digital procedures become the rule rather than the exception. Although the EU has an open market, a maritime transport segment often creates an impediment with respect to cargo customs clearance. It is presumed that the ship leaves the EU and then re-enters, thus not distinguishing between global and regional trade. For short-sea shipping to be a reality, there needs to be an agile process that goes beyond cabotage (trade within the coastal state), to ensure trade between states with access to the EU market is not made difficult. Digitalization of administrative data facilitates this process, and this is the point of creating "single windows" for communication.

A Maritime Single Window (MSW) is a public-private data collaboration electronic platform. It enables the exchange of information and data related to maritime transport between government agencies, port authorities, shipping lines, and other stakeholders. The purpose of a maritime single window is to facilitate the processing of maritime transport-related formalities and reduce administrative burdens and costs for all parties involved. However, there are several legal challenges associated with the implementation of a maritime single window. The exchange of sensitive information and data between different government agencies and stakeholders can raise concerns regarding data privacy and security, namely about the level of protection afforded to the confidentiality, integrity, and availability of data. The exchange of data and information between different stakeholders can also raise issues regarding intellectual property rights and it is therefore also important to provide legal guarantees on the use of proprietary data and information. Since single windows create new legal obligations and responsibilities for the parties involved, there is a need to establish rules and guidelines for the allocation of liability and responsibility in cases of data breaches or other legal issues. All these challenges get further complicated by jurisdictional conflict; it can be challenging to coordinate and harmonize different legal frameworks.

The implementation of a maritime single window thus implicitly requires the adoption of international standards for data exchange and interoperability. The work to standardize practices is ongoing. IMO's Facilitation Committee has adopted amendments to the FAL Convention which will make the single window for data exchange mandatory in ports around the world, marking a significant step in the acceleration of digitalization in shipping, enabling the introduction of the AEGIS solutions. At the European level, EU Member States have set up Maritime National Single Windows where ship operators and agents can fulfil in electronic format reporting obligations applied to ships arriving in and departing from their ports [35]. The EU has also laid down harmonised rules for the provision of the information that is required for port calls, in particular by ensuring that the same data sets can be reported to each Maritime National Single Window in the same way. Its application is expected beginning in 2025 (six years after coming in force).

Conclusion

This report highlighted the legal and regulatory challenges to be overcome when introducing a new European waterborne transport system, as designed under the AEGIS project. The structure of this report sought to illustrate how different challenges exist depending on the component of the system. For an optimal application of the concept, all challenges must be overcome. This can be done either by regulating matters, or by adopting new interpretations to existing concepts. A transversal problem to any law-making process is the underlying political compromise that is necessary, and the time and expertise necessary to prepare the quite complex technical rules and standards that govern technology. However, this report did not aim to identify or discuss existing legislation, but rather provide an overview of challenges applicable in various European contexts, albeit inspired by the experiences of stakeholders in the AEGIS project use-cases. This option allows the report to not be bound to a moment in time or a country context and encompass all dimensions of the proposed transport system.

During the course of the AEGIS project, various organizations including the CCNR, the CESNI, and the IMO have made significant strides in addressing the legal challenges associated with autonomous vessels. The field of autonomous shipping is still immature, which makes it difficult to provide detailed rules on processes to follow for the approval of alternative designs, new concepts, and novel technologies in the maritime industry. However, through a regulatory scoping exercise by the IMO, high-priority issues were identified and are being addressed at a policy level. In inland navigation, temporary regulations or permits have been issued for the testing of vessels with less or no crew in countries such as Belgium, the Netherlands, and Germany. The CCNR has elaborated a framework for the authorization of pilot projects that require temporary derogations and has published a detailed vision to support the development of automated navigation in the CCNR. Furthermore, CESNI working groups have been collecting experiences from pilot projects to determine future automation pathways and related regulatory needs. Through collaboration and continued research, these organizations are making significant strides towards addressing legal challenges and shaping the future of autonomous vessels in the maritime industry.

Since most of the legal challenges in a context of technological transition benefits from legal and regulatory flexibility, authorities are approaching the challenges from a public policy perspective instead. This aims at creating political conditions to incentivize stakeholders through policy that indirectly affects the shift to a new system that is more efficient and environmentally sustainable. For this reason, the discussion on what can be recommended is linked not to what legislators can do that is binding. Rather, legal challenges rely on stakeholders to accumulate best practices within exceptions granted under the existing framework, which would later change to respond to a wider variety of industrial practices meanwhile being developed.

References

[1] AEGIS report on public policy recommendations will answer that matter (see AEGIS Deliverable 6.2).

[2] AEGIS Deliverable D6.1 "Public policy recommendations for a new European waterborne transport system" and AEGIS Deliverable D6.3 "Policy implementation measures for a new European waterborne transport system".

[3] Krause, S., Wurzler, L., Mørkrid, O. E., Fjørtoft, K., Psaraftis, H. N., Vilanova, M. R., ... & Kristiansen, J. N. (2022, July). Development of an advanced, efficient and green intermodal system with autonomous inland and short sea shipping-AEGIS. In *Journal of Physics: Conference Series* (Vol. 2311, No. 1, p. 012031). IOP Publishing.

[4] European Commission (n.d). *Green transition.* https://reform-support.ec.europa.eu/what-we-do/green-transition_en Visited 25.05.2023

[5] AEGIS Deliverable D4.3 "Specification of vessel types for use cases - final"

[6] Domenighini, C. (2022). Autonomous inland shipping: will the barge owner be stuck 'between the devil and the deep blue sea'?. *Il Diritto marittimo.-Genova: Francesco Berlingieri, Ed & Pub., 1941*, (4), 752-784.

[7] European Commission (2018), Report on the Application of the Council Directive on the approximation of the laws, regulations, and administrative provisions of the Member States concerning liability for defective products, COM(2018) 246 final, Brussels, 7 May 2018

[8] Madiega, T. (2023). *Artificial intelligence liability directive.* EPRS European Parliament.

[9] Appazov, A. (2014). *Legal Aspects of Cybersecurity*. Faculty of Law University of Copenhagen.

[10] Kampantais, N. (2016). *Seaworthiness in autonomous unmanned cargo ships.* Erasmus University Rotterdam.

[11] European Parliament, Council of the European Union (2016), Directive (EU) 2016/1629 of the European Parliament and of the Council of 14 September 2016 laying down technical requirements for inland waterway vessels. *Official Journal of the European Union,* L 252/118.

[12] European Commission (2020), Commission Implementing Decision (EU) 2020/980 of 6 July 2020 authorising Germany to derogate from technical requirements of Annexes II and V to Directive (EU) 2016/1629 of the European Parliament and of the Council for passenger vessels Innogy and Alsterwasser. *Official Journal of the European Union,* L 220/1.

[13] MSC 98/23/Add.1 *Annex 10 Resolution MSC.428(98). Maritime Cyber Risk Management in Safety Management Systems*.

[14] Varela Chouciño, M., Echebarria Fernández, J., & Hjalmarsson, J. (2023). Insurance of Marine Autonomous Surface Ships: Risk Allocation, Seaworthiness and Technological Challenges from an Underwriter's Perspective. In *Autonomous Vessels in Maritime Affairs: Law and Governance Implications* (pp. 315-334). Cham: Springer International Publishing.

[15] VTMIS. (2020). EU Operational Guidelines For Safe, Secure And Sustainable Trials Of Maritime Autonomous Surface Ships (MASS). European Commission.

[16] Varela Chouciño, M., Echebarria Fernández, J., & Hjalmarsson, J. (2023). Insurance of Marine Autonomous Surface Ships: Risk Allocation, Seaworthiness and Technological Challenges from an Underwriter's Perspective. In *Autonomous Vessels in Maritime Affairs: Law and Governance Implications* (pp. 315-334). Cham: Springer International Publishing.

[17] Ringbom, H. (2019). Regulating autonomous ships—concepts, challenges and precedents. *Ocean Development & International Law*, *50*(2-3), 141-169

[18] Eronen, M. (2023). Autonomy, Autonomous Shipping and Coastal Authorities' Concerns. In *Autonomous Vessels in Maritime Affairs: Law and Governance Implications* (pp. 245-261). Cham: Springer International Publishing. Ringbom, H., Viljanen, M., Poikonen, J., & Ilvessalo, S. (2020). Charting regulatory frameworks for maritime autonomous surface ship testing, pilots, and commercial deployments.

[19] Bruno, K., & Lützhöft, M. (2009). Shore-based pilotage: pilot or autopilot? Piloting as a control problem. *The journal of navigation*, *62*(3), 427-437.

[20] Carey, L. (2017). *All hands off deck? The legal barriers to autonomous ships.* doi.org/10.2139/ssrn.3025882

[21] Nzengu, W., Faivre, J., Pauwelyn, A. S., Bolbot, V., Lien Wennersberg, L. A., & Theotokatos, G. (2021). Regulatory framework analysis for the unmanned inland waterway vessel. *WMU Journal of Maritime Affairs*, *20*(3), 357-376.

[22] The European Parliament & The Council Of The European Union (2016), Directive (EU) 2016/1629 of the European Parliament and of the Council of 14 September 2016 laying down technical requirements for inland waterway vessels, amending Directive 2009/100/EC and repealing Directive 2006/87/EC. L 252/118. Brussels, 14 September 2016

[23] McLinden, G., Fanta, E., Widdowson, D., & Doyle, T. (Eds.). (2010). *Border management modernization*. World Bank Publications.

[24] Directive 85/374/EEC - liability for defective products. (2017, October 4). European Agency for Safety and Health at Work. Directive 85/374/EEC - liability for defective products | Safety and health at work EU-OSHA (europa.eu) Visited 25.05.2023

[25] The European Parliament & The Council Of The European Union. (2006). Directive 2006/42/EC Of The European Parliament And Of The Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast). *Official Journal of the European Union,* L 157/24. Brussels, 17 may.

[26] The European Parliament & The Council of The European Union. (2019). Regulation (EU) 2019/1020 of the European Parliament and of the Council of 20 June 2019 on market surveillance and compliance of products and amending Directive 2004/42/EC and Regulations (EC) No 765/2008 and (EU) No 305/2011. *Official Journal of the European Union,* L 169/1. Brussels, 20 June 2019.

[27] The European Parliament & The Council of The European Union. (2016). Directive (EU) 2016/1148 of the European Parliament and of the Council of 6 July 2016 concerning measures for a high common level of security of network and information systems across the Union. *Official Journal of the European Union,* L 194/1. Brussels, 6. July 2016.

[28] Council of the European Union. (1989). Council Directive 89/391/EEC of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work. *Official Journal,* L 183. 12 June 1989.

[29] U.S. Department of State, Bureau of Intelligence and Research (1978). *Limits in the sea Straight Baselines: Denmark.*https://www.state.gov/wp-content/uploads/2019/10/LIS-19.pdf Visited 25.05.2023.

[30] Transportstyrelsen. (2019, July 11). *Nya vägar för inlandssjöfarten.* https://transportstyrelsen.se/sv/Nyhetsarkiv/2019/nya-vagar-for-inlandssjofarten/ Visited 25.05.2023

[31] The European Parliament And The Council Of The European Union. (2005). Directive 2005/65/EC of The European Parliament and of The Council of 26 October 2005 on enhancing port security. Official Journal of the European Union. Official Journal of the European Union, L 310/28. Brussels, 26 October 2005.

[32] The European Parliament And The Council Of The European Union. (2019). Directive (EU) 2019/883 of the European Parliament and of the Council of 17 April 2019 on port reception facilities for the delivery of waste from ships, amending Directive 2010/65/EU and repealing Directive 2000/59/EC. Official Journal of the European Union, Official Journal of the European Union, L 151/116. Brussels, 17 April 2019

[33] The European Parliament And The Council Of The European Union. (2014). Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure Text with EEA relevance. Official Journal of the European Union. Official Journal of the European Union, L 307/1. Brussels, 22 October 2014

[34] Council of the European Union. (1982). Council Directive 82/501/EEC of 24 June 1982 on the major-accident hazards of certain industrial activities. Official Journal of the European Union, L 307/1. Brussels, 24 June 1982

[35] The European Parliament And The Council Of The European Union. (2019). Regulation (EU) 2019/1239 of the European Parliament and of the Council of 20 June 2019 establishing a European Maritime Single Window environment and repealing Directive 2010/65/EU. Official Journal of the European Union, L 307/1. Brussels, 20 June 2019

[36] International Maritime Organization. (2021 June 3). *Outcome of the regulatory scoping exercise for the use of maritime autonomous surface ships (MASS).* [Press release]. MSC.1-Circ.1638 - Outcome Of The Regulatory Scoping ExerciseFor The Use Of Maritime Autonomous Surface Ships... (Secretariat).pdf (imo.org)

[37] Nzengu, W., Faivre, J., Pauwelyn, AS. *et al.* Regulatory framework analysis for the unmanned inland waterway vessel. *WMU J Marit Affairs* **20**, 357–376 (2021). https://doi.org/10.1007/s13437-021-00237-z

Annex A. IMO regulatory Scoping Exercise for the use of MASS

The IMO regulatory scoping exercise is described in [36].

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3 June 2021

OUTCOME OF THE REGULATORY SCOPING EXERCISE FOR THE USE OF MARITIME AUTONOMOUS SURFACE SHIPS (MASS)

1 The Maritime Safety Committee, at its 103rd session (5 to 14 May 2021), approved the *Outcome of the regulatory Scoping Exercise for the use of Maritime Autonomous Surface Ships (MASS)*, as set out in the annex, which provides the assessment of the degree to which the existing regulatory framework under purview of the Maritime Safety Committee (MSC) might be affected in order to address MASS operations. It further provides guidance to the MSC and interested parties to identify, select and decide on future work on MASS and, as such, facilitate the preparation of requests for, and consideration and approval of, new outputs.

2 Member States and international organizations are invited to take the annex into account when proposing future work on MASS for consideration by the MSC and bring it to the attention of shipowners, operators, academia and all other parties concerned.

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	Assumptions	Instruments
1	*Degree of autonomy Four* means no crew on board	SOLAS chapters III and V, 1966 LL Convention and 1988 Protocol, 2008 Intact Stability Code, III Code
2	Alternative arrangement, equivalent arrangement would be allowed and available	SOLAS chapter XI-2
3	Passenger transports without seafarers on board cannot be performed	SOLAS chapters XI-2 and XIV and Polar Code
4	The instrument applies to seafarers serving on board seagoing ships	STCW Convention and Code, STCW-F Convention
5	Determination of whether "remote operator" is a seafarer and whether "remote operator" encompasses all personnel working aboard of a ship or those individuals capable of operational control of the ship are outside of the remit of the RSE	STCW Convention and Code, STCW-F Convention
6	For degrees One and Two, seafarers are on board and available to take control of shipboard systems	SOLAS chapters II-1, II-2, VI, VII IBC, FSS, FTP, IMSBC, Grain, CSS, IMDG, IGC, INF
7	For degrees Three and Four, persons may stay on board during berthing, cargo handling and anchoring	SOLAS chapters II-1, II-2, VI, VII IBC, FSS, FTP, IMSBC, Grain, CSS, IMDG, IGC, INF
8	For degree Four, supervision by person is provided at a remote location	SOLAS chapters II-2, VI and VII IBC, FSS, FTP, IMSBC, Grain, CSS, IMDG, IGC, INF
9	MASS of degree one is considered as a conventional ship with some additional functions to support human decision-making. However, no particular automated process or function of decision support was considered owing to their diversities.	SOLAS chapter V
10	As long as MASS is not fully autonomous; the role of master is still required. For degree Three (higher degrees), the responsibility of the master will be extended/amended.	SOLAS chapter V
11	The Safety Management of MASS relates, inter alia, to functions which are autonomous	SOLAS chapter IX

Table 1: List of assumptions used for the RSE

	Common potential gaps and/or themes	Instruments
1	Meaning of the terms master, crew or responsible person	SOLAS chapters II-2, III, V, VI, VII IX and XI-1, COLREG, TONNAGE 1969, 1966 LL Convention and 1988 Protocol, Intact Stability Code, III Code, STCW Convention and Code
2	Remote Control Station/Centre	SOLAS chapters II-1, II-2, III, IV, V IX and XI-1, STCW Convention and Code, FSS, ISM, 1966 LL Convention and 1988 Protocol, Casualty Investigation Code
3	Remote Operator as a seafarer	STCW, STCW-F, SOLAS chapter IX, ISM
4	Provisions containing manual operations, alarms to the bridge	SOLAS chapters II-1, II-2, VI and IX, 1966 LL Convention and 1988 Protocol, Intact Stability Code, III Code
5	Provisions requiring actions by personnel (Fire, Spillage Cargo Management, onboard maintenance, etc.)	SOLAS chapters II-2, VI, VII, IX and XII
6	Certificates and manuals on board	SOLAS chapters III, XI-1, XI-2 and XIV
7	Connectivity, Cybersecurity	SOLAS chapters IV, V and IX
8	Watchkeeping	SOLAS chapters IV and V, COLREG
9	Implication of MASS in SAR	SOLAS chapters III, IV and V, SAR
10	Information to be available on board and required for the safe operation	SOLAS chapters II-1and II-2
11	Terminology	SOLAS chapters II-1, IV and V, COLREG, FSS, IBC, IGC, Grain, INF, 1966 LL Convention and 1988 Protocol, Intact Stability Code, SAR, TONNAGE, CSS, Casualty Investigation Code

Table 2: List of common potential gaps and/or themes

IMO Instruments	The most appropriate way(s) of addressing MASS operations			
Degree of Autonomy	One	Two	Three	Four
SOLAS II-1	IV	II	II - III	II - III
SOLAS II-2	IV	II - III	II - III	II - III
SOLAS III	IV	II - III	III	III
SOLAS IV	II	II - III	III	III
SOLAS V	II	II - III	III	III
SOLAS VI	IV	II - III	II - III	II - III
SOLAS VII	IV	II - III	II - III	II - III
SOLAS IX	IV	III	III	III
SOLAS XI-1	IV	III	I - III	I - III
SOLAS XI-2	I - II	II - III	II - III	II - III
COLREG	I	I - II	I - II	II
STCW	I - II	I - II - III	I - II - III	IV
STCW-F	I - II	I - II - III	I - II - III	IV
LL 1966 + 1988 Protocol	IV	II	II	II
SAR 1979	IV	II	II	II
TONNAGE 1969	IV	I	I	I
IMDG Code	IV	II- III	II - III	II - III
IMSBC Code	IV	II- III	II - III	II - III
FSS Code	IV	II- III	II - III	II - III
IBC Code	IV	II- III	II - III	II - III
IGC Code	IV	II- III	II - III	II - III

Table 3: List of high-priority instruments

instruments is set out in table 4 below.

IMO Instruments	The most appropriate way(s) of addressing MASS operations			
Degree of Autonomy	One	Two	Three	Four
SOLAS XII	IV	II - III	II - III	II - III
CSS Code	IV	II - III	II - III	II - III
Casualty Investigation Code	IV	II	II	II
III Code	IV	II	II	II
Grain Code	IV	II - III	II - III	II - III
INF Code	IV	II - III	II - III	II - III
IS Code	IV	II	II	II
Standards for owners' inspection and maintenance of bulk carrier hatch covers	IV	IV	II - III	II - III

Table 4: List of medium-priority instruments

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IMO Instruments	The most appropriate way(s) of addressing MASS operations			
Degree of Autonomy	One	Two	Three	Four
SOLAS chapter XIII	IV	IV	IV	IV
SOLAS chapter XIV	IV	IV	IV	IV
CSC Code	IV	IV	IV	IV
ESP Code	IV	IV	IV	IV
RO Code	IV	IV	IV	IV
FTP Code	IV	IV	IV	IV
Polar Code	IV	IV	IV	IV
LSA Code	IV	IV	IV	IV
ISM Code	IV	IV	IV	IV
ISPS Code	IV	IV	IV	IV
Standards for the evaluation of scantlings of the transverse watertight vertically corrugated bulkhead between the two foremost cargo holds and for the evaluation of allowable hold loading of the foremost cargo hold	IV	IV	IV	IV
Standards and criteria for side structure of bulk carriers of single-side skin construction	IV	IV	IV	IV

Table 5: List of low-priority instruments

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Issue		Planned activities and result
1	**Consideration of a holistic approach to MASS operations in IMO instruments**	
	Development of a goal-based MASS instrument	Consideration on how to develop a new MASS instrument and draft amendments to the applicable instruments through which it can be made mandatory
	Definition of MASS	Consideration on the need to revise definition and/or degrees and if revision is deemed necessary, agreeing on the definition and/or degrees
	Terminology for MASS operations in the IMO regulatory framework	Consideration on the need of supplementing terminology, and if deemed necessary, agreeing on such terminology
	High-priority common gaps and themes in relation to MASS operations and IMOs regulatory framework: - Meaning of Master, crew or responsible person - Remote control station/centre - Remote operator designated as seafarer	Consideration of the high-priority common gaps and themes
	Non-mandatory instrument	Consideration of the development of guidelines for MASS operations such as guidelines for installation and guidelines for system application

Table 6: Addressing MASS operations in IMO instruments under the remit of the Maritime Safety Committee

Annex B. Pan-European Legal Instruments in the field of Inland Water Transport (prepared with the assistance or under the auspices of UNECE)

- Budapest Convention on the Contract for the Carriage of Goods by Inland Waterway (CMNI), of 22 June 2001 (5 languages text – Contracting Parties)
- European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (and) of 26 May 2000
- Protocol on Combined Transport on Inland Waterways to the European Agreement on Important International Combined Transport Lines and Related Installations (AGTC) of 17 January 1997
- European Agreement on Main Inland Waterways of International Importance (AGN), of 19 January 1996 (UNECE Transport Agreements and Conventions No. 6)
- Protocol to the Convention relating to the Limitation of the Liability of Owners of Inland Navigation Vessels (CLN), of 5 July 1978 (UNECE Transport Agreements and Conventions No. 35)
- Protocol to the Convention on the Contract for the International Carriage of Passengers and Luggage by Inland Waterways (CVN), of 5 July 1978 (UNECE Transport Agreements and Conventions No. 37)
- Convention on the Contract for the International Carriage of Passengers and Luggage by Inland Waterway (CVN), of 6 February 1976 (UNECE Transport Agreements and Conventions No. 36)
- Convention relating to the Limitation of the Liability of Owners of Inland Navigation Vessels (CLN), of 1 March 1973 (UNECE Transport Agreements and Conventions No. 34)
- Convention on the Measurement of Inland Navigation Vessels, of 15 February 1966 (UNECE Transport Agreements and Conventions No. 33)
- Convention on the Registration of Inland Navigation Vessels, of 25 January 1965 (UNECE Transport Agreements and Conventions No. 32)
- Convention relating to the Unification of Certain Rules concerning Collisions in Inland Navigation, of 15 March 1960 (UNECE Transport Agreements and Conventions No. 32)

Annex C. Mapping of relevant rules and regulations for UC-B

Relevant rules and regulations for UC-B are found in [37].

Rules/regulations	Purpose	Regulatory body
European Directive 2016/1629/EC [24]	European Standard laying down Technical Requirements for Inland Navigation vessels (ESTRIN)	CESNI
European Directive 2008/68/EC [25]	Annexed Regulations of the European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN)	UNECE
Rhine convention	Police Regulations for the Navigation of the Rhine (RPNR)	CCNR
	Regulations for the Rhine Navigation Personnel (RPN)	CCNR
European Directive 1996/50/EC [26]	On the harmonisation of the conditions for obtaining national boat masters' certificates for the carriage of goods and passengers by inland waterway in the community	CESNI
European Directive 2014/112/EC [27]	Implementing the European Agreement concerning certain aspects of the organisation of working time in inland waterway transport	CESNI
CLNI – Strasbourg convention of 2012 [28]	Convention on the limitation of liability in inland navigation (CLNI) 2012	CCNR
CDNI – Strasbourg convention of 1996 [29]	Convention on the collection, deposit and reception of waste generated during navigation of the Rhine and other inland waterways (CDNI)	CCNR
Resolution N° 24 – European Code for Inland Waterways (CEVNI) [30]	European Code for Inland Waterways – CEVNI adopted on 15/11/ 1985 (the identified challenges are similar to the RPNR code)	UNECE
Belgian Royal Decree of 24/09/2006 [31]	General Police Regulations for the navigation of the Belgian IWW	Belgian government
Specific regulations	Ship Navigation Regulations for the Brussels-Scheldt Canal	Belgian government

Annex D. ESTRIN review summary

The ESTRIN review summary can be found in [37].

Ref	Topic/requirement	Remarks/comments
3.03(5)	Doors in the aft-peak bulkhead shall be permitted only if it can be determined by remote monitoring in the wheelhouse whether they are open or closed and shall bear the following readily legible instruction on both sides: 'Door to be closed immediately after use'.	This requirement foresees the remote monitoring of doors in aft-peak bulkhead but does not require any means of remote control of such doors. The doors are to be operated by a human.
3.04(3)	All openings in walls, ceilings and doors of engine rooms, boiler rooms and bunker rooms shall be such that they can be closed from outside the room.	This provision does not explicitly allow remote control of openings in walls, ceilings and doors of engine rooms, boiler rooms and bunker rooms. The doors are to be operated by a human.
4.04	Vessels shall have at least three pairs of draught marks, of which one pair shall be at ½ of length L and the two others located, respectively, at a distance from the bow and stern that is equal to roughly 1/6 of the length L.	This provision does not require an automatic way of reading the draught marks (a draught indicating system).
7.01.1	Wheelhouses shall be arranged in such a way that the helmsman may at all times perform his task while the vessel is underway.	Vessels are operated by a human from the wheelhouse, design of which implies the crew.
7.02.1	There shall be an adequately unobstructed view in all directions from the steering position.	This requirement implies an attended steering position on board.
7.02.2	The area of obstructed vision for the helmsman ahead of the vessel in an unladen state with half of its supplies but without ballast shall not exceed 250 m. To further reduce any area of obstructed vision, only appropriate auxiliary means shall be used.	This rule implies that sufficient visibility from the wheelhouse should be attained primarily by design adapted to human perception.
7.04.1	It shall be possible to control and monitor the main engines and steering systems from the steering position.	The steering position is located in the vessel wheelhouse.
7.06.5a)	In wheelhouses designed for radar navigation by one person: a) The radar screen shall not be shifted significantly out of the helmsman's axis of view in its normal position.	This requirement implies manned steering position.

Ref	Topic/requirement	Remarks/comments
13.03.1	There shall be at least one portable fire extinguisher in accordance with the European Standards EN 3-7: 2007 and EN 3-8: 2007 at a number of the places.	This provision implies the presence of crew on board.
15	This provision requires living spaces for crew.	This provision implies the presence of crew on board.
27.01(2)	Stability documents shall provide the boat master with comprehensible information on vessel stability for each loading condition.	It is required that the stability assessment for a given loading condition is to be carried out by the boat master.
27.04	The procedure for assessing stability may be determined by the documents referred to in Article 27.01(2).	
28.03(3)	For diversified cargo, the stability calculation shall be performed for the most unfavourable loading condition. This stability calculation shall be carried on board.	The stability assessment procedure implies the involvement of the boat master (or another crew member).
30.03	A safety rota shall be provided on board craft equipped with propulsion or auxiliary systems operating on fuel with a flashpoint equal to or lower than 55 °C. The safety rota shall include safety instructions according to (2) and a safety plan according to (3) of the craft.	The rule implies that the safety organisation on board vessels using low-flashpoint fuels relies upon the human operators.

Annex E. RPNR review summary

The RPNR review summary can be found in [37].

Ref	Topic/requirement	Remarks/comments
1.02	Boat master	This provision explicitly requires the presence of a person on board of the ship with the necessary qualifications. This person is also responsible for making sure that everybody follows the regulation.
1.03	Duties of other people on board	This provision refers to other people on board of the ship.
1.04	General duty of vigilance	Presence of crew on board is required to exercise vigilance.
1.08	Crew	This provision explicitly requires the presence of enough crew on board.
1.09.1	On board of any vessel underway, the helm must be held by at least one person.	This provision explicitly requires the presence of a person.
1.09.3	The helmsman must be able to receive and to give all information and orders that arrive at the wheelhouse or depart from it.	This provision implies an attended wheelhouse.
4.06	Use of radar: the vessels can only navigate on the radar as long as there is permanently a person holding an approved driving certificate.	This provision implies the presence of crew on board.
6.13.2	If the proposed manoeuvre can or must force other vessels to deviate from or change their speed, the building that wants to turn must, before turning, announce its manoeuvre in useful time, emitting: (a) “an extended sound followed by a short sound” if he wishes to turn to starboard or b) “a prolonged sound followed by two short sounds”, if he wants to turn to port.	This provision implies the presence of crew on board.
6.32.1	The vessels can only navigate on the radar as long as there is permanently a person holding a Rhine license or an approved driving certificate or recognized as equivalent under the Rhine Navigation Staff Regulations for the sector to be covered, and a certificate of proficiency for radar	This provision implies the presence of crew on board.

Ref	Topic/requirement	Remarks/comments
	operation issued or recognized equivalent under his Regulation, as well as a second person who knows how to use the radar.	
7.08.1	The operational guard must be permanently on board buildings in the parking.	The number of the crew has to be sufficient in the vessel.

Annex F. IWW RPN review summary

The IWW RPN review summary can be found in [37].

Ref	Topic/requirement	Remarks/comments
3.15	A minimum crew of self-propelled and pushers.	The minimum crew may not be reduced to zero.
4.01	On board vessels carrying dangerous goods, a person must hold an expert attestation in accordance with model 8.6.2 of the ADN, under 7.1.3.15 and 7.2.3.15 of ADN.	An ADN expert should be on board the vessel.

Annex G. European Directive 2014/112/EC review summary

The European Directive 2014/112/EC review summary can be found in [37].

Ref	Topic/requirement	Remarks/comments
Article 2	"for the purposes of this Directive: (i) 'boatmaster' shall mean the person who has the necessary aptitude and qualifications to sail a vessel on the Member States' waterways and who has nautical responsibility on board; (ii) 'member of the deck crew' shall mean a person who has regularly participated in sailing a vessel in inland navigation, including manning the tiller".	If people work in a Remote Control Centre, this directive might not be relevant for them as they work on land. They will fall under the work time regulations for people who work on land.
Article 7	"An applicant must provide proof of at least four years' professional experience as a member of the deck crew on an inland waterway vessel".	If people work in a Remote Control Centre, this directive might not be relevant for them as they work on land. They will fall under the work time regulations for people who work on land.

Annex H. CDNI review summary

The CDNI review summary can be found in [37].

Ref	Topic/requirement	Remarks/comments
	To achieve environmental protection, the Convention aims at improved checking of any waste that occurs, specifically through (i) the safe and separate collection and subsequent disposal of wastes arising from operating the vessel, (ii) requiring those causing wastes to pay the costs of collection and disposal, (iii) the application of uniform regulations within all signatory states of the Convention in order to avoid any unfair competition.	The application of the CDNI convention relies mainly on the boatmaster. Within the scope of the CDNI convention, "boatmaster" means the person under whose authority the vessel is placed. As there is no further specification about the location from where the authority is exercised, the application of the CDNI Convention may raise problems at level 3 and above of automation.