THE 2025 EUROPEAN MARITIME SAFETY REPORT

EUROPEAN MARITIME SAFETY AGENCY

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Commissioner's welcome

It is my great pleasure to present the second edition of the European Maritime Safety Report, published by the European Maritime Safety Agency (EMSA). This report serves both as a window and a mirror for maritime safety in the European Union: a window offering a clear view of the full safety panorama across our waters, and a mirror reflecting how EU legislation continues to shape a maritime safety culture that is resilient, effective, secure, and forward-looking.

Nearly a quarter of a century has passed since EMSA was created as a cornerstone of a far-reaching and visionary package of maritime legislation aimed at strengthening safety at sea, protecting the marine environment, and applying high uniform standards across the European Union. Today, that vision is being tested by a shifting geopolitical landscape, where new security pressures, from hybrid threats to the emergence of shadow fleets, introduce fresh layers of complexity into Europe's maritime domain.

Our waters are among the busiest anywhere in the world, with close to 800.000 port calls every year. Over time, Europe has built one of the most advanced and comprehensive maritime safety systems globally: specialised regimes for vessels such as high-speed craft and ro-pax ships, a robust second line of defence through port State control, and, crucially, an ever-evolving legislative framework that supports high-quality, safe, and secure shipping.

This report clearly shows that our policies are delivering real, measurable results, thanks above all to the dedication of Member States in their roles as coastal, flag, and port States. Particularly noteworthy is the swift and determined resumption of inspections after the pandemic, and the fact that inspection numbers now exceed pre-pandemic levels. This achievement reflects a deep and shared commitment to vigilance, responsibility, and the highest safety standards.

Such a safety culture is essential for the EU's maritime transport sector. EU Member States control roughly one-third of the global passenger ship fleet. Around a quarter of the world's gas and chemical tankers are under European ownership. Europe is also leading the uptake of alternative fuels, an evolution that demands uncompromising safety and security standards to safeguard life at sea, protect our marine environment, and defend the strategic maritime interests of the Union.

But vigilance must remain our guiding principle. The report highlights several areas of concern that require sustained attention, today and in the years ahead, and that must be addressed at EU, national, and operational levels alike. The coming years will bring new, interconnected challenges, including those linked to security, decarbonisation, and automation. These developments will reshape shipping patterns, vessel design, and maritime operations in ways that we must fully understand, anticipate, and prepare for.

This is precisely why reports like this one, grounded in reliable data, verifiable evidence, and rigorous analysis, are indispensable. They help us grasp the scale and nature of emerging challenges, whether environmental, technological, or security-related, and they equip us to design effective, forward-looking policies that keep Europe at the global forefront of maritime safety.

Apostolos Tzitzikostas

Commissioner for Sustainable Transport and Tourism

Foreword

Dear readers,

I am very proud to present you with the second, edition of our European Maritime Safety Report - EMSAFE. This report is built on the integration of facts, information, and data, including from EMSA's own unique databases, to make a factual assessment of the state of maritime safety in the EU.

EMSAFE is intended to continue be a key tool and a reference for policymakers at national and European level, maritime administrations, industry, and civil society. We already know that the first edition of the report, published in 2022, has been increasingly used in maritime universities as an initial introduction to the maritime safety framework and the different actors in the maritime industry. Likewise, it has become a key resource for researchers on topics like fleet status and performance.

Developed here at EMSA with the active involvement of stakeholders from across the maritime sector, and in close collaboration with the European Commission, EMSAFE was the subject of an open and transparent consultation process. I would like to take this opportunity to thank all those who took part: the European Commission, national administrations, classification societies, shipping companies, the cruise industry, trade unions, and many more. Their contribution, feedback, and insights have all helped to make this second edition of EMSAFE a truly representative document.

The comprehensive data and rigorous analysis upon which the report is built allows us to dig deep into the current challenges faced by the EU maritime sector. The flags of the EU Member States continue to excel in their performance from a safety perspective. The annual average number of incidents reported to EMCIP has significantly decreased compared to the previous edition. This clearly demonstrates the ongoing commitment of the EU maritime administrations and industry towards a safer sector.

Seafarers are at the centre of maritime safety, but their contribution to safety is not always given the recognition that it deserves. This is not the case with EMSAFE, which underlines the role of seafarers as the most valuable resource for the shipping industry. This is why it is important to mention that this second edition finds no sign of improvement in the deficiencies related to the Maritime Labour Convention (MLC). This is particularly worrying, not just for the welfare of those who currently serve on board, but also in terms of being able to attract the seafarers of the future.

For example, EMSAFE further brings other challenges that need to be addressed, and passenger ship safety is one of them. 400 million passenger journeys are made through European ports every year. Passenger ships are, therefore, an important facilitator of the free movement of people within our European Union. They are also a lifeline for our many island communities which depend on these vessels for their very existence. But, as this second edition shows, the aging trend of the EU passenger fleet shows no sign of reversing, which brings safety concerns.

EMSAFE provides important information on fishing vessels. 68% of the EU fishing fleet is now composed of vessels measuring less than 24 metres and more than 25 years old. The vulnerability of fishing vessels to accidents cannot be overstated; they account for 17 % of the total number of accidents recorded each year under the scope of applicable EU legislation, and 60 % of the total number of vessels lost.

This publication comes at an important moment for the European maritime sector, which is navigating a period of profound change. The opportunities posed by new technologies, digitalisation, and alternative fuels for shipping come with safety risks, which need to be fully understood and mitigated. EMSA is providing research, tools and studies to support national administrations, industry, port authorities, regulators, and other relevant actors as they transition towards a smarter, more sustainable, and more digital future.

In EMSA, we are proud of our role as a pillar of the maritime safety framework in the EU. For nearly two and a half decades now, we have been at the side of the European Commission and Member States, making a significant contribution to safer seas in Europe, just as the legislators intended. With new tasks and an expanded mandate following the revision of our Founding Regulation in 2025 and the new maritime safety package, we will continue our voyage in support of maritime safety for the many more years to come.

Maja Markovčić Kostelac

Executive Director of the European Maritime Safety Agency

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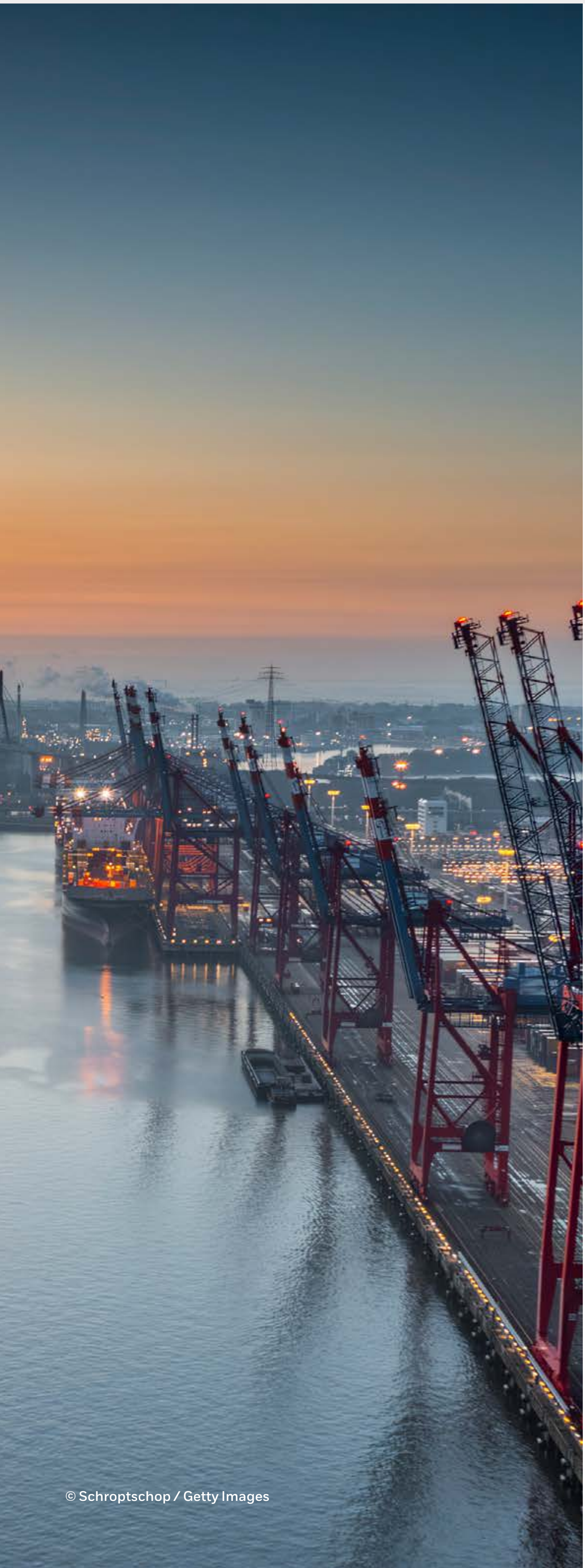

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List of acronyms and abbreviations

A	
ABS	American Bureau of Shipping
AC	Alternating current
ADRIREP	Ship Reporting System (SRS) in the Adriatic Sea
AFI	Alternative Fuels Insight
AFV	Alternatively fuelled vehicles
AI	Accident investigation
AIB	Accident Investigation Bodies
AIS	Automatic Identification System
ASM	Application Specific Messages
B	
BESS	Battery Energy Storage Systems
BLEVE	Boiling Liquid Expanding Vapour Explosion
BMS	Battery Management System
BULK	Bulk Carriers Loading and Unloading Safety Directive
C	
CEA	Cost-effectiveness analysis
CG	Cooperation Group
CNG	Compressed natural gas
CoC	Certificates of Competency
COLREG	Convention on the International Regulations for Preventing Collisions at Sea
COSS	Committee of Safe Seas and the Prevention of Pollution from Ships
CSC	International Convention for Safe Containers
D	
DC	Direct current
DG MARE	Directorate-General for Maritime Affairs and Fisheries
DLP	Distance Learning Programmes
DME	Dimethyl Ether
DNV-GL	Det Norske Veritas
DoC	Document of Compliance
DPG	Dangerous and Polluting Goods
DWT	Deadweight Tonnage
E	
EaR	Endorsements attesting Recognition
EC	European Commission
ECSA	The European Community Shipowners' Associations
EEA	European Economic Area
EFTA	European Free Trade Association
EMCIP	European Marine Casualty Information Platform
EMSA	European Maritime Safety Agency
EMSAFE	European Maritime Safety Report
EMSWe	European Maritime Single Window Environment

EQUASIS	Electronic Quality Shipping Information System
ESA	European Space Agency
ETF	The European Transport Workers' Federation
EU	European Union
F	
FAME	Fatty Acid Methyl Ester
FAO	Food and Agriculture Organization
FC	Fuel cell
FSA	Formal Safety Assessment
FT-diesel	Fischer-Tropsch diesel
G	
GBS	Global based standard
GCS	Ground Control Station
GHG	Greenhouse Gas
GISIS	Global Integrated Shipping Information System
GT	Gross Tonnage
H	
HA	Horizontal Analysis
HSC	High-speed craft
HT-PEM	High Temperature Proton Exchange Membrane
HTW	Human Element, Training and Watchkeeping
HVO	Hydrogenated Vegetable Oil
I	
IACS	International Association of Classification Societies
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
ICE	Internal combustion engine
ICLL	International Load Lines Convention
IDLH	Immediately Dangerous to Life or Health
IEC	International Electrotechnical Commission
IGF	International Code of Safety for Ship Using Gases or Other Low-flashpoint Fuels
IGP&I	International Group of Protection & Indemnity
ILO	International Labour Organisation
IMO	International Maritime Organisation
IMS	Integrated Maritime Services
IMSAS	IMO's Member State Audit Scheme
IP code	Code for the carriage of "Industrial Personnel"
IQARB	International Quality Assessment Review Body
IR	Infrared
ISM	International Safety Management
ISO	International Organisation for Standardisation
IT	Information technology
ITU	International Telecommunication Union

List of acronyms and abbreviations (cont.)

L	
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LRIT	Long-Range Identification and Tracking System
M	
MARPOL	International Convention for the Prevention of Pollution from Ships
MASS	Maritime Autonomous Surface Ships
MCA	Maritime Coastguard Agency
MED	Maritime Equipment Directive
MGO	Marine gas oil
MLC	Maritime Labour Convention
MoU	Memorandum of Understanding
MRCC	Maritime Rescue and Coordination Centre
MRS	Mandatory ship reporting system
MS	Member States
MSA	Market Surveillance Authorities
MSC	Maritime Safety Committee
MW	Megawatt
N	
NCSR	Sub-Committee on Navigation, Communications and Search and Rescue
NSW	National Single Window
O	
OPS	Onshore Power Supply
P	
PAX	Registration of persons on board ships
PCF	Permanent Cooperation Framework
PCTC	Pure Car and Truck Carriers
PDS	Professional Development Schemes
PEM	Proton Exchange Membrane
P&I	Protection & Indemnity
PoR	Places of Refuge
PSC	Port State Control
PSCO	Port State Control officers
PTA	Pilot Transfer Arrangements
Q	
QACE	Quality Assessment and Certification Entity
IQARB	International Quality Assessment Review Body
R	
R&D	Research and Development
RBAT	Risk Based Assessment Tool
RCC	Rescue Coordination Centres
RCO	Risk Control Options
REFIT	Regulatory Fitness and Performance
RO	Recognised Organisation

ROC	Remote operation centres
Ro-Pax	Ro-Ro passenger ships
Ro-Ro	Roll-on/Roll-off
ROV	Remotely Operated Vehicles
RPAS	Remotely Piloted Aircraft Systems
S	
SAR	Search and rescue
SARCP	SAR cooperation plan
SAR-SURPIC	Search and Rescue Surface Picture
SBC	Shore-side Battery Charging
SMS	Safety Management System
SOFC	Solid Oxide Fuel Cells
SOLAS	International Convention for the Safety of Life at Sea
SRR	Search and Rescue Region
SSE	Shore-side electricity
SSE Sub-Committee	Sub-Committee on Ship Systems and Equipment
SSN	SafeSeaNet
STCW	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers
STCW-F	STCW for Fishing Vessel Personnel
T	
TEU	Twenty-foot Equivalent Unit
THETIS	The Hybrid European Targeting and Inspection System
TRL	Technology Readiness Level
TTE	Table-top exercises
U	
UI	Unified Interpretations
UK	United Kingdom
UN	United Nations
UNCLOS	United Nations Convention for the Law of the Sea
USCG	United States Coast Guard
V	
VASP	VDE-SAT Application and Services Platform
VDES	VHF Data Exchange System
VDE-TER	VHF Data Exchange-Terrestrial
VDE-SAT	VHF Data Exchange-Satellite
VDL	VHF Data Link
VHF	Very High Frequency
VMS	Vessel Monitoring System
VTMIS	Vessel Traffic Monitoring and Information System
VTS	Vessel Traffic Service
W	
WGB	White, Grey, and Black list
WSC	World Shipping Council

Executive summary

The European Maritime Safety Report (EMSAFE) provides a factual analysis of the maritime safety landscape in the European Union (EU), along with an in-depth analysis of specific technical areas. The European Maritime Safety Agency (EMSA) prepares the report on the basis of data collected from several internal and industry databases. It is then further enhanced through consultation with stakeholders. This second edition of Emsafe, issued three years after the first, focuses on current issues that affect shipping and safety; provides for a comparison with the information in the last report on the evolution of the fleets' characteristics and safety performance over an equivalent five-year period; and identifies the challenges lying ahead.

This second edition covers the period from 2019 to 2023 and depicts the far-reaching impacts of recent global events on the maritime sector. The impact of and recovery from the COVID-19 pandemic, the economic and logistical disruptions following Brexit and the cascading effects of global conflicts have significantly influenced maritime traffic. At the same time, the Russian war of aggression against Ukraine and the ongoing conflicts in the Middle East are having a significant impact on maritime security.

Within this context, the report highlights how the maritime community strives to maintain safety levels while adapting to an evolving regulatory landscape and addressing additional challenges such as the ageing of the fleet, digitalisation, decarbonisation and the need to retain and attract a qualified workforce.

In 2023, the European Commission presented a new package of legislative proposals to modernise and strengthen maritime safety rules within the EU. This package included revisions to existing regulations and an updated mandate for EMSA, providing it with new responsibilities. EMSA is proud to contribute to the development and maintenance of a robust maritime safety system in the EU in support of the Member States and for the benefit of the wider maritime community.

It is important to note that this report does not cover issues in relation to the 'shadow fleet' or the sabotage of critical maritime infrastructure. These are issues that have developed rapidly and recently, and are outside the scope of this analysis.

This executive summary presents the main conclusions classified according to the traditional maritime subdivision of responsibilities that Member States have as a flag, port or coastal state.

Flag state

The main responsibility for the implementation of safety standards, including seafarers' certification, training and working conditions, lies with the flag state. Before covering the main safety challenges it is important to understand the context of the EU Member States' flag administration.

Fleet

The size of the EU Member States' fleet ([1]) is an important indicator of its relevance within the global maritime transport sector. The number of ships registered with EU Member States' flags decreased by 2 % over the five-year reference period, while the world fleet grew 6 % during the same period. In 2023, the EU Member State-flagged fleet represented around 13 % of the world fleet in number of ships and around 16 % of global gross tonnage.

In contrast, the fleet of passenger ships registered with EU Member States increased by close to 2 % from 2019. Roll-on/roll-off passenger ships (ro-pax) and passenger high-speed craft with EU Member States' flags represented more than 30 % of the world fleet of those ship types by number, and more than 50 % in terms of gross tonnage. The number of EU Member State-flagged passenger high-speed craft registered a 17 % increase in five years. The increase in the number of passenger ships was not accompanied by a decrease in their average age, which was 29 years in 2023, whereas in 2019 it was 28 years. This increase in the average age indicates that the key factor for passenger fleet growth is not the number of newbuilds but the transfer of older ships from non-EU countries' flags.

The ageing of passenger ships flagged in EU Member States is an area of concern. In general, safety standards are not applied retroactively and, accordingly, ships comply with the standards applicable at the date of construction. An analysis of the EU Member States' fleet of passenger ships shows that 38 % of the ships in operation were built at a time when the applicable damage stability standards were those of the 1960 and 1974 versions of the International Convention for the Safety of Life at Sea (SOLAS). This means that, while abiding by the rules, the fleet continues to have a heterogeneous safety level as far as damaged stability is concerned.

Another negative factor in terms of the competitiveness of EU Member States' flags shown in this report is that from 2019 to 2023 there were 35 % more ships transferred out from an EU Member State's flag to flags outside the EU than were transferred in. Most ships transferring from EU Member States' flags to those of non-EU countries were bulk carriers, oil and chemical tankers and general cargo ships.

1 Unless specified otherwise, the terms 'Europe' and 'EU Member States' refer to the 27 Member States of the EU, along with Iceland and Norway.

Safety performance

The most reliable indicator of the fleet's safety performance is the number of accidents. Over the 2019–2023 period, an average of 2 344 accidents involving at least one EU Member State-flagged ship took place every year. These accidents are recorded for those ships under the scope of applicable EU legislation, which excludes fishing vessels of less than 15 metres in length, among others. Serious and very serious accidents represented 27.8 % and 2.2 %, respectively, of all accidents reported. In 2023, 22 people lost their lives and around 741 were injured in these accidents.

The outcomes of port state control (PSC) inspections are also an indicator of the safety performance of the EU Member States' international fleets. An analysis of the performance rating of EU Member States' flags in the Paris Memorandum of Understanding (MoU) regime reveals that, in 2023, all flags were whitelisted except one, which was on the grey list, while there were none on the latter list in 2019. In this second edition of Emsafe, the safety performance of the EU Member States' fleet in other PSC regimes (those of the Tokyo MoU and the United States Coast Guard) has been analysed. It is shown that two flags were considered high risk by the United States Coast Guard in 2023, while none was on the same list in 2019. Two additional EU Member States' flags are also now on the grey list of the Tokyo MoU. These performance indicators relate to ships flying the flag of an EU Member State but trading in various regions around the world, outside the EU.

Availability of seafarers

The end of 2023 saw 297 827 masters and officers certified to serve on board EU Member State-flagged vessels, which overall represents a 12 % decrease with respect to 2019. The number of masters and officers with certificates of competency issued by EU Member States decreased by 20 % during the same period. Deducting the effect of Brexit, this is still a reduction of around 7 %. On the other hand, another 125 519 masters and officers held, in 2023, original certificates of competency issued by non-EU countries (an increase of 4 % since 2019, partially attributed to Brexit).

The work of seafarers is crucial to maritime safety, as their competence, well-being and working environment play a vital role in the safe and efficient operation of vessels. Adding to the inherent challenges of the profession, recent crises such as COVID-19 have further impacted on seafarers, exacerbating issues relating to mental health and motivation to be at sea. These issues were also attributed to a lack of support from regulations and protocols, both on board and on land while in port, in dealing with unexpected events such as those arising during a pandemic.

The stable average age of seafarers within the European labour market suggests that there have been young entrants replacing those leaving the seafaring career. However, the attractiveness of the career remains low, and is particularly affected by the still deficient working conditions often known to be found on board vessels. The latest research has shown that there is still insufficient consideration of human factors and social welfare in the industry's practices and regulations.

Delegation to recognised organisations

The delegation of tasks from flag states to recognised organisations (ROs) continues to increase. While in the previous report the data indicated that this was especially the case in relation to conducting statutory surveys, in general there has been a significant increase in delegations with regard to issuing certificates. In 2024, 66 % of the EU Member States delegated the issuance of the passenger ship safety certificate fully or partially to an RO, representing a 10-percentage point increase in comparison with 2020. A similar tendency was found in relation to the delegation of the International Safety Management certification.

Following the withdrawal of the recognition of the Russian Register of Shipping in 2023, there are 11 classification societies that are recognised as ROs in the EU. The oversight of ROs by EU Member States is critical to ensure that the level of maritime safety is kept at an appropriate level. The audits of flag states by the International Maritime Organization (IMO) (under the IMO's Member State Audit Scheme) show that with respect to the delegation of authority to ROs, the most recurrent findings relate precisely to weaknesses in the administration's oversight programme. Accordingly, it must be considered whether this activity should be strengthened in the EU.

EMSA's visits to the EU Member States on behalf of the Commission offer an excellent opportunity to measure the extent to which the application of the requirements, as set out by the relevant legislation, is harmonised in all Member States to promote the establishment and exchange of best practices and to ensure a level playing field throughout the EU. As an example, the visits that EMSA is carrying out in the context of the domestic passenger ship safety legislation allow for increased awareness about the occasional weak implementation of safety requirements. Such weak implementation, in a category of ships that transport around 200 million passengers per year, is linked with significant safety risks.

Fishing vessels

Fishing vessels flagged in EU Member States merit specific analysis. In the 27 EU Member States alone there are close to 70 000 fishing vessels, reflecting a decrease of around 6 % in the fleet size since 2020. The age of the fleet is also a concern: 70 % of the vessels are now 25 years old or more, while only 2 % were built between 2019 and 2023. An ageing fleet often lacks modern safety features, which can potentially exacerbate the risks associated with fishing operations. These factors, combined with the hazardous nature of fishing operations, which are conducted in often challenging environments, underscore the need for improved safety measures.

Fishing vessels are particularly vulnerable to accidents, making them a priority for enhanced safety measures. These vessels account for 17 % of the total number of accidents recorded in the European Marine Casualty Information Platform and 60 % of the total number of vessels lost. Alarmingly, the majority of these accidents (55 % as of 2023) resulted in very serious or serious consequences.

The current safety standards for fishing vessels lag behind the more rigorous regulations applied to commercial shipping. The international convention dealing with the implementation of safety standards for fishing vessels, the Cape Town Agreement, is not yet in force, and only nine of the EU's 27 Member States, plus Iceland and Norway, have deposited the accession act.

At the EU level, the Commission is in the process of evaluating the implementation of Council Directive 97/70/EC setting up a harmonised safety regime for fishing vessels of 24 metres in length and over, and some additional measures have been taken and are expected to give new insight into the vulnerabilities of these vessels.

Port state

Given the increase in maritime traffic and safety risks posed by substandard ships, PSC remains a critical tool for ensuring compliance with safety regulations in EU waters.

The European territorial waters are among the busiest in the world. In 2023, there were more than 880 000 calls at EU ports, which represents an increase of almost 20 % compared with pre-pandemic levels. More than 50 % of those calls corresponded to domestic traffic, with ro-pax and passenger ships being the ship types that call most often at EU ports. Most of the ships that visit EU ports have an EU Member State's flag, with fewer than 25 % flying the flag of a non-EU country.

The number of PSC inspections carried out every year in the EU under the Paris MoU remains over 14 000, after recovering from the COVID-19 period. Most Member States have restarted their inspection efforts, in some cases exceeding their pre-pandemic figures. The number of individual ships inspected in 2023 by port state control officers in the EU increased by 4 % in comparison with 2019. At least one out of every two deficiencies found was safety related (falling under SOLAS).

Requirements relating to healthcare, safety protection and accident prevention for seafarers, as described in Title 4 of the Maritime Labour Convention (MLC), have consistently been the topics of most human-element-related deficiencies found during PSC inspections since 2019. MLC Title 4 addresses those elements that may pose a risk to the health and safety of crew on board. Such deficiencies are found in 25 % of inspections annually and consistently rank among the top three overall deficiency categories in Paris MoU reports. The analysis of deficiencies under the MLC and the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers in relation to the total number of inspections revealed that between 2019 and 2023, on average, one deficiency relating to working and living conditions was found during every second inspection.

Since 2023, one of the top 10 non-EU flags of ships calling in the EU – that of Panama – has been moved from the white list to the grey list of the Paris MoU based on its safety performance. Therefore, in 2023, 19 % of non-EU-flagged ships vising ports in the EU were registered to flags with some safety issues (listed on the Paris MoU grey list) – compared to 5 % in 2020 – and 4 % were registered to flags with significant safety issues (listed on the Paris MoU black list).

This has a direct impact on maritime safety, particularly in the reporting, monitoring and inspection efforts of EU Member States. The increase in the number of ships with greylisted flags visiting EU ports will require greater inspection efforts from PSC authorities in the EU.

The safety risk from having substandard ships calling at EU ports is potentially higher when they are carrying cargoes consisting of hazardous materials (hazmat). Greylisted and blacklisted non-EU-flagged ships correspond to 14 % of the ships carrying hazmat and arriving at EU ports from ports and terminals outside the EU in 2023. On the positive side, the percentage of undeclared hazmat has decreased by close to 50 % since 2019 when looking at arrivals from non-EU ports.

Coastal state

EU Member States also have responsibilities with regard to ships that pass through their coastal waters, especially with regard to preventing and managing accidents that could happen there and supporting the maritime communication network.

Between 2019 and 2023, an average of 1 631 accidents occurred within EU territorial waters each year, leading to 1 018 search and rescue (SAR) operations reported in connection to those accidents. Regardless of all the mechanisms set up to prevent them, accidents still happen.

It is therefore essential to maintain an appropriate safety net on the coast to respond to such accidents. One of the safety fallback systems to help ships in need of assistance is the use of designated places of refuge where a ship can stabilise its condition, reduce the hazards to navigation and protect human life and the environment. To that end, the latest EU Table-top Exercise on Places of Refuge demonstrated again the importance of having means of communication available to allow states and industry to cooperate when it is necessary to accommodate ships in need of assistance.

SAR procedures, under the remit of Member States – including exercises and evacuation methods – should be updated as necessary to ensure that suitable measures are in place to tackle a potential mass evacuation considering current and future passenger ship sizes. SAR is an essential element of accident response that can be supported using new technologies, such as remotely piloted aircraft systems and satellite-based Earth-observation services. The Very High Frequency Data Exchange System is bringing about a new era in maritime communications and providing significant opportunities for exchanging digital data for the benefit of diverse users within the maritime transport domain, including during SAR operations.

Cross-cutting safety challenges

In addition to the specific challenges identified relating to the capacities of flag, port and coastal states, there are certain topics that will affect EU Member States in the three dimensions. They are summarised below, distinguishing between existing and forthcoming challenges.

Existing challenges

The increasing size and passenger capacity of ships, coupled with the expansion of their operating areas, presents significant challenges for emergency evacuation and rescue operations. In this context, clarifications regarding the concept of 'safe return to port' and assessments of the effectiveness of current evacuation designs and operational practices are crucial for enhancing safety.

Recent fire-related accidents on board vehicle carriers (e.g. the MV *Fremantle Highway* and the *Felicity Ace*) and on land involving electric vehicles have raised concerns about the safety of the carriage of such vehicles on board ships. The current fire safety requirements mainly address fires from vehicles using oil-based fuels, and need to be adapted to these new vehicles. Research is ongoing on relevant issues, such as the effectiveness of the available fixed firefighting solutions; means for the early detection of thermal runaway; the mitigation of reignition risk and explosion risk; and training and operation procedures for the safe handling of fires involving electric vehicles. The protection of vehicle and roll-on/roll-off spaces from the risks of transporting electric vehicles is not specifically addressed in SOLAS, but


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the relevant subcommittee at the IMO is currently revising the existing fire safety provisions to address and mitigate those risks as necessary.

The growing electrification of the fleet has also led to discussions in recent years on the concept of safety in relation to the integration of batteries on board ships. Currently, there are no international regulations concerning the risk management of battery storage and installations for electric propulsion. EMSA, at the request of the Commission, has recently developed guidance on this topic in conjunction with Member States, classification societies, manufacturers, shipowners, shipyards and other relevant stakeholders.

Forthcoming challenges

The understanding of the safety risks associated with new fuels in shipping has advanced rapidly since the last report, though it remains incomplete. However, stakeholders must recognise the paradigm shift needed when handling fuels that pose severe risks to human life and ships in the event of an accident. To ensure safety in the light of the toxicity risks associated with ammonia and the explosion risks posed by hydrogen – both of which are heightened compared to conventional fuels by their dispersion characteristics – it is essential to implement robust risk mitigation measures and prioritise inherently safer design strategies.

For new technologies in particular, such as maritime autonomous surface ships or alternative fuels, risk assessment is crucial for the overall safety assessment and verification of new designs. It should be looked at holistically, considering hazards associated with physical layout, operation, control of risk mitigation actions and maintenance.

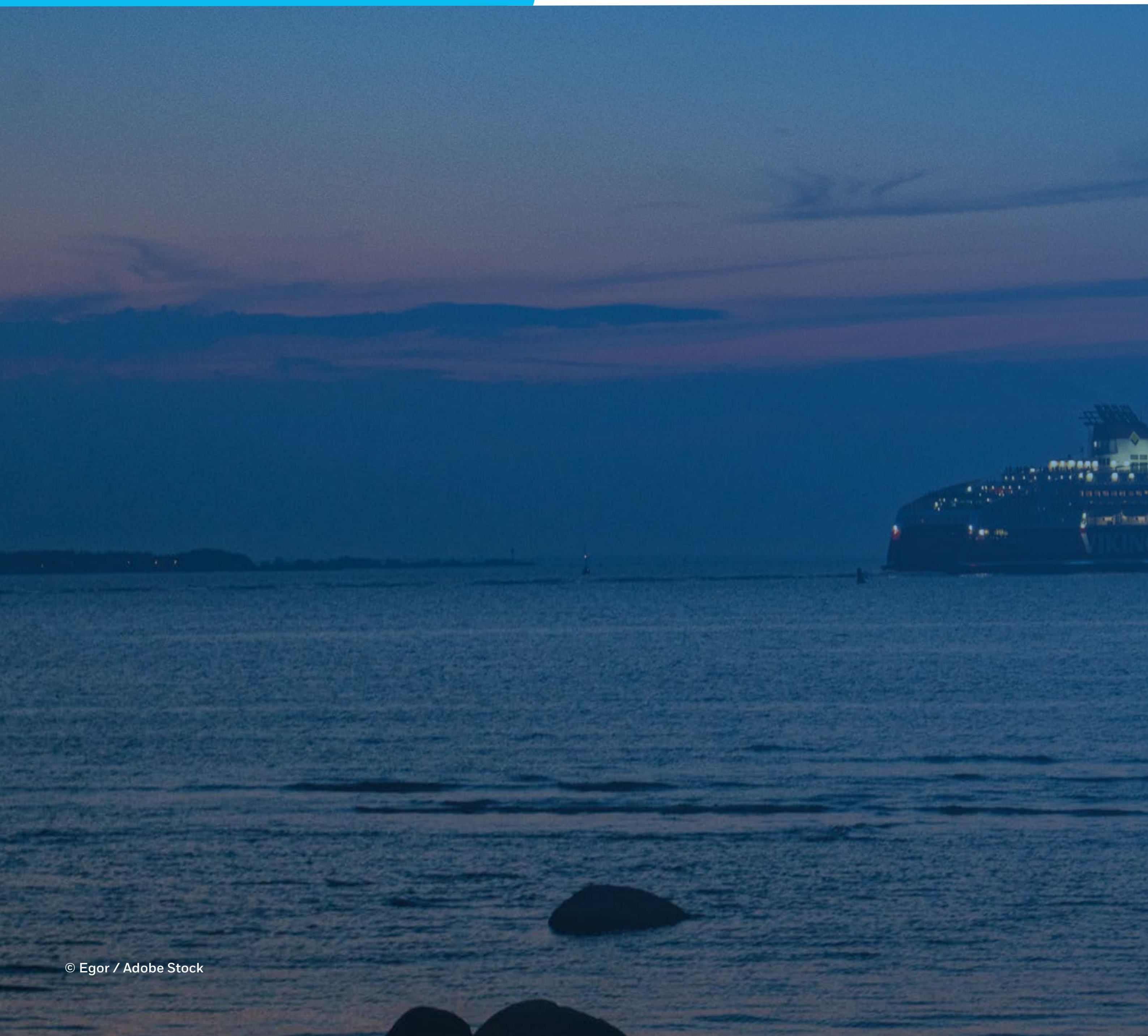
Discussions continue about the implications that ships with higher degrees of autonomy will have for seafarers and their training. Still, the human element will be pivotal in the development and operation of these ships and of remote operation centres. It will likewise be crucial for the introduction of alternative fuels in the sector, which needs to include guidelines for the development of training and assessment programmes for seafarers as part of new regulatory proposals.

Shipbuilding industry and marine equipment

Although the focus of this report is safety, it is important to briefly examine the competitiveness of the EU shipbuilding and marine equipment industry. In the five-year period between 2019 and 2023, Europe-based shipyards were responsible for 7.6 % of the world's newbuild activity, based on the number of ships built. This represents a decrease of 15.6 % over the period between 2016 and 2020. However, it is also to be considered that the COVID-19 crisis might have had an impact on this industry. With respect to the previous Emsafe report, it is important to note that the global share of ships built in the EU over the equivalent five-year period (from 2016 to 2020) decreased by 1.2 %. Most of the ships built in Europe are passenger ships, fishing vessels and others such as offshore supply vessels, dredgers and tugs.

The European marine equipment industry is still a world leader for a wide range of products. According to the MED Portal, 45 % of the marine equipment allowed to be installed on board EU Member States' flagged ships is manufactured by companies based in the EU. However, the declining market share of EU shipyards may also negatively impact EU marine equipment manufacturers, reducing demand for manufacturers mainly serving EU shipyards while increasing reliance on Asian shipbuilders.

Overview 01



1.1
Introduction

This is the second edition of *The European Maritime Safety Report* (Emsafe), published by the European Maritime Safety Agency (EMSA). This report provides a comprehensive overview of a wide range of maritime safety topics, along with an in-depth analysis of specific technical areas selected on the basis of European Union (EU) interest.

Emsafe looks at the development, application and status of relevant EU and international safety standards, with the goal of identifying possible areas for improvement through critical thinking. Overall, it is intended to contribute to a greater understanding of the safety-related challenges and opportunities facing the maritime sector by bringing together a set of key technical data relating to the safety of ships and their operation.

The report combines information from various databases hosted by EMSA that has been enhanced through consultation with stakeholders, offering the possibility of cross-analysing data and obtaining detailed insights into the status of maritime safetyin the EU.

This second edition covers the period from 2019 to 2023 and depicts the far-reaching impacts of recent global events on the maritime sector. The recovery from the COVID-19 pandemic, the economic and logistical disruptions following Brexit and the cascading effects of global conflicts have significantly influenced maritime traffic. At the same time, Russia's unprovoked and unjustified military aggression against Ukraine and the ongoing conflicts in the Middle East are having a significant impact on maritime security. In addition, high-profile maritime accidents, such as the fires on board the MV *Fremantle Highway* and the *Felicity Ace*, have highlighted new safety risks that the industry should work to mitigate.

Maritime safety has been at the heart of EMSA's activities since its inception in 2002. It encompasses, among other issues, a full range of technical actions relating to passenger ship safety, marine equipment, alternative fuels and energy systems for ships, maritime autonomous surface ships (MASS), fire safety and several overarching ship design principles. A proposal was put forward by the European Commission in 2023 to update EMSA's mandate to better reflect the growing role of the agency and its full set of current tasks and objectives in providing the Member States and the Commission with the necessary technical, operational and scientific assistance to ensure maritime safety and security and the sector's green and digital transitions. EMSA's work is highlighted throughout Emsafe, and includes developing guidance documents; supporting the development of EU legislation and monitoring its implementation through visits; building capacity within the Member States' administrations and across the world through inspections; and representing the EU's interests in a wide range of international settings, systems and projects.

This edition of Emsafe is structured according to the traditional maritime subdivision of responsibilities that Member States have as flag, port and coastal states.

In 2023, more than 3 375 million tonnes of goods (European Commission: Eurostat, 2025a) were loaded and unloaded at EU ports. In the main EU ports ([2]), 39 % of the trade volume corresponded to national and intra-EU transport, a slight increase when compared with 2019 figures (37 %). In addition, more than 395 million passengers embarked and disembarked passenger ships at all EU ports in 2023 (European Commission: Eurostat, 2025b ([3])), 5.5 % fewer than in 2019, after a 45 % drop in 2020 due to the travel restrictions imposed by the COVID-19 pandemic. Nevertheless, both the size of the world fleet and the number of EU Member State-flagged passenger ships grew between 2019 and 2023 to match the global demand for passenger transport. The safety of these ships is a particular priority due to the standing ageing trend of passenger ships under the flag of EU Member States, along with the non-retroactive applicability of new standards and the reflagging of older ships into the domestic fleet.

Maritime transport is highly competitive in relation to the external costs of transport when compared with other modes. These costs include environmental impacts such as air pollution, climate change, noise, up- and downstream processes, accidents, congestion, and infrastructure wear and tear. In the EU, the cost of long-haul transport by road is, on average, already six times higher in euro-cent/tonne-kilometre compared to maritime. Internal waterways and rail (diesel or electric) are transportation options that have much lower costs compared to road, but even electric rail transport still costs, on average, close to twice as much as maritime transport. Trucks have more external costs, and, in the majority, these costs have higher values, such as in relation to accidents and congestion. In a world where all modes of transport are expected to be emission free, the advantage of maritime over the other modes of transport in terms of saving external costs is undeniable. In such a scenario, road transport could present external costs 50 times higher than maritime transport (Nordahl et al., 2023).

Fishing vessels remain a key consideration. In the last edition of Emsafe, it was shown that fishing vessels present the greatest vulnerability to accidents. While there is still no international convention in force to ensure the safety of these vessels, the EU is revising various directives so as to tackle this important safety topic.

Fisheries and maritime transport are part of what is known as the blue economy. Both of these activities make use of ocean resources for economic growth, depending in turn on the reliability of ships and the maritime transport network. In some cases, in insular Member States or those with archipelagos, the blue economy represents 3–6 % of national gross value added. Moreover, according to the Commission, a sustainable blue economy in the EU is essential to achieving the objectives of the European Green Deal. Therefore, economic activities and environmental protection must go hand in hand, with decarbonisation made possible through the expected uptake of alternative fuels and energy technologies (European Commission: Directorate-General for Maritime Affairs and Fisheries et al., 2024).

Similarly, at their most basic level, sustainability and safety perform the same task: saving costs for the environment and society. As outlined in the sustainable and smart mobility strategy([4]), the Commission remains focused on enabling safe, secure and efficient maritime transport with lower costs for businesses and administrations.

In general terms, safety is the state during which the risk of harm to persons or damage to property is reduced or maintained below an acceptable level (Formela et al., 2019).

While transport safety is reflected outwardly in the number and severity of the accidents that happen, for each transportation mode there is an additional set of safety performance indicators that need to be monitored and developed to allow for the identification of problems at an early stage and for an understanding of what circumstances can lead to safety concerns. In this sense, maritime safety deals not only with the reporting and analysis of maritime accidents but also with safety standards, ship inspections, traffic patterns, working conditions and other relevant elements that may be causally related to accidents.

Throughout this report, the term ‘maritime safety’ is used interchangeably with ‘safety at sea’, and therefore includes safety of navigation, the impact of the human element, the technological and operational safety of ships and their crews, and the safety of people in distress. It also refers, unless stated otherwise, to all ships used in maritime activities of a commercial nature, including shipping, fisheries and offshore industry. Unless specified otherwise, the terms ‘Europe’ and ‘EU Member States’ refer to the 27 Member States of the EU, along with Iceland and Norway (the European Free Trade Association (EFTA) coastal states).

2 Main ports are those handling more than 1 million tonnes of goods or recording more than 200 000 passenger movements annually.

3 Eurostat’s definition excludes cruise passengers who disembark and rejoin the same ship before it leaves the port.

4 Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Sustainable and smart mobility strategy – Putting European transport on track for the future, COM(2020) 789 final, 9 December 2020, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52020DC0789.

1.2
Design, registration and operation of a ship

From the moment a shipowner decides to build a ship, maritime safety becomes a key part of the equation. The type of ship and the area of its operation, whether international or domestic, oceanic or coastal, are key elements that influence its design and the applicable safety standards.

Just as people have nationalities, so too must ships be registered to a country. This registration, i.e. the state in which the ship will be flagged, is essential in determining the legislation that applies to it. The state behind the flag can be a member state of the International Maritime Organization (IMO), but will only be subject to the conventions the state has ratified. In addition, if the state forms part of a supranational or international governmental organisation, such as the EU, it will be subject to additional legislative requirements. Should the ship be operating in a certain region, such as the United States or the EU, there will also be specific requirements, regardless of its flag.

The legislative regime to which a ship is subject is associated with a complex inspection and survey system.

Nevertheless, a ship is merely a piece of metal without the qualified personnel to operate it; the crew is fundamental to the running of a vessel, both operationally and from a safety perspective. The mental and physical well-being of crew members, so often tested by the demands of life at sea, are essential in keeping on-board safety at the appropriate level. Although there have been some improvements in the working conditions for seafarers, in particular after the adoption of the Maritime Labour Convention (MLC) in 2006, the work is far from being complete, as outlined in Section 5.1 'The human element' of this report.

1.2.1 Design

The concept of a ship starts with its **design**, the main elements of which are determined by its intended use, which in turn will determine its typification. The areas that affect safety on board include the ship's stability, structural integrity, fire prevention and response, navigation and life-saving appliances, all of whichmust be considered in the design process.

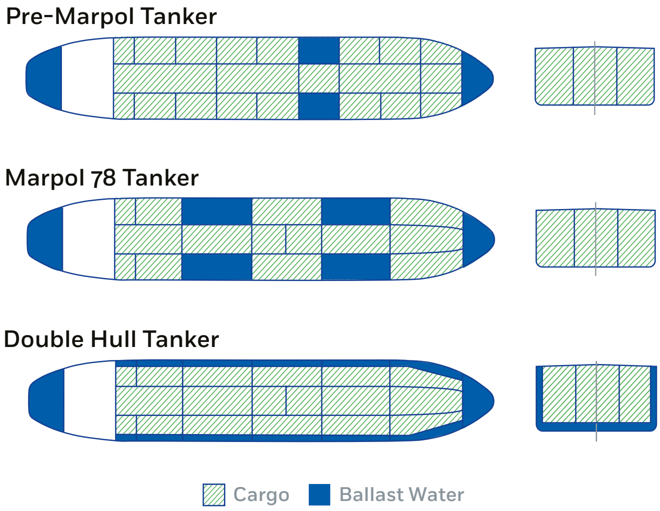
At the design stage, the naval architect will draw up plans, ship specifications and other technical documents in line with international regulations and standards. For all ship types, design features are introduced to accommodate the specific risks inherent in the ship's intended function or area of operations, some examples of which are presented in the following sections. Design evolution is often based on operational needs, such as more space to transport more cargo, but should always consider the dignity of those working on board as a key element, ensuring proper living conditions and safety.

Ship types are categorised not only based on their design but also on their purpose and operational requirements. Depending on the basis for classification, the fleet may be divided into different ship types when referring to various rules, verification processes or regulatory frameworks.

1.2.1.1 Tankers

Tankers carry liquid cargo in bulk. The consequences of their cargo being spilled at sea and potential fires and explosions due to the flammability of their cargo are two of the specific risks associated with this type of ship. Therefore, several safety requirements only apply to tankers, in terms of their fire safety or structural elements. One of these is the double-hull requirement, introduced in the wake of several high-profile oil spills, including those from the *Erika* in 1999 and the *Prestige* in 2002, both of which severely affected the EU coastline. Although the double hull had been mandatory for tankers above 5 000 dwt (deadweight tonnage) since 1993 through the International Convention for the Prevention of Pollution from Ships (MARPOL), the phasing out of single-hull tankers was further accelerated as a consequence of these major oil spills in EU waters.

Figure 1: Hull design of tankers under safety requirements.



Source: Lamb (2003).

Other examples include the introduction of inert gas systems to prevent explosions in the presence of flammable gases inside tanks; the introduction of emergency towing arrangements; and the specific SOLAS Convention requirement for every oil, chemical or gas tanker of with a gross tonnage (GT) of 10 000 and above to have a backup steering capability immediately available to ensure control in the event of a mechanical failure. In Figure 1, the evolution of tanker hull design is presented visually, following the introduction of additional safety requirements.

1.2.1.2 Passenger ships

Passenger ships are defined as those ships carrying more than 12 passengers. However, the subtypes roll-on/roll-off (ro-ro) passenger ships, high-speed craft (HSC) and large cruise ships all bring their own design-specific safety concerns.

Passenger cruise ships

Due to the challenges associated with crowd management and control, the primary concerns for large cruise ships relate to evacuation – particularly for passengers with reduced mobility – and scenarios such as fires that may escalate, impair visibility or restrict movement.

There are specific outfitting and operational elements to cruise ships that may impact on the safety of these vessels and make the design challenging and complex, such as waterslides that are in the way of typical evacuation routes; the fact that people can be expected to be present in most areas both above and below the waterline, in which case there are strict requirements to avoid the presence of hazardous atmospheres; and the greater importance of correct maintenance and guaranteeing the survivability conditions of the lifeboats to accommodate, if needed, a very large number of people.

While it may be that commercial needs are essential to some design solutions, it is also true that the profitability of this business is invested back into the ships, with cruise liners often being at the forefront of the commercial shipping industry when it comes to implementing new technologies in the fleets to enhance safety and efficiency.

Ro-ro passenger ships

Roll-on/roll-off passenger ships (ro-pax) are passenger ships with very distinctive design characteristics, due to the nature of their operations. The main design characteristic that differentiates a ro-pax from a conventional passenger ship is the long, undivided deck for vehicles. Their internal and/or weather decks have no vertical subdivisions; the lack of any physical barriers allows vehicles to be loaded and unloaded from these ships in a very short space of time. In essence, these decks act very much like indoor garages, and frequently have both stern and bow openings with ramps to enable freight to be handled on a drive-through basis.

While very practical from an operational perspective, this design characteristic means that there is a higher risk of capsizing if this space is flooded, compared to a conventional passenger ship in which the compartments are of limited length and vertical bulkheads control the extent of the flooding. Similar reasoning can be applied regarding the spread of fire on a ro-ro deck compared with that of a conventional ship; unlike in other ship designs, there are no vertical bulkheads to limit the damage from a fire.

At the same time, these ships often include accommodation and other passenger spaces in the superstructure, which increases the risk and adds challenges common to other passenger ships, such as those relating to evacuation in the event of an emergency.

Passenger high-speed craft

Passenger HSC are designed to compete with other modes of transportation over short distances. By increasing their speed, these ships complete some voyages in less time compared to other transportation methods.

In addition to the general challenges of evacuation and fire associated with all passenger ships, HSC face extra risks due to their defining feature: speed.

To achieve high speeds, these ships are typically built using lightweight materials. While this reduces weight and improves performance, it raises concerns about structural integrity, especially in rough seas or during collisions, as lightweight materials may not be as durable as traditional steel hulls.

At high speeds, these ships are also more susceptible to collisions because the amount of time for detecting and avoiding obstacles is significantly reduced. In the event of an accident, the impact forces are much greater than those experienced by slower vessels, potentially causing severe structural damage and increasing the risk to passengers.

Finally, although HSC are designed for high speeds, maintaining stability at these speeds requires careful engineering. Sudden changes in sea conditions or high winds can lead to instability, potentially causing loss of control or capsizing.

Image 1: Ro-ro passenger ship – main deck openings and superstructure.

Source: C messier / Wikimedia Commons.

Image 2: Vehicle carrier – hull view.

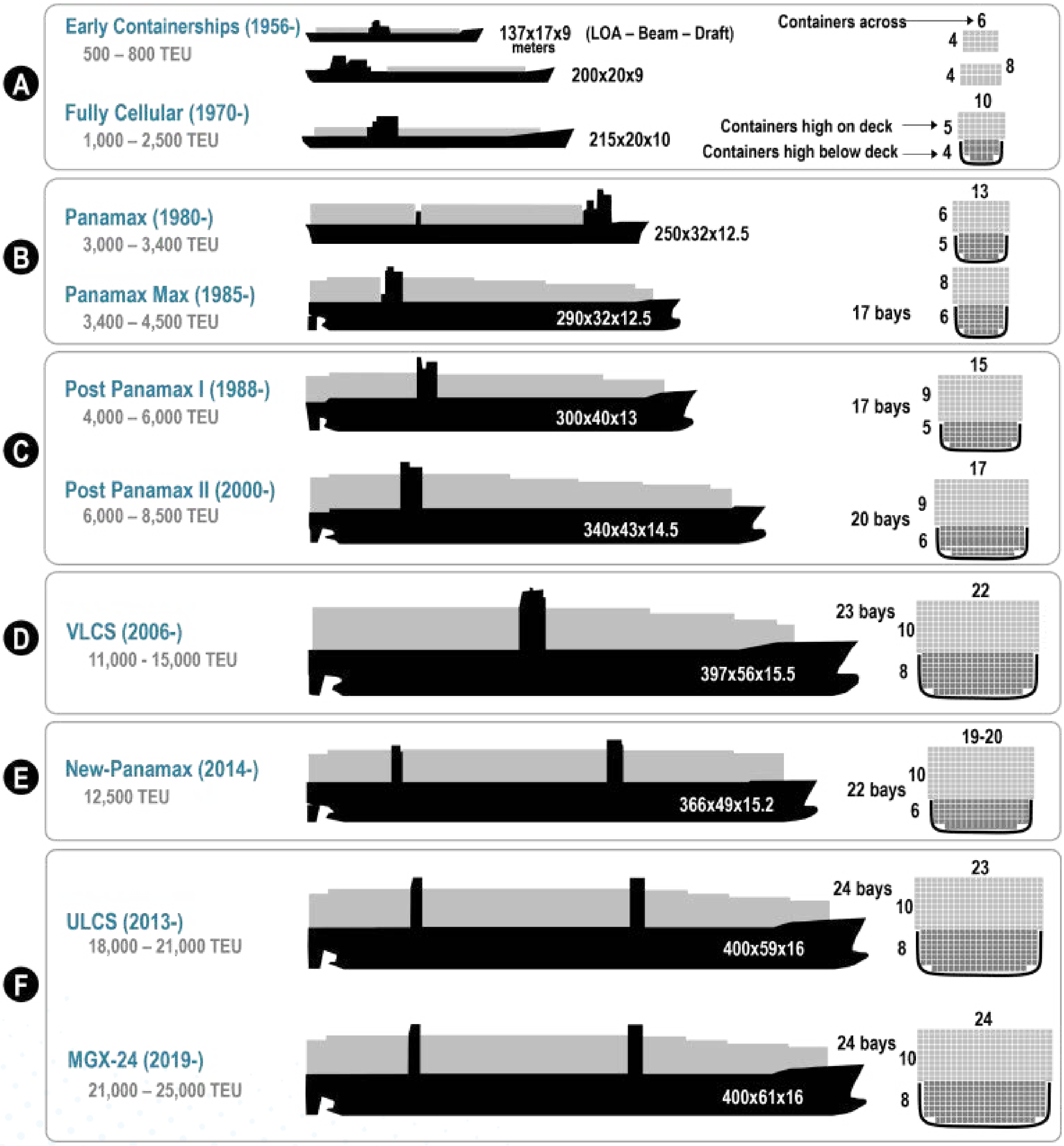
Source: Adobe Stock.

1.2.1.3 Vehicle carriers

Ro-ro cargo ships, also known as vehicle carriers, pure car carriers or pure car and truck carriers depending on the type of cargo, have similar design characteristics to ro-ro passenger ships as they transport the same type of rolling cargo. Nevertheless, they are considerably different in terms of deck design, risk control measures and incident responses because there are no passengers on board, either driving the cargo or needing to access ship spaces.

These ships have several, often movable, internal decks for the loading of vehicles. These decks can be placed for reduced ceiling height to make the most of the available cargo space. For the same reason, vehicles are often loaded with minimal space between them. This brings challenges relating to keeping adequate airflow for firefighting and ventilation in the cargo spaces and, for some types of cargo, keeping the vertical centre of gravity within the minimum requirements for stability. These add to the challenge, shared by ro-pax, of fire and flooding containment due to the absence of vertical bulkheads along the decks UK P&I Club, 2017).

Figure 2: Size evolution of container ships.



NB: All dimensions are in metres. LOA: length overall; VLCS: very large container ship; ULCS: ultra large container ship; MGX: Megamax container ship. The loads displayed on deck represent maximum possible loads, which would involve a large share of empty containers. Container ships usually carry fewer containers because of weight restrictions and lack of demand.

Source: Rodrigue (2024).

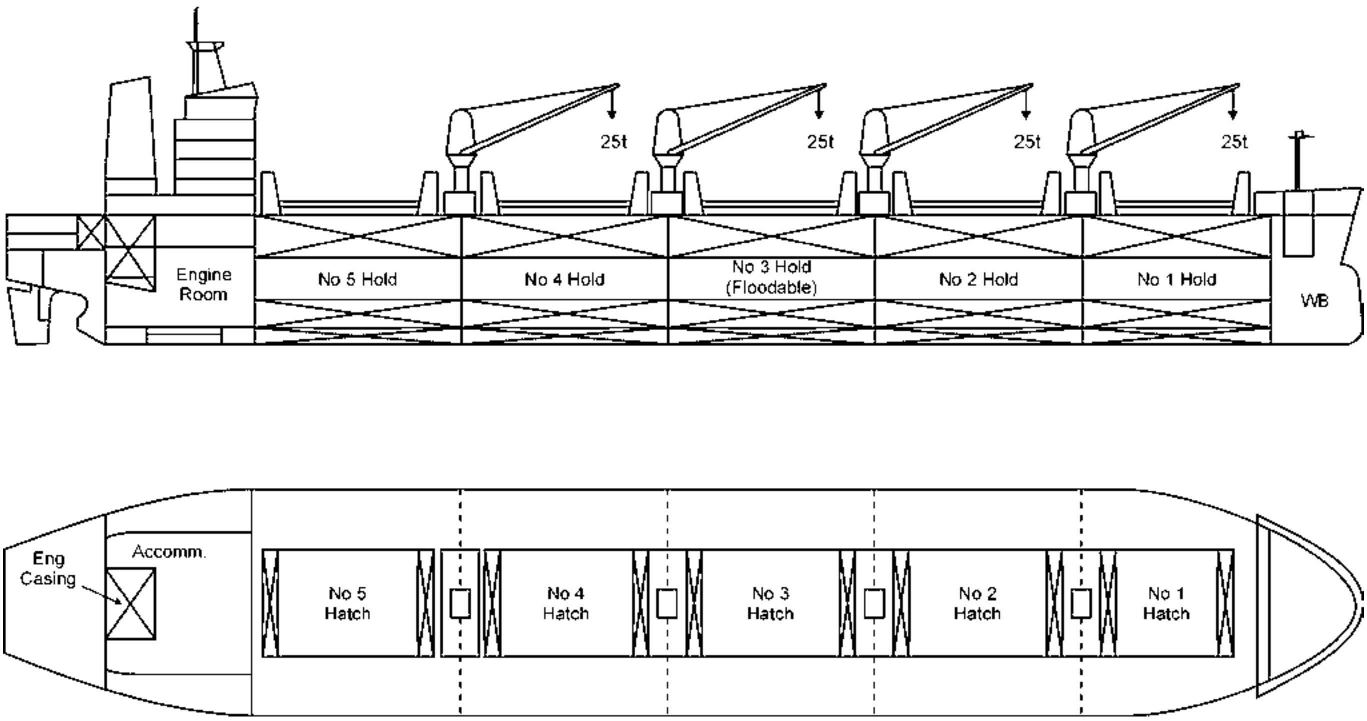
1.2.1.4 Container ships

Growing transport demand has greatly influenced the size of container ships (see Figure 2). As their size has increased, so too have the design and safety challenges they present, meaning that their design has had to be adapted. To comply with the forward visibility line requirement in SOLAS Chapter V Regulation 22, the superstructure has changed from a one-aft to a two-island structure. The breadth of these ships has gradually expanded, with the maximum length kept at around 400 metres. However, cargo-securing procedures are still essentially manual, and, with little evolution in the last 30 years, these tasks are becoming physically more demanding. Also, the containers themselves are tightly spaced, which makes fires hard to detect, control and extinguish due to the sheer size and the configuration of these ships.

1.2.1.5 Bulk carriers

Bulk carriers also exist in a broad range of different sizes, from 10 000 dwt to up to 380 000 dwt (Valemax class). Their evolution in terms of design has mainly been driven by the need for efficient loading and unloading. All bulk carriers have transverse bulkheads between their holds, which divide the ship into watertight compartments and provide additional transverse strength to the overall structure. The sequence involved in the loading and unloading process and coordination with the terminal are key concerns in avoiding potential stability and structural problems. Cargo liquefaction, whereby dry bulk cargo with a high moisture content is liquefied due to external pressures, thereby creating stability problems, is one of the specific safety problems of this type of ship, and has been responsible for 55 deaths globally between 2015 and 2024 (International Association of Dry Cargo Shipowners, 2025).

Figure 3: General arrangement of bulk carrier.



Source: Rémi Kaupp for the original drawing, Calips for clean-up, CC BY-SA 3.0.

1.2.2 Construction

Throughout the ship design and construction process, a chain of entities and bodies is responsible for ensuring the safety of the vessel. Examples include the shipowner, who contributes through internal culture and safety management systems (SMSs), and the shipyard and its personnel, who deal with everything from the ship's design and technical aspects to production and quality management. Additionally, flag authorities are responsible for certifying the safety of the ships from construction, while classification societies verify the correct application of their own rules for classed ships from design and construction.

The objective of ship classification is to verify the structural strength and integrity of essential parts of the ship's hull and its appendages, and the reliability and functioning of the propulsion and steering systems, power generation and those other features and auxiliary systems which have been built into the ship in order to maintain essential services on board (IACS, n.d.b).

Classification societies were created in the 18th century as the only bodies that 'classified' ships according to their safety, allowing insurance fees to be assigned on this basis. It was only later, in the 19th century, that the flag state became involved in safety, following the initiative of a British Member of Parliament, Samuel Plimsoll, who introduced the maximum load line of ships through the so-called Plimsoll line, which is still in use today.

The construction of ships is a broad and complex process that starts with the signing of the shipbuilding contract. It is during construction that the safety of the material and equipment purchased is verified. The keel-laying date, an important milestone for the applicability of safety legislation, marks the start of the construction process.

In the five-year period between 2019 and 2023, European shipyards were responsible for 7.6 % of newbuild activity in the world based on number of ships built, corresponding to 3.1 % of the worldwide GT built in that period.

The EU Member States where the highest number of ships were built were the Netherlands, Poland, Spain, Norway, France and Croatia (Figure 4), representing 76 % of all newbuilds in European shipyards over that period. However, it was in Finland, Italy and Germany that the largest ships – mostly large cruise ships – were constructed, with an average of over 92 700 GT, 63 400 GT and 38 200 GT per ship, respectively.

Figure 4: Top 10 EU Member States by total GT of ships built in the 2019–2023 period: newbuilds by number of ships and total GT. Self-propelled merchant ships of 100 GT and above, with IMO number.

	Number of ships	Total GT
Italy	44	2,791,072
Germany	48	1,835,561
France	83	1,610,082
Finland	13	1,205,380
Romania	66	506,454
Spain	127	466,098
Netherlands	218	396,580
Poland	152	266,579
Croatia	71	247,101
Norway	116	147,247

Source: EMSA services.

Figure 5 shows how the shipbuilding industry was divided up in terms of type of vessel constructed between 2019 and 2023.

Most of the ships built in Europe are passenger ships, fishing vessels and other work vessels, such as offshore supply vessels and tugs.

Figure 5 Number of newly built ships by ship type in the EU and worldwide and share of EU builds by ship type in the 2019–2023 period – self-propelled merchant ships of 100 GT and above, with IMO number.

	In the EU	In the world	%
Tankers	17	2,429	0.7%
Bulk carriers	10	2,262	0.4%
General cargo ships	69	1,076	6.4%
Container ships	1	994	0.1%
Ro-Ro cargo ships	14	271	5.2%
Passenger ships	262	814	32.2%
Other cargo ships	0	68	0%
Fishing vessels	277	1,610	17.2%
Other work vessels	358	3,819	9.4%
Total	1,008	13,343	7.6%

Source: EMSA services.

With respect to the previous Emsafe report, it is important to note that the number of ships built in the EU over an equivalent five-year period decreased by 15.6 %. Looking at the top 10 countries, there was also a decrease of 15.7 % in terms of both the number of ships built and the GT. This tendency shows a significant decline in this key industry in a short period of time. However, it is also to be considered that between 2019 and 2023 the COVID-19 crisis might have had an impact on this industry.

With respect to the previous Emsafe report, the global share of ships built in the EU compared to the equivalent five-year period (from 2016 to 2020) decreased by 1.2 %.

The global share of the EU shipbuilding industry is very low when compared to its share in terms of maritime transport and ship ownership, as indicated in Section 2.3. Conversely, the European marine equipment industry is a world leader in a wide range of products, with a market share of 35 % (European Commission: Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, n.d.). However, the decreasing global market share held by EU shipyards has also had a negative effect on EU manufacturers. On the one hand, the decreasing demand has put stress on EU manufacturers mainly or solely serving EU shipyards; on the other hand, globally active EU manufacturers have become more or mainly dependent on Asia, where a large number of ships are now built.

1.2.3 Flagging and registration

In the initial stages of the construction process, a ship must be registered and given a nationality that registers proof of its ownership. The country of registration is called the flag state ([5]), and each country can have more than one register with different tax or labour regimes. Crucially, the country of registration of the ship does not need to be the same as that of the shipowner. The selection of the register is made by the owner based on considerations such as risk management, the countries where the ship is expected to operate, contractual issues with the operator (which can be a different from the owning company), tax regimes, etc.

Each flag state has its own requirements and conditions for allowing a ship to fly its flag and be registered under its nationality.

As indicated above, flags can have more than one register with different admission rules. Registration is a complex matter, with many specific issues that may not match the specific categories presented. Therefore, the types of registers identified below are a simplification that may not reflect all possible cases.

- **Closed registers.** National registries for ships owned, operated and manned by nationals of that country.
- **Open registers.** Open to shipowners with nationalities other than that of the flag state.
- **Secondary registers.** To compete with open registers, some countries, including EU Member States, have created a secondary register with more flexible legislation in terms of taxation, country of origin or crew nationality, while keeping safety standards and working conditions at an appropriate level.

Whichever register is chosen, before entering into operation the ship is subject to certification schemes that verify that national and international safety standards are met. Certification is obtained through inspections that start with the verification of the technical drawings during the design stage and continue during the construction phase.

The flag state exercises regulatory control over the ship, and is required to inspect it regularly under its safety requirements and to certify compliance with regulatory standards. Flag states may delegate that duty to recognised organisations (ROs), which are classification societies carrying out a different set of tasks. If the requirements set by the flag state are met, a certificate of registry is issued.

As indicated above, classification societies inspect and survey vessels to verify that the technical standards for the design of structures and outfitting – not explicitly specified in international legislation – are met during construction and commissioning. A certificate of classification is then issued, on top of the statutory certificates; for ships engaged in international voyages, this certificate is required for the registration of the ship.

1.2.4 Operational life

During its operational life, the ship is periodically subject to several inspection regimes, including statutory (flag/RO), port state control (PSC), class, special regimes (ro-pax and HSC) and private schemes. Upon a vessel's arrival in port, inspections may be carried out on a planned or unplanned basis, depending on the situation.

There are also company-based schemes and industry-accepted vetting programmes for particular ship types, which are not certification systems required by legislation but act as risk assessment tools for charterers and ship operators. This helps to avoid the use of ships with substandard, or lower, levels of safety. . One example is the tanker industry's self-regulating framework, which directly ties the commercial viability of tankers to the various statutory and industry standards implemented. Tankers, in general, are subject to an additional layer of quality assurance through the vetting framework prior to cargo transaction with charterers. Both operators and tankers are evaluated and/or screened against indicators set out in the oil companies' marine assurance criteria. One of the fundamental factors in this process is the physical inspection, which is conducted according to the Oil Companies International Marine Forum's Ship Inspection Report Programme (known as SIRE).

At the end of their operational life, which on average lasts 25 to 30 years, most ships are dismantled for their parts or for the extraction of raw material. Ship recycling yards are mainly located outside the EU (European Environment Agency et al., 2025).

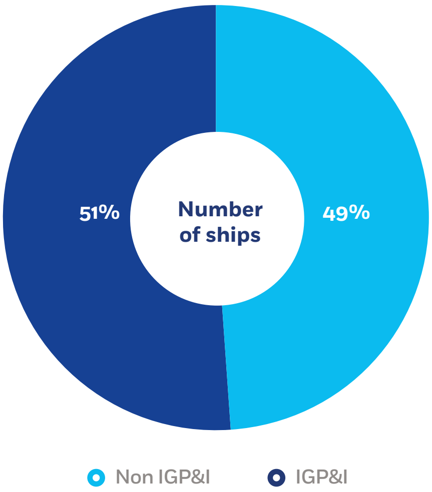
Marine insurance and protection and indemnity (P & I) clubs also play a crucial role in maintaining the safety and operational integrity of ships throughout their lifespan. Marine insurance provides financial coverage against risks

5 UNCLOS, Articles 91 and 94.

such as damage to the vessel, cargo or equipment, allowing shipowners to address unforeseen incidents without jeopardising their business viability. P & I clubs, on the other hand, focus on liabilities that arise from ship operations, including crew injuries, oil spills or collisions, promoting compliance with safety regulations and environmental standards. Together, these entities encourage shipowners to invest in robust safety measures and maintenance protocols, potentially reducing the likelihood of accidents. By incentivising adherence to international maritime regulations and underwriting risk management practices, marine insurance and P & I clubs contribute significantly to the sustainability and safety of global shipping operations.

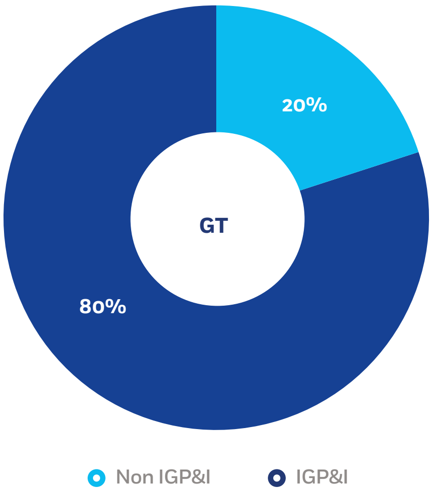
If a ship is insured by an entity that is part of the International Group of Protection and Indemnity Clubs (IGP&I), it means that the ship is covered for third-party liabilities under a globally recognised and highly robust mutual insurance system. Indirectly, it reflects the commitment of its shipowner to implement best practices in safety, compliance and risk management. Figure 6 and Figure 7 show the distribution by number of ships and sum of GT of the world fleet in terms of their coverage by P & I clubs and their subsidiary associations that are part of the IGP&I. The IGP&I provides marine liability cover around 50 % of the world's fleet (≥ 500 GT) in numbers and 80 % of the world's cargo-carrying tonnage.

Figure 6: Number of ships in the world fleet ≥ 500 GT – distribution by IGP&I coverage.



Source: Equasis dashboards. Dataset 31 December 2023.

Figure 7: Sum of GT in the world fleet ≥ 500 GT – distribution by IGP&I coverage.



Source: Equasis dashboards. Dataset 31 December 2023.

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1.3 Regulatory framework

There is a complex regulatory framework around maritime safety that is composed of international, regional and national layers, with different rules of applicability and associated inspection regimes. Its application depends not only on the ship's type, size and other characteristics, but also on the type of voyage it is undertaking. International voyages are those in which the port of origin and the port of destination are in different countries. A domestic voyage is one where the port of origin and port of destination are in the same country, regardless of whether international waters are crossed when in transit. An intra-EU voyage – a voyage between ports of different Member States – is therefore considered an international voyage.

Shipping in the EU is mainly subject to three regulatory layers: international, EU and national.

1.3.1 Development of standards

The standardisation of any industry is a key element for its growth at the global scale. However, economic factors should always be balanced with a proper level of safety, to minimise accidents that can bring about fatalities, injuries, loss of property and damage to the environment. As shipping is a global industry, a level playing field is required for all economic actors so that competition is based on service, specialisation, etc., but not on safety. To achieve this objective, the United Nations (UN) created the IMO, an agency that specialises in harmonising the minimum safety standards that ships trading internationally should meet.

Several conventions have been concluded at the IMO in different fields. SOLAS is the main convention dealing with maritime safety, and has several associated codes. The safety standards were, until recently, based exclusively on prescriptive requirements according to the existing technology at the time the relevant regulation was drafted. This approach facilitates uniform implementation but hampers the introduction of new technologies into the market. To overcome this obstacle, the prescriptive requirements have been complemented, in some limited cases, with goals and with functional and performance requirements according to the goal-based standards (GBS) framework. Another way to introduce new technologies under the SOLAS Convention is through the alternative design framework, which requires an equivalent safety analysis on a case-by-case basis. However, this approach may present some disadvantages, which are further explored in this section.

The IMO's cycle for developing safety standards is quite complex, due to the multilayered approach of committees and sub-committees that must discuss and approve any new proposals. In the case of the EU, the internal mechanisms to submit a proposal to the IMO – which include the technical groups, the Commission's internal consideration and the decision at the level of the Council – must be added to this complex set-up. Finally, the fact that most new standards are not applicable retroactively, through the so-called grandfather clause, means that a real change in the level of safety when a new safety standard is proposed can take decades.

On certain occasions, the EU, to speed up the implementation process of a certain requirement or to increase/complement the safety level agreed at the IMO, has also developed several pieces of legislation applicable to EU-flagged ships or ships visiting EU ports engaged in international and domestic voyages. This is the case, for example, in the specific damage stability requirements applicable to ro-ro passenger ships.

In principle, any major new introduction or modification of a safety standard must include a complete risk assessment, balanced with an economic analysis that states that the new measure is cost-efficient, i.e. that the risk avoided in economic terms is not achieved at a disproportional cost for the industry. This means, in practice, assigning a cost not only to property but also to human life. This approach is common to most industries, and in the maritime sector is called a formal safety assessment (FSA). It is equivalent to an impact assessment at the EU level.

Complementing SOLAS and EU legislation are standards established by specialised technical bodies, the classification societies, that cover aspects such as the structure and the mechanical and electrical elements essential to ensuring the seaworthiness and safety of ships. Finally, there are non-specialised standardisation bodies, such as the International Organization for Standardization (ISO) and the European Committee for Electrotechnical Standardisation, that cover gaps left by the other two regulatory layers in very specific areas, such as testing. In this regard, one example is the Marine Equipment Directive

(MED) [6], which complements the IMO requirements through the specification of relevant standards for safety equipment to be installed on board EU Member State-flagged ships so that there is harmonisation at the safety level.

1.3.1.1 Triggering elements

The main factors triggering the introduction/modification of standards are the following.

Lessons learnt from accident investigation

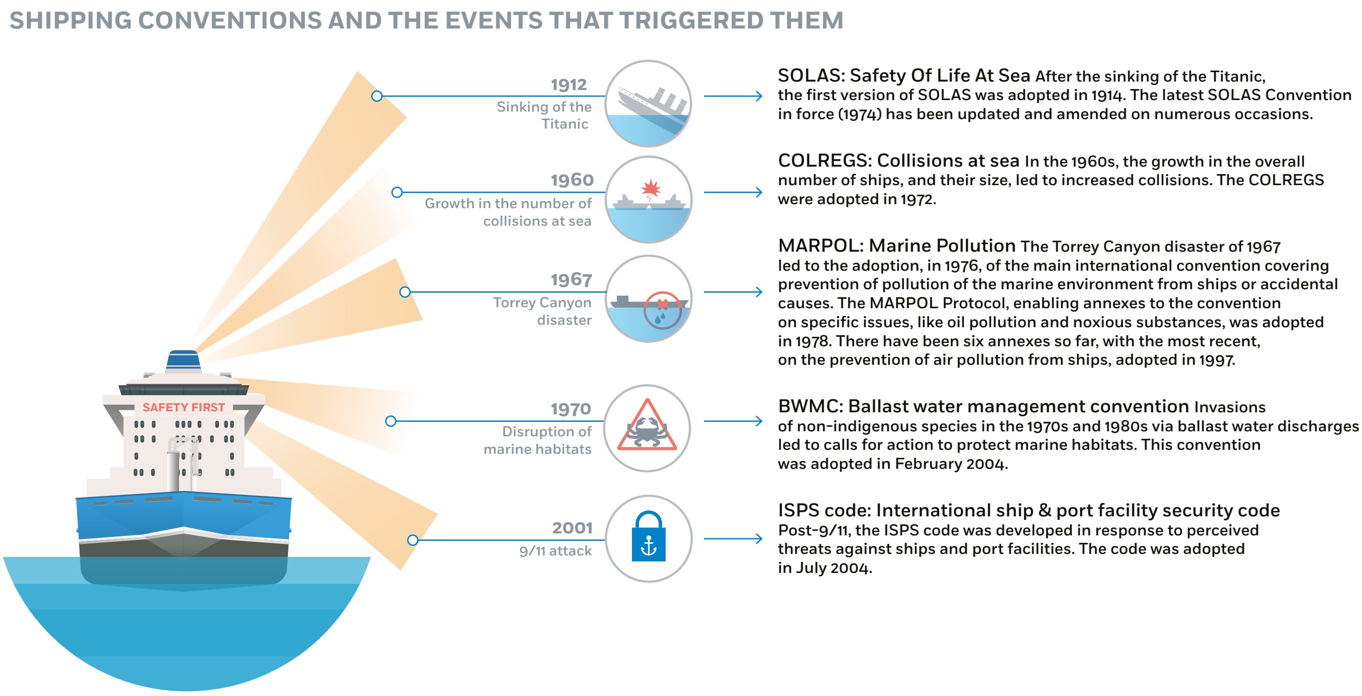
This is the main source of new safety proposals. The investigation reports of serious and very serious accidents, developed by the flag states concerned, include safety recommendations to be implemented by different actors.

Some of the recommendations relate to the need to improve certain standards that were considered not to provide a sufficient safety level and are discussed, where appropriate, within the IMO framework. When several accidents point in the same direction, there is a need to act. However, such action requires time, determination, resilience and investment from interested parties for the development of comprehensive scientific studies with cost–benefit analyses. In general, flags alone lack the financial and human resources to carry out a project of this nature, especially if it covers a large number of technical elements. The EU's common action in these cases provides efficiency and facilitates cooperation.

Ideally, safety standards should be upgraded before accidents happen, but unfortunately this is not always the case. It is not due to a lack of will on the part of the industry, but rather because of elements that fail which are difficult to predict.

As shown in Figure 8, the major IMO conventions came into being after catastrophic accidents.

Figure 8: Shipping conventions and the events that triggered them.



Source: marineinsight.com.

6 Directive 2014/90/EU of the European Parliament and of the Council of 23 July 2014 on marine equipment and repealing Council Directive 96/98/EC (OJ L 257, 28.8.2014, p. 146, ELI: http://data.europa.eu/eli/dir/2014/90/oj).

Vaguely defined standards that make implementation difficult

On many occasions, the final drafting of a requirement leaves elements open to interpretation. These elements are, in general, addressed by the International Association of Classification Societies (IACS), which proposes unified interpretations (UIs) to be used when implementing a certain safety requirement. The UIs have two sides: on the one hand, they provide for a clear basis for approval; on the other hand, they do not ensure that all flags will adopt the IACS UI. Around 80 % of the world merchant fleet is classed by IACS members, rising to more than 95 % in terms of tonnage. This means that the UIs have a substantial global impact, but are nevertheless not always adopted by flags and/or classification societies other than IACS members. Although an IACS UI often becomes an IMO UI, the ideal situation would be to integrate, where possible, the contents of the UI into the relevant conventions.

Outdated standards

The SOLAS Convention currently in force dates to 1974. On several occasions, this convention has been amended due to safety concerns. However, there are certain elements of the convention that, due to a lack of time or momentum, have never been updated in line with the state of the art of traditional technologies and are implemented through common practices established by industry but not supported by the regulations in force. A clear example of this can be found in the current steering and manoeuvrability standards. These standards were developed with a traditional propeller-plus-rudder set-up in mind. Since the regulation was drafted, different technologies have emerged that are commonly used by the industry today, such as pods, azimuthal thrusters and Voith Schneider propellers.

Following an initiative from the IACS to update these requirements, EMSA launched a study called Steersafe in 2020 to address this topic and specify the amendments that SOLAS requires in order to be aligned with the latest technologies. Submissions were sent to the IMO in this respect and a new output was opened in 2021; however, due to the heavy workload at the IMO, the consideration of this proposal was delayed until 2024. The technical discussions are currently taking place within the framework of the IMO Ship Design and Construction Sub-Committee, and will last for two sessions at least. The EU proposed significant amendments (document MSC 105/18/1) in relation to:

- improving the consistency and structure of the rules;
- including goals and functional requirements, using the same model as for SOLAS Chapter II-2;
- introducing technology-neutral requirements;
- incorporating the contents of existing related UIs;
- reinforcing the link between ship manoeuvrability performance and steering/propulsion requirements;
- adding criteria for ship manoeuvrability performance in a failure / reduced service condition;
- adding specific requirements addressing solutions with multiple rudder/steering systems –acceptance of redundancy on the system level as being equivalent to redundancy on the component level.

New technologies

In terms of new technologies, the maritime industry is at a crossroads, with substantial change on the horizon. On the one hand, the environmental challenges bring with them a need to replace fossil fuels with cleaner alternatives. These alternative fuels imply profound changes in business logistics and ship design, but also new safety risks that must be handled appropriately. On the other hand, the increase in the autonomy of on-board ship systems will gradually entail new business models, with the potential transfer of people from ships to onshore stations. These new developments will have associated implications for maritime safety, which are difficult to anticipate but which will include topics such as responsibility and accountability, the increasing role of communications, remote control systems, maintenance, etc. The change will be gradual, and there could therefore be a long period, perhaps decades, during which more automated ships will co-exist with others, thus creating a dual system of standardisation and operation.

1.3.1.2 Methodologies

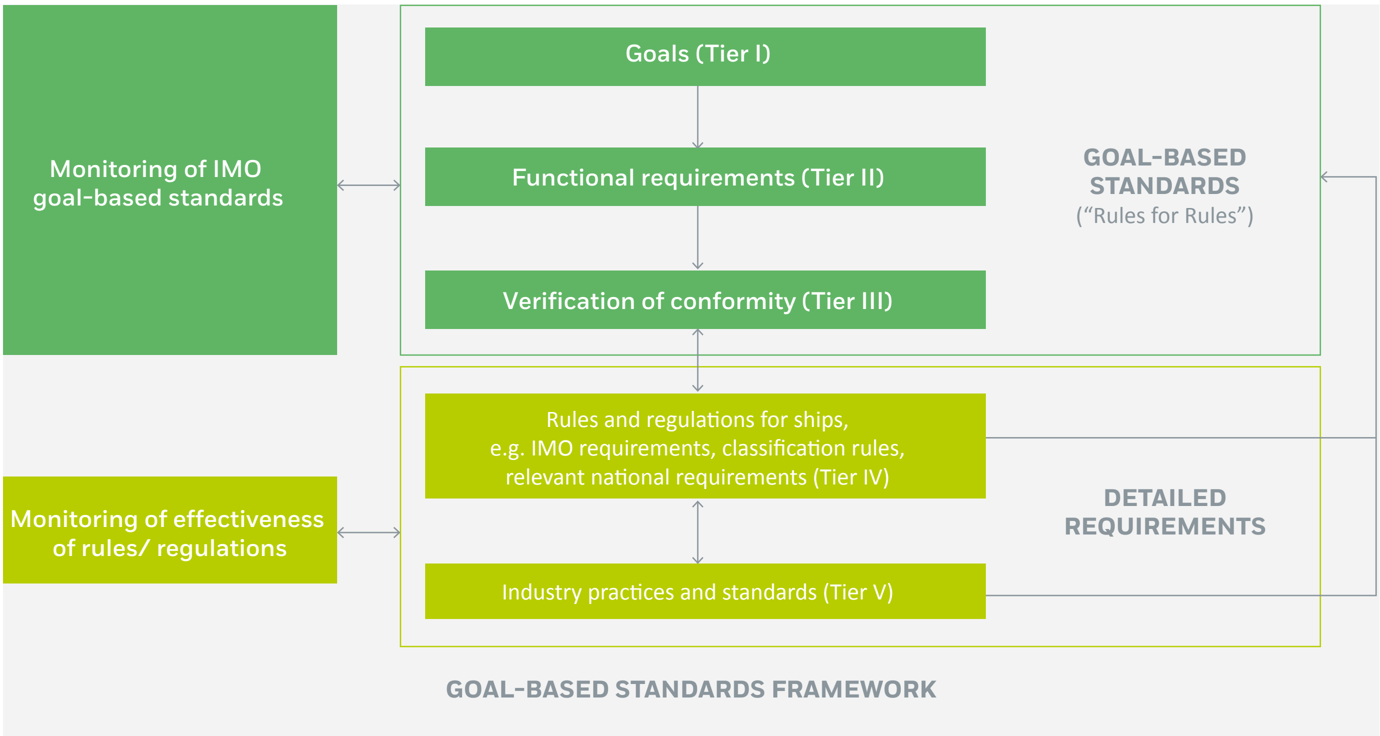
Irrespective of the motivating factor behind introducing a new safety standard, there are several existing methodologies to address their development, depending on the circumstances. The main ones are listed below.

1. Goal-based standards

The goal-based approach is a regulatory approach that establishes a methodology to develop regulations, i.e. rules for rules. The methodology has a hierarchical structure of principles (tiers) that starts with more general principles (goals and functional requirements) and finishes with detailed rules and industry standards. Between the general principles and the detailed rules is a verification procedure through which it should be possible to assess whether the detailed rules fulfil the general principles.

Within the maritime safety sector, the benchmark for a goal-based approach is the IMO's GBS framework (IMO, 2019a). Although it is considered a robust model from a theoretical point of view, in practice it has not always been easy to implement. Figure 9 shows the main steps in the GBS methodology.

Figure 9: The GBS framework.



Source: IMO (2019a).

Each tier increases the level of detail. A common misunderstanding of this methodology is to assume that the GBS finishes with the definition of Tier II, i.e. the functional requirements that provide general principles. This leads some industry stakeholders to claim that the GBS methodology is not effective for practical implementation as, when designing, building or modifying a ship, detailed safety requirements are needed. It is clear that a standard ship cannot be built based on the general principles of Tiers I and II, however, it is usually overlooked that the GBS exercise is only finalised when detailed prescriptive requirements (Tiers IV and V) are established, and they can indeed be used in shipbuilding.

What is then the point of developing goals and functions if only the detailed requirements are needed? Are Tiers I and II purely academic? There are several advantages of developing Tiers I and II.

- Tiers I and II require a hazard-identification exercise, based on which the goals to mitigate those hazards are defined and the functions necessary to do so are established. Accordingly, when carrying out the verification exercise, i.e. checking that the detailed requirements match the functional ones (Tier III), it is confirmed that all the relevant hazards are properly addressed by the detailed regulations.

- Tiers I and II are drafted in a technology-neutral way. This means that new technologies and designs, which do not match the existing detailed regulations, can be introduced as long as Tiers I and II are respected. On the one hand, this implies that technological development is not hampered by regulatory barriers; on the other hand, it implies that a valuable reference is provided for the flag administration when assessing the safety level of the new technologies. Similar reasoning can be followed in the case of a design for non-standard ships built only to address a very specific need.

- The development of regulations following the GBS model can take years of work and involve the participation of many specialists in the field. Such a model has been used until now for a specific part of certain ship types, for example the Common Structural Rules for Bulk Carriers and Oil Tankers. The International Code for Ships Operating in Polar Waters was also developed on the basis of GBS standards, although the functional requirements lack performance requirements and hazards. Chapter II-2 of SOLAS was also framed considering the GBS philosophy, although in a more generic way. Finally, at the EU level, Tiers I and II were developed for passenger ships of less than 24 metres in length operating domestically [7].

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7 Council Recommendation of 9 April 2019 on safety goals and non-binding functional requirements for passenger ships below 24 metres in length (2019/C 142/01) (OJ C 142, 23.4.2019, p. 1, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019H0423%2801%29).

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2. Formal safety assessment

In general, an FSA is used by the IMO to modify/ upgrade relevant regulations, ensuring that the risks are appropriately addressed and, at the same time, that the cost of implementing risk control options (RCOs) is proportional to the risk reduction.

The FSA and GBS methodologies can be combined, though this is not usually the case. The step common to both methodologies is hazard identification, though GBS is used for more transversal topics or when there is a need to develop a new instrument, such as the International Code for Ships Operating in Polar Waters, whereas an FSA is more efficient (with a real impact on regulation) when upgrading specific existing standards, for example the damage stability of passenger ships. The FSA methodology is quantitative by nature, as risks have to be characterised and calculated, along with the impact of the correction measures (RCOs), to establish a safety level. A key part of the FSA is the cost–benefit analysis, in which the costs of RCOs are balanced with their risk reduction in terms of potential loss of life, property and environmental damage. If the RCO proves to be cost-effective it must be proposed for implementation through regulatory amendments. The cost-effectiveness of RCOs can be verified for both newbuilds and existing ships. An advantage of the FSA methodology is its transparency and verification. The IMO has an ad hoc group, the FSA expert group, that analyses and assesses each FSA submitted to the organisation to ensure that the methodology is complied with.

A recent example of a study following the FSA methodology is the EMSA-contracted Cargosafe study addressing the risk of cargo-borne fires in container ships ([8]). In the study, 16 RCOs were assessed, resulting in at least half of them proving cost-effective for specific ship size segments, which could constitute proposals to the IMO as amendments to the existing regulatory framework. Some of these options are being discussed in the Sub-Committee on Ship Systems and Equipment. (More information about Cargosafe can be found in Section 5.2.3.)

3. Alternative design

Alternative design is a methodology used at the IMO when a specific ship needs to deviate from the prescriptive requirements of SOLAS, and the IMO has developed relevant guidelines for its use. The alternative design approach, contrary to GBS and FSA, is generally applied to a specific ship and is approved by the relevant flag on a case-by-case basis (although, on many occasions, the analysis made for one ship is used for other cases). Once an alternative design is approved, the IMO should be informed.

The main disadvantage of this methodology, with respect to the other two, is transparency. Firstly not all cases are reported to the IMO, and secondly there is no need to submit the engineering analysis to the IMO; only a notification is required. Accordingly, there is no expert group or sub-committee that reviews the alternative design. If the system is abused by a flag state, there is no control element that can be used to avoid it.

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8 https://emsa.europa.eu/containership-safety/cargosafe.html.

Alternative design was developed not to allow the safety level to decrease, but to ensure that innovative elements introduced on a particular ship provide a level of safety equivalent to that of the applicable regulations. A well-known case of alternative design has to do with maximum lifeboat capacity. According to the Life-Saving Appliances Code, included in SOLAS, 'No lifeboat shall be approved to accommodate more than 150 persons.' This limitation mainly centres on the time needed to enter lifeboats in the event of an accident. However, on large passenger ships, this implied the installation of many lifeboats, thereby restricting the space dedicated to cabins. To avoid this problem, some lifeboat manufacturers carried out an engineering analysis to establish that there would be no decrease in the safety level if the lifeboat capacity were to be increased. The analysis was accepted by several flags, to the effect that today it is considered normal practice to install such lifeboats, which can reach a capacity of more than 400 people, on board large passenger ships. An alternative design, in this case, became a standard design.

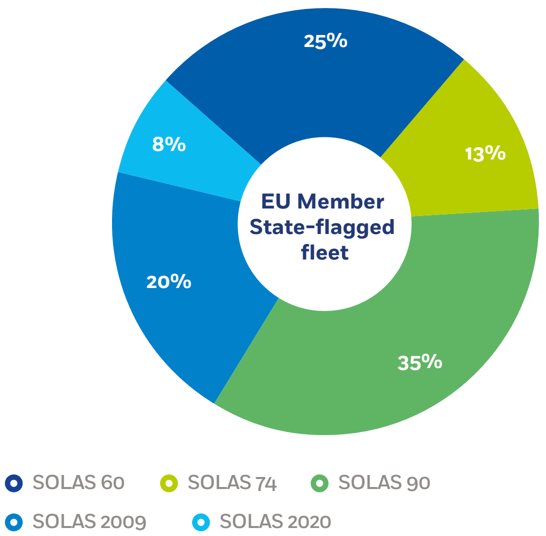
In 2024, EMSA contracted a new study that should serve as basis to develop guidance for the alternative design approval of large lifeboats (see Section 5.2.2).

1.3.1.3 Cycle to develop safety standards and consequences

As indicated above, the cycle of proposing, discussing and approving new safety requirements, and their subsequent entry into force, is a complex and lengthy process. However, developing a new requirement will not produce any real effect in relation to safety unless it is implemented in practice. Considering that, in most cases, new safety requirements are not applied retroactively but only on ships yet to be constructed (due to the grandfather clause), the real effect of a new requirement in the fleet can take decades. This can mean that certain safety improvements become outdated and need to be replaced before they have a global effect on safety. Another consequence of the grandfather clause is that there can be ships with different safety levels operating on the same routes and in the same areas of maritime traffic for long periods of time, something that users of maritime services, like passengers, are often not aware of.

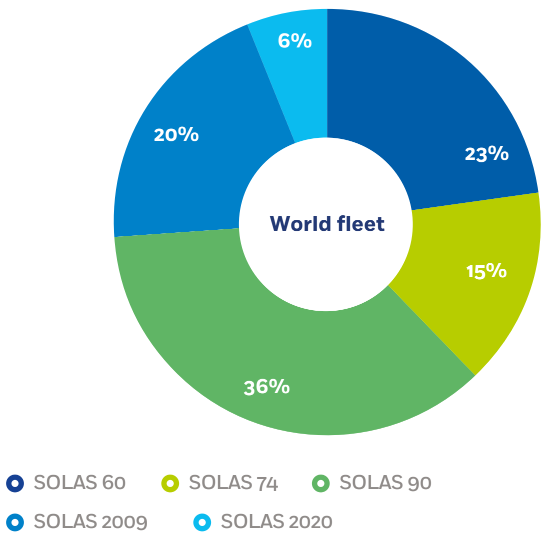
A good example of this can be seen in the damage stability requirements for passenger ships. The 1960 version of the SOLAS Convention, known as SOLAS 60, had certain damage stability requirements that were upgraded in subsequent versions (SOLAS 74, SOLAS 90, SOLAS 2009 and finally SOLAS 2020). Each update brought with it a safer standard due to lessons learnt from accidents; however, in general, none of these upgrades were retroactively applied, meaning that ships built before certain dates could continue sailing without any modification. The consequence is the picture that can be seen in Figure 10 and Figure 11, in which the EU Member States' and world passenger fleets are classified according to the damage stability standards applicable at the date of construction.

Figure 10: Passenger ships, excluding HSC, under different SOLAS damage stability requirements based on date of build – EU Member State fleet in 2023.



Source: EMSA services.

Figure 11: Passenger ships, excluding HSC, under different SOLAS damage stability requirements based on date of build – world fleet in 2023.

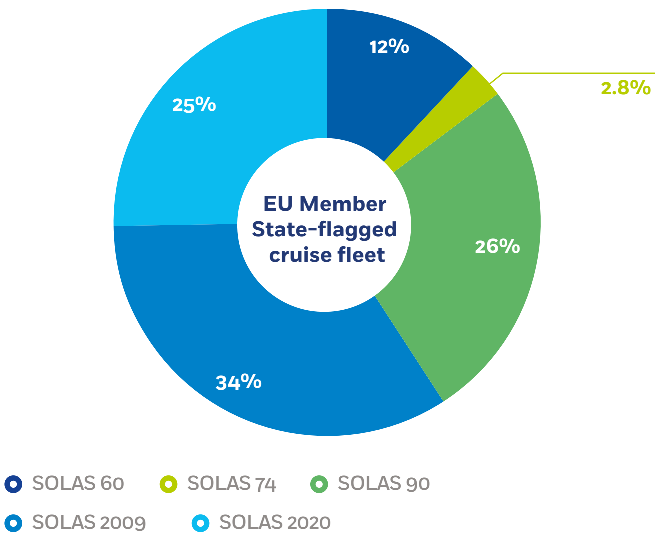


Source: EMSA services.

In 2023, the average age of EU Member States' passenger ships was 29 years, one year older than that of the world fleet (more information can be found in Section 2.3.4). It can also be seen that 26 % of the world fleet was built following the mandatory introduction of the probabilistic method to calculate damage stability (SOLAS 2009 and 2020 standards), and almost 40 % was constructed before SOLAS 90 (a standard developed following the *Herald of Free Enterprise* accident, in which 193 people lost their lives) became mandatory. SOLAS 90 introduced important upgrades in terms of residual stability and other factors to be considered, such as passengers crowding on one side, wind, etc. (Vavourakis, n.d.). This means that the fleet continues to have a very heterogenous safety level as far as damage stability is concerned.

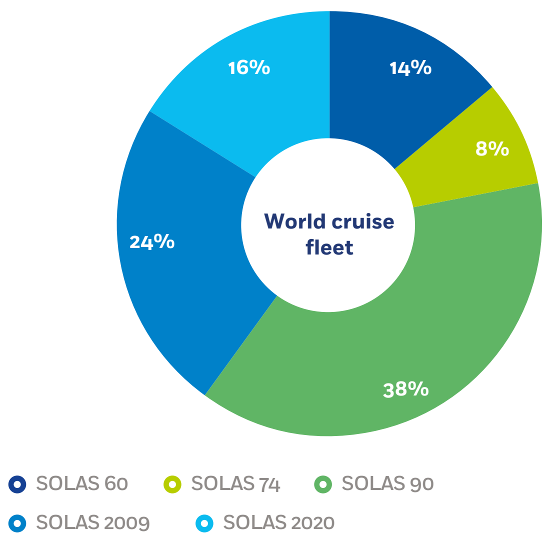
However, the distribution of damage stability standards is different within the cruise fleet, as shown in Figure 12 and Figure 13. Among EU Member State-flagged cruise ships, 59 % were built after the mandatory introduction of the probabilistic method (SOLAS 2009 and 2020 standards), while fewer than 15 % were constructed before SOLAS 90 became mandatory. These figures show not only the young age of the EU Member States' cruise fleet but also the investment made by the cruise companies in recent years. In fact, 40 % of the world cruise fleet was built within the 15 years prior to 2023.

Figure 12: Cruise ships under different SOLAS damage stability requirements based on date of build – EU Member State fleet in 2023.



Source: EMSA services.

Figure 13: Cruise ships under different SOLAS damage stability requirements based on date of build – world fleet in 2023.



Source: EMSA services.

It is also interesting to note the time it takes for a new requirement to have an impact and the quantification of such impacts. SOLAS 2009 was mandatory for 11 years, a period in which around 20 % of the current fleet was built. This period can be added to the years that it took for the new standard to be developed and approved. Therefore, in this case, it took around 20 years from the standard's development until the new and improved safety level had a positive effect on a limited part (20 %) of the world fleet, before being replaced by another standard, SOLAS 2020.

This can be seen as controversial, but it must be balanced against the huge economic investment of building a ship in general and a passenger ship in particular. These investments have a long-term perspective – around 25 years. Retrofitting a passenger ship to upgrade it to fulfil new damage stability requirements may imply, in some cases, heavy modifications in the ship's configuration, which can be very costly and can take a long time. It is, in many cases, not proportional to ask for such an upgrade to be made to ships that have recently been built or are in the middle of their life cycle. This slow renewal of the fleet can be seen by comparing the figures in this edition of Emsafe with those in the previous one.

A middle way was found when introducing other standards. One of the few cases in which new standards were retroactively applied related to fire safety elements on passenger ships. In 1992, the IMO decided to require that all passenger ships built according to SOLAS 60 standards be retrofitted in accordance with SOLAS 74, taking a phased-in approach. The additional elements required, which included sprinklers, structural fire protection and ventilation improvements, among many others, had to be upgraded, following a sequential timeline, by 2010 at the latest. This implied, in practice, that passenger ships that were 30 years old had to be either upgraded in terms of their safety level or phased out. By the current point in time, all SOLAS 60 passenger ships, i.e. 23 % of the fleet in 2023, should have been upgraded (9).

A conclusion that could be taken from this brief analysis is that, on many occasions, the increase in the safety level, if not accompanied by appropriate phase-out measures and financial support for fleet renewal in cases of passenger routes essential for public transport, can provoke an effect that is opposite to the one intended.

This is particularly true in those cases in which the new requirements imply a significant investment. The operational life of the ship is often extended to avoid the financial investment associated with the new requirements.

The grandfather clause is a necessary practice when used for its original purpose: to allow existing ships that comply with previous applicable rules within a certain market to continue operating without the obligation of adapting to new costly requirements. However, this purpose can be distorted in certain instances. For example, the EU's domestic passenger ship legislation was drafted such in a way that domestic ships built before 1998 could continue operating without major adaptations to the new rules, to avoid making them economically unviable. However, it was found during the EMSA RO inspections that some passenger ships built before 1998 were transferred from international to EU domestic traffic at a moment when costly retrofitting in accordance with international legislation was due, for example upgrades to the fire safety standards of SOLAS 60 ships.

In the same context, during the preparation of the EMSA visits to Member States to verify the implementation of Directive 2009/45/EC (10), it became noticeable that there were cases of domestic ships of non-EU countries (such as Japan, South Korea or Türkiye) that were flagged by EUMember States and introduced in the EU domestic fleet after 1 July 1998. The ships were, in general, not upgraded to the standards for new ships when certified under an EU flag, despite having never traded either internationally under SOLAS or as domestic passenger ships in the EU under Directive 2009/45/EC before that date. This means that these ships, newly introduced into the domestic passenger fleet, are currently lowering the safety level of the EU fleet. EMSA has initiated a discussion with the Commission and EU Member States, in various forums, to try to rectify this.

The grandfather clause acted as a refuge for old ships that could not trade internationally due to their safety standards, instead of being used for its original purpose, which was the recognition of the rights of existing ships operating in the domestic market before 1998. The recently amendments to Directive 2003/25/EC (11) also aim to avoid such misuse of the grandfather clause.

1.3.1.4 EU research and development projects

The EU has a permanent research and development programme, the name of which is updated every seven years to coincide with the EU budgetary cycle. The programme for the 2020–2027 period is called Horizon Europe. It covers all types of activities and sectors, including maritime safety. Although most of these projects have a more academic or technology-development perspective, there are some with a more pragmatic approach in terms of proposals to amend maritime safety legislation. They are usually formed by several partners, including industry, academia and even, in some cases, maritime authorities. Within this group, the list in Annex 3 includes those that could potentially impact some key areas in the development of ship safety standards.

1.3.2 International rules

As shipping is inherently international, its safety is regulated in the first instance by an international layer. The IMO is the dedicated UN agency that sets the main safety, security and environmental standards for shipping at the global level. The IMO basically provides a framework under which states can meet and cooperate to agree on technical matters affecting international maritime trade.

While all EU Member States are members of the IMO, the Commission has observer status there as an intergovernmental organisation. EMSA contributes to the IMO as part of the Commission delegation and provides technical input on specific topics with a view to facilitating cooperation and amending the relevant conventions where appropriate. The main safety convention at the international level is SOLAS, which came into being in its first version following the *Titanic* disaster in 1912.

9 EMSA has been carrying out inspections to verify that these retroactive requirements have been implemented. The results have shown that on many occasions this is not the case. For more information, see Section 2.5.

10 Directive 2009/45/EC of the European Parliament and of the Council of 6 May 2009 on safety rules and standards for passenger ships (OJ L 163, 25.6.2009, p. 1, ELI: http://data.europa.eu/eli/dir/2009/45/oj).

11 Directive 2003/25/EC of the European Parliament and of the Council of 14 April 2003 on specific stability requirements for ro-ro passenger ships (OJ L 123, 17.5.2003, p. 22, ELI: http://data.europa.eu/eli/dir/2003/25/oj).

EU Member States and the Commission participate in the main committees that are responsible for the technical discussions at the IMO on the adoption of relevant legislative measures and amendments to international conventions. In particular, all Member States take part in the Maritime Safety Committee (MSC), the functions of which include: ... aids to navigation, construction and equipment of vessels, manning from a safety standpoint, rules for the prevention of collisions, handling of dangerous cargoes, maritime safety procedures and requirements, hydrographic information, log-books and navigational records, marine casualty investigations, salvage and rescue and any other matters directly affecting maritime safety (IMO, n.d.b).

The International Labour Organization (ILO) establishes standards complementing those of the IMO regarding the human element. In particular, the MLC, covering minimum working and living rights, is one of the pillars of the international regulatory regime for quality shipping.

The working method of the MSC and its subsidiary bodies requires the human factor to be considered whenever new requirements are developed and existing requirements are reviewed that should be demonstrated by adherence to the 'Checklist for considering and addressing the human element' in Annex 5 to IMO MSC-MEPC.1/Circ.5/Rev.5 ([12]).

The instruments developed by the IMO play a vital role in the implementation of the provisions of the UN Convention on the Law of the Sea (UNCLOS), the main framework convention governing the use of the oceans and their resources.

The principal international conventions relating to maritime safety are described in Table 1, along with the domain to which they refer, their general application and exceptions.

Table 1: List of the main international conventions relating to maritime safety.

Regulation	Safety domain	Application	Exceptions
International Convention for the Safety of Life at Sea (SOLAS)	Construction, outfitting and operation, including fire safety, life-saving appliances, radio communications, safety of navigation, carriage of cargoes.	Ships engaged in international voyages (Chapter V on navigation also applies to domestic voyages).	• Cargo ships < 500 GT. • Ships not propelled by mechanical means. • Wooden ships of primitive build. • Pleasure yachts not engaged in trade. • Fishing vessels. • Warships.
Maritime Labour Convention (MLC)	Safety of people on board.	All seafarers and all ships.	• Ships engaged in fishing or in similar pursuits and ships of traditional build. • Warships or naval auxiliaries.
International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW)	Qualification of seafarers.	Seafarers on seagoing merchant ships.	
Convention on the International Regulations for Preventing Collisions at Sea (COLREG)	Safety of navigation.	All ships at sea and in all waterways connected to the sea.	

12 https://www.imu.edu.in/imunew/uploads/files/I-ESKIMO2024/MethodOfWork.pdf

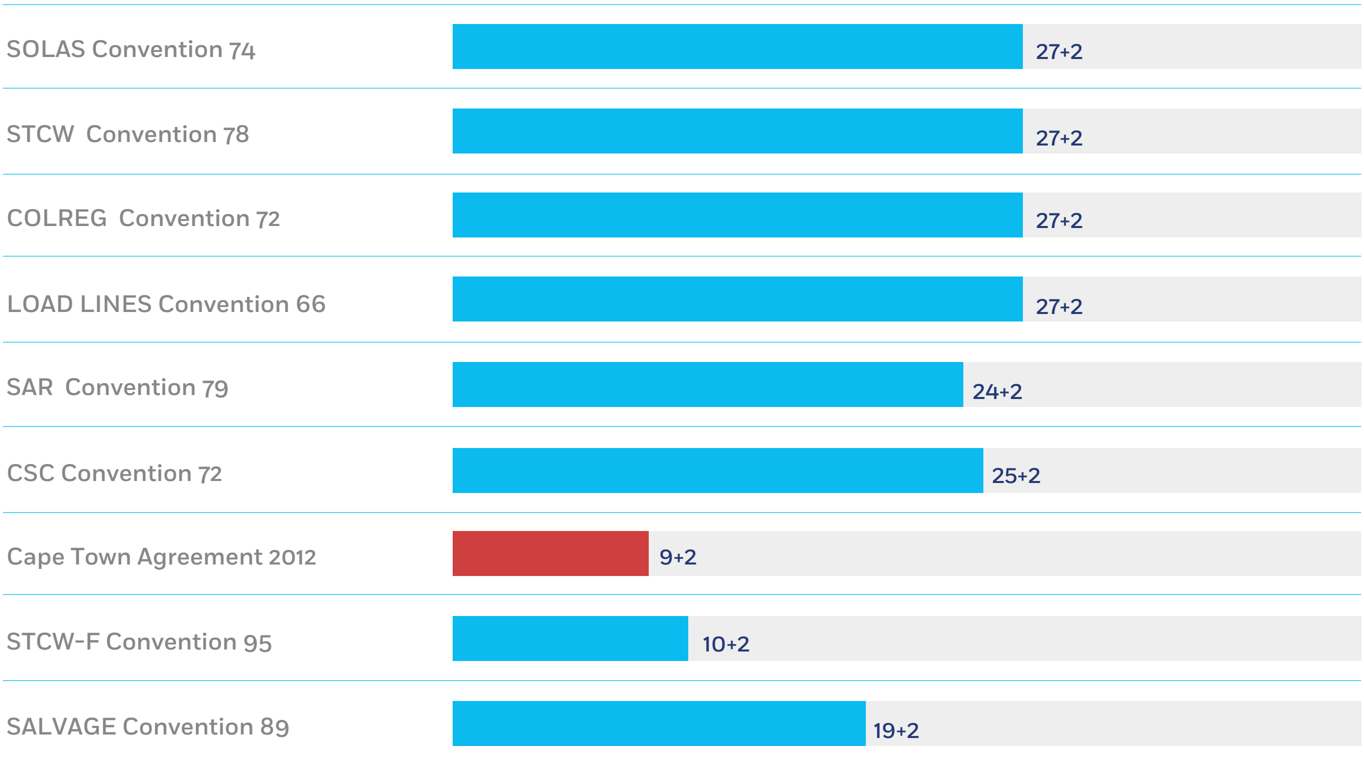
Regulation	Safety domain	Application	Exceptions
International Convention on Load Lines	Construction: structure, subdivisions and stability.	Ships engaged in international voyages.	• New ships < 24 m in length. • Existing ships < 150 GT. • Pleasure craft not engaged in trade. • Fishing vessels. • Warships.
International Convention on Maritime Search and Rescue (SAR Convention)	Safety of people in distress.	SAR services provided by parties to the convention.	
International Convention for Safe Containers	Cargo.	New and existing containers used in international transport.	Containers specially designed for air transport.
Torremolinos International Convention for the Safety of Fishing Vessels – Cape Town Agreement (not in force)	Construction and outfitting, including life-saving appliances and radio communication.	New seagoing fishing vessels > 24 m in length.	Vessels exclusively used in sport or recreation, processing of fish or other living resources of the sea, research and training or fish carriers.
International Convention on Standards of Training, Certification and Watchkeeping for Fishing Vessel Personnel (STCW-F)	Qualification of fishing personnel.	Fishing personnel on board fishing vessels of 24 m in length and above.	
International Convention on Salvage	Safety of people in distress.	Whenever judicial or arbitral proceedings relating to matters within the convention are brought in a state party.	• Fixed or floating platforms or mobile offshore units in expedition. • Warships or other vessels owned or operated by a state engaged in non-commercial voyages.
International Convention on Tonnage Measurement of Ships	Basis for manning regulations, safety rules and registration fees.	All ships built on or after 18 July 1982 – the date of entry into force.	

Of the above conventions, the Torremolinos International Convention for the Safety of Fishing Vessels, implemented through the Cape Town Agreement, has not yet entered into force, despite the significant growth in the accession rate, with 12 more states acceding in the five years between 2019 and 2023 compared to the period between 2012 and 2019. The minimum number of ratifications necessary for a convention to enter into force is established in the convention's articles, and the EU Member States can have an important role in this process.

For example, for the STCW-F only 15 ratifications were required, 12 of which were by EU Member States.

Figure 14 shows the level of ratification of the main conventions by the EU and EFTA coastal Member States. The only change with respect to the previous edition of this report is the ratification by Portugal of the Cape Town Agreement.

Figure 14: Number of EU and EFTA coastal Member States ratifying the main IMO safety conventions.



Source: EMSA based on IMO data.

Worldwide, the main safety convention – SOLAS 74 – has been contracted by 168 states with combined merchant fleets covering approximately 98.91 % of the world's merchant tonnage. A similar percentage is covered by two other essential safety conventions: COLREG and the International Convention on Load Lines.

A ship must comply with the requirements in the international conventions ratified by its flag state. When a ship changes flag to a state that has not ratified the same conventions, it is no longer required to adhere to them under the principle that international obligations apply only to the signatories.

1.3.3 EU legislation

The EU's approach to maritime legislation aligns with international obligations negotiated at the IMO while adding value through harmonised implementation, effective enforcement, cooperation among Member States and the ability to address the latter's specific concerns. This approach ultimately contributes to a safer and more environmentally responsible maritime industry within the EU, fostering a level playing field and encouraging sustainable practices across the board.

The EU, on certain occasions, adds safety requirements for those ships flagged in EU Member States (e.g. marine equipment, ROs, SMSs) or operating to/from EU ports irrespective of the flag (e.g. damage stability of ro-pax, passenger registration requirements, a special survey regime for ro-pax and HSC). In addition, the EU has enforced legislation with respect to fishing vessels by making the IMO's Torremolinos Convention (which is not in force at the international level) mandatory and has developed safety legislation applicable to domestic passenger ships, which are, generally, outside the scope of international instruments.

The Committee on Safe Seas and the Prevention of Pollution from Ships assists the Commission in the implementation of maritime legislation. This committee, which includes representatives of the EU Member States and is chaired by the Commission, deals with wide-ranging aspects covered by EU maritime legislation, including ship safety, marine equipment and the qualification and certification of seafarers, along with other issues. Its decisions have a significant impact on safety, including the recognition of classification societies and the acceptance of exemptions for domestic passenger ships.

The EU has competences or powers conferred on it by the treaties on different levels depending on the topic. In general, for transport policy matters, there are shared competences between the Member States and the EU, which means that the Member States can only act independently if the EU has chosen not to, which is the case for passenger ship safety. Depending on the specific topic, the EU may have supporting competences, which means that it can only support, coordinate or supplement the actions of the Member States in those areas.

The EU legislative framework is explained throughout the report for each safety topic, and is summarised in Annex 1: EU policies and their focus.

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1.3.4 National legislation

In general, national legislation covers all the gaps not already covered by the other regulatory layers. These include domestic cargo ships, fishing vessels of less than 24 metres in length and sailing ships.

1.3.5 Guidelines and best practices

Apart from international, EU and national legislation there are other forms of standards and best practices, often developed by industry associations, that aim at covering any regulatory gaps. These are often the result of collaborations between multiple stakeholders, such as manufacturers, shipyards, classification societies, shipowners and operators, and represent efforts towards harmonisation when international regulations are not yet in force or are not designed for prescriptive implementation. To a large extent, they also serve as a basis for the development of such regulations.

For example, several guidelines are being developed for the use of alternative fuels and powering technologies for which regulations are still under development, such as the *Handbook for Hydrogen-fuelled Vessels* ([13]) published by Det Norske Veritas (DNV, formerly DNV GL), a result of the joint industry project MarHySafe. To address the safety of transportation of electric vehicles on board, the industry has also been active in providing guidance, such as in the 'Best practices for the transport of electric vehicles on board vessels' ([14]), the 'Guidelines for the safe transportation of electric vehicles' ([15]), the 'Common guidance on the presentation and loading of vehicles' ([16]) and others.

EMSA guidance documents would also fit into this category. These are developed by EMSA by bringing together the knowledge of the industry and the needs of the regulators. Examples of such work include the EMSA guidance on the carriage of alternative fuelled vehicles and the EMSA guidance on the safety of battery energy storage systems, which will be mentioned in the sections ahead.

13 https://ww2.eagle.org/content/dam/eagle/advisories-and-debriefs/best-practices-transport-electric-vehicles-board-vessels.pdf.

14 https://www.dnv.com/maritime/publications/handbook-for-hydrogen-fuelled-vessels-download.

15 https://www.classnk.or.jp/hp/pdf/activities/statutory/ev_carriage_safety/gl_ev_carriage_safety_e202412.pdf.

16 https://www.ics-shipping.org/wp-content/uploads/2024/03/Common-Guidance-on-the-Presentation-and-Loading-of-Vehicles.pdf.

1.3.6 Cycles of visits monitoring the implementation of EU legislation

The EU has several pieces of legislation dealing with the essential elements of maritime safety and the prevention of pollution, which must be enforced. The Commission is entrusted with monitoring the implementation of legislation and has delegated to EMSA the task of visiting Member States to report on their degree of compliance with these legal acts. On this basis, the Commission can take the appropriate decisions to amend the legislation or initiate specific actions to ensure that Member States fulfil their obligations. Cycles of visits to Member States, at the request of the Commission, have become one of the main tasks of EMSA since it was founded in 2002. Through these cycles, valuable information has been collected on the implementation of the body of EU maritime law, and best practices to support Member State administrations have been developed.

This section presents an overview of how EMSA organises its visits and includes the underlying objectives, the methodology and the work carried out at the end of each of the cycles to analyse the degree of implementation of the respective pieces of legislation and to assess the effectiveness and efficiency of the related measures adopted by the Member States. Some aspects that have emerged from this activity over the years are presented at the end of the section.

1.3.6.1 The visit methodology

The main objective of the visits is to assess the effective implementation of EU maritime legislation by Member States. The visits also offer an excellent opportunity to measure the extent to which the application of the requirements, as set out by the relevant legislation, is harmonised in all Member States, thus ensuring a level playing field throughout the EU.

Visits to Member States also offer specific added value in terms of building up trust and confidence at the EU level in the uniformity and effectiveness of the implementation of EU law.

Each visit not only serves to identify non-compliances, for which the Member States must provide corrective measures, but also offers direct feedback to the Member State and gives input to improve the implementation of the requirements of EU law. At the EU level, the horizontal findings arising from the cycles of visits to the Member States serve to analyse areas of common concern in legislative implementation, along with identifying best practices and lessons learnt on the effectiveness and cost-efficiency of the measures in place. As a direct consequence, the visits provide feedback to the policy cycle and help set the direction for the review and further development of related EU law.

The visit methodology requires that EMSA visits also provide added value for the Member States. The inclusion of EMSA technical experts in the visiting teams provides an immediate opportunity for the relevant officials of the Member States to have detailed technical discussions on various important aspects of the applicable legislation that is being addressed during the visit.

Finally, the results of the visits feed into EMSA's prioritisation of its own tasks, including assisting the Commission and the Member States, building capacity at the national level and providing guidance for further developments in relation to various areas and activities.

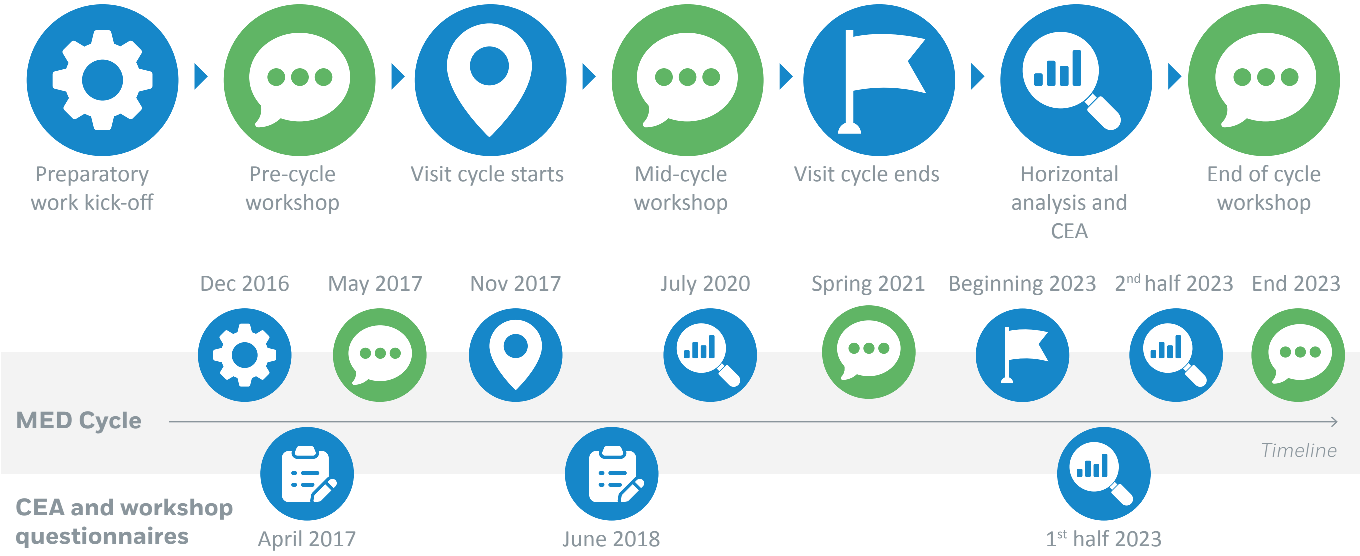
The start of a cycle

The visits to Member States are generally organised in cycles of four to five years and entail visits to all the EU and EFTA Member States to which the respective pieces of EU legislation apply.

The Commission is responsible for deciding which legal instrument should be the subject of a particular cycle.

This choice could be based on the need to assess the efficacy of a new piece of legislation in meeting its intended goals and objectives; the usefulness and/or the need to update older versions of EU legislation; or specific requests or concerns expressed by Member States or other stakeholders. Following the decision by the Commission to initiate a cycle of visits, EMSA organises an ad hoc pre-cycle workshop, which is attended by the Commission and delegates of the relevant Member States' competent authorities. In this pre-cycle workshop, the purpose, scope and objectives of the visit cycle are presented. All participants have the possibility to provide information and details that may be of assistance to the Commission and EMSA when carrying out the visits.

Figure 15: Example of a visit cycle timeline – MED visit cycle.

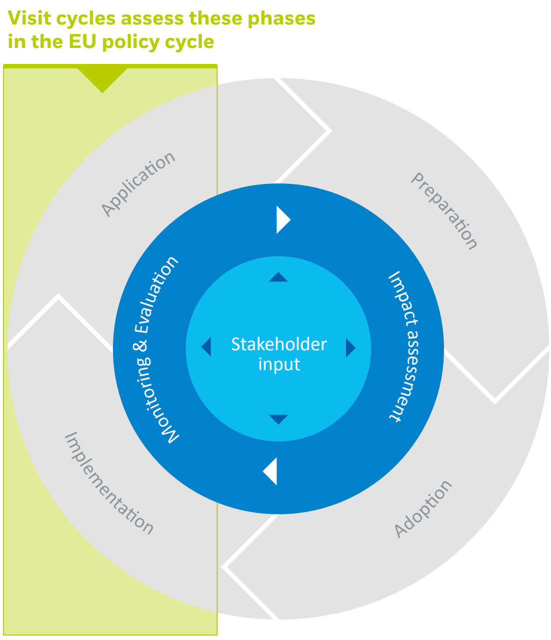


Source: EMSA services.

The process approach within the EU policy cycle

Prior to a cycle of visits, the relevant piece of legislation is analysed and its articles and requirements are sorted into logical processes. The resulting process breakdown structure provides a general overview of the logical sequence of activities that Member States must carry out when implementing the legislation. This facilitates the organisation of the findings that will be established during the visits and the understanding of how the legislation is implemented and enforced by each Member State.

Figure 16: The EU policy cycle.



Source: EMSA services.

Each process involves the compilation of specific requirements from EU law that translate into actions or duties related to each other. The piece of legislation in question is therefore organised by main areas of activity when it comes to implementing its mandate.

The process breakdown structure is framed within the EU policy cycle framework. The four phases that regulate the life cycle of all EU law, also referred to as the EU policy cycle, are preparation, adoption, implementation and application

Preparation and adoption are the two initial phases through which the legislation becomes alive. They are not relevant for the cycle of visits carried out by EMSA. Indeed, the purpose of a cycle of visits is not to evaluate the legislation, but rather to assess the extent to which Member States have correctly and efficiently implemented it. Therefore, during a cycle of visits, the aim is to assess the compliance, effectiveness and cost-efficiency of the measures put in place by the Member States during the subsequent implementation and application phases of the EU policy cycle, along with the underlying monitoring activity.

Specifically, these phases can be considered as the overarching processes defined as follows.

- **Implementation.** The process by which Member States give force to a specific piece of EU law by adopting appropriate implementation measures into their national legislation and providing the means to achieve the legislative mandate.
- **Application.** The task of enacting the relevant mechanisms and legislative framework for the specific purpose of meeting the requirements of the legislation.
- **Monitoring and evaluation.** Systematic tracking of progress and information relating to the main evaluation criteria – including relevance, coherence,

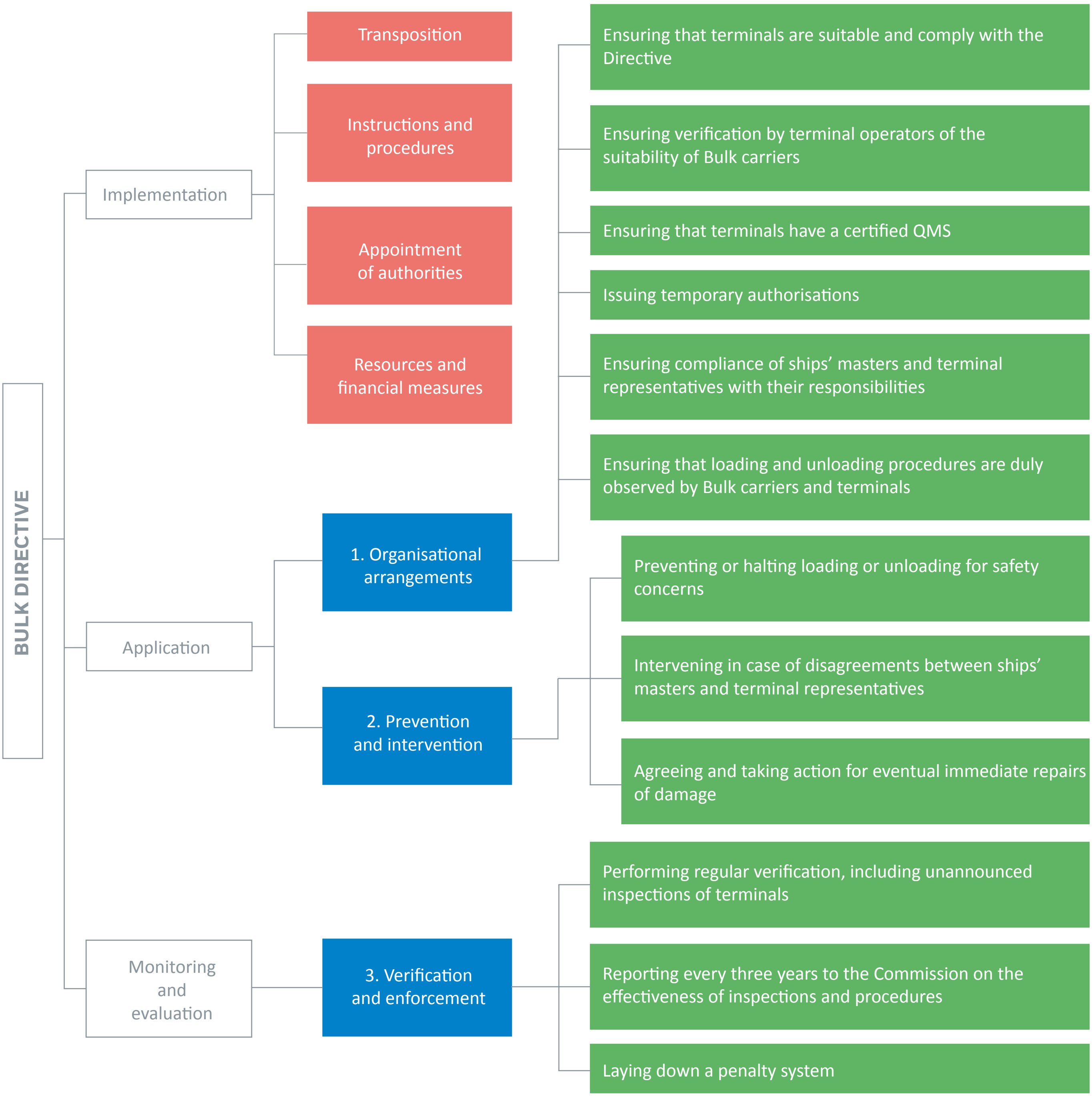
EU added value, effectiveness and efficiency – during the implementation and application phases, for future improvements of the EU law under assessment.

This process analysis takes the implementation and the application phases as the basis for the development of subsequent sub-processes, also called core processes, that characterise every piece of legislation.

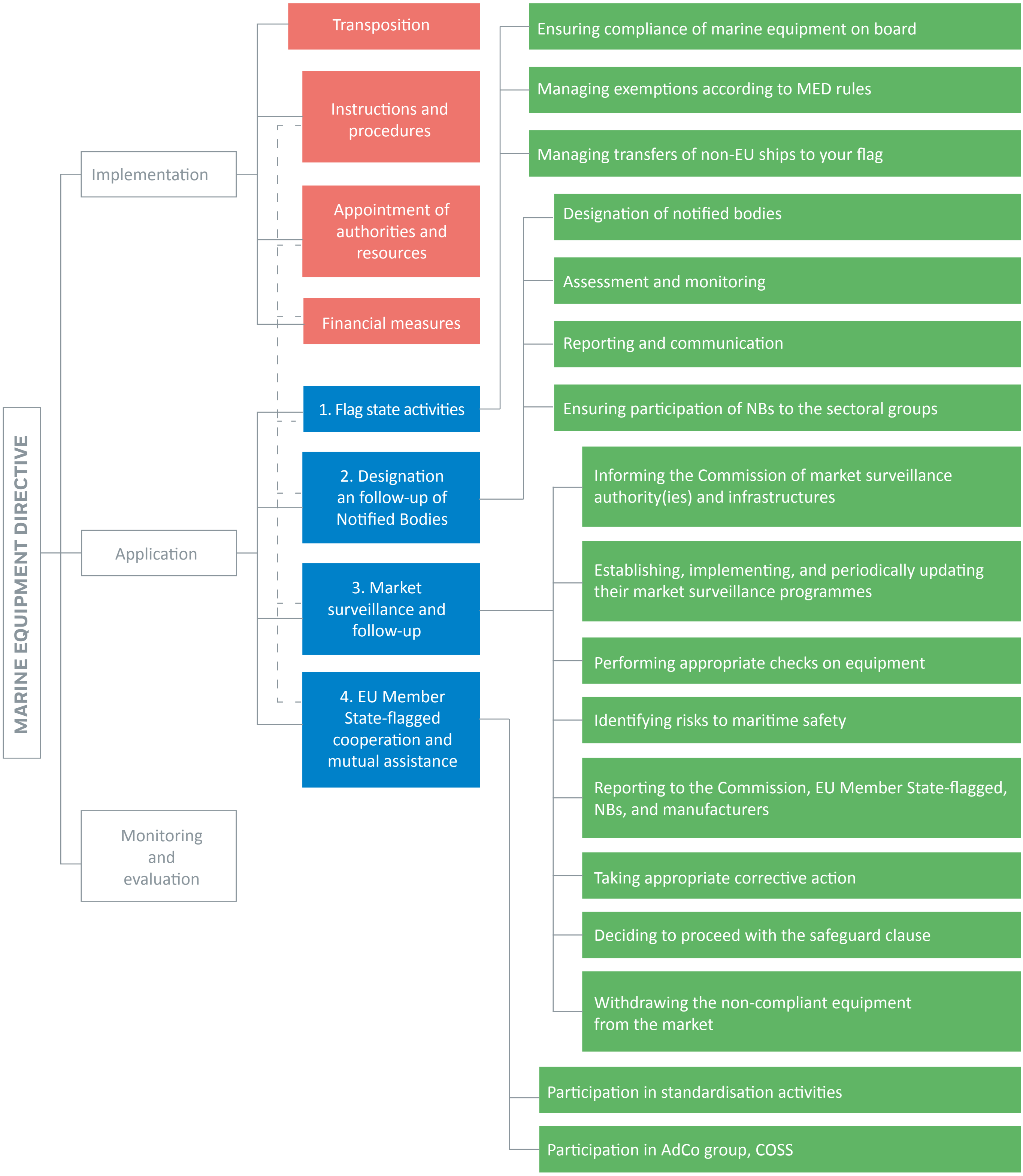
Each process involves a set of specific requirements that specify correlated actions and duties.

Below are some examples of process breakdown structures as applied to the MED and the Bulk Directive ([17]).

Figure 17: Examples of block diagrams with the process breakdown structure used for the MED and the Bulk Directive.



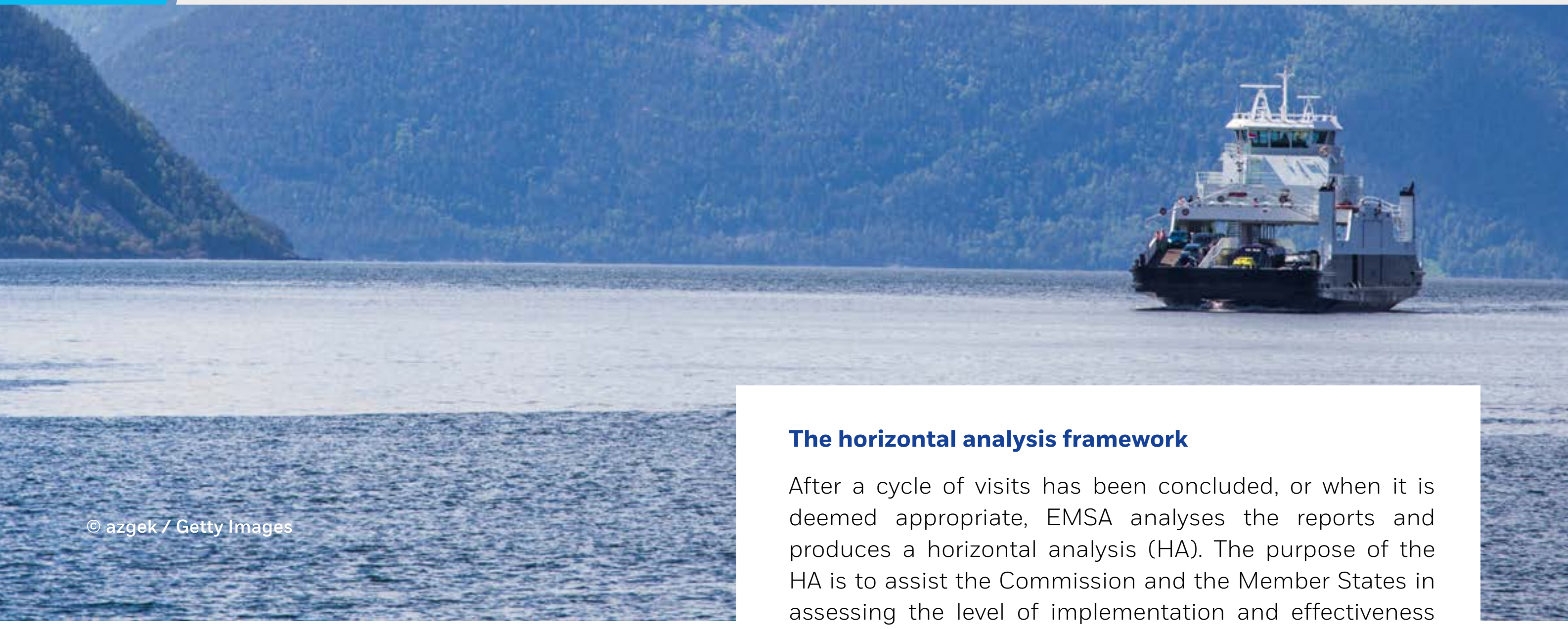
17 Directive 2001/96/EC of the European Parliament and of the Council of 4 December 2001 establishing harmonised requirements and procedures for the safe loading and unloading of bulk carriers (OJ L 13, 16.1.2002, p. 9, ELI: http://data.europa.eu/eli/dir/2001/96/oj).



NB: The core application processes are in blue, the preliminary implementation processes in orange and the activities in green.
Source: EMSA services.

Organisation of visits to Member States

Based on the initial request for a cycle of visits, its defined scope, the outcome of the pre-cycle workshop and the process approach, EMSA develops a methodology for the cycle of visits, which is sent to the Commission for approval. Questionnaires, visit plans, the reporting format, etc. are all prepared prior to the start of the cycle of visits.



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Preparatory work for each individual visit usually starts around four to six months in advance, with EMSA informally contacting the relevant representative of the Member State to agree on the dates for the visit and to discuss other practical arrangements.

Generally, the visits are performed within a period of four to five working days. A visit includes a document review, the verification of facilities, staff interviews and the examination of sample files. While the approach may vary according to the piece of legislation, a top-down approach is generally applied throughout. A visit begins with meetings at the central competent authority and then proceeds to designated authorities at the national, regional and local levels, and to other relevant institutions. While remote work is prioritised to minimise on-the-spot visits, field work is key to understanding how procedures and processes are translated into effective working practices. Visits to ships, terminals, ports or equipment manufacturers and the shadowing of notified bodies or Member States' officers while performing their monitoring duties are essential components of every visit.

Following each visit, the EMSA team prepares a comprehensive report reflecting the outcome of the visit, including a detailed description of the situation as encountered. The report is sent to the Commission and to the Member State visited.

Problematic aspects are reported as findings, categorised as either shortcomings ([18]) or observations ([19]). The report includes all relevant details of the findings and the related documentary evidence.

18 Shortcomings are defined in EMSA's methodology as 'Full or partial failures to implement, or inadequate implementation of, a particular requirement of the Directive'.

19 Observations are defined in EMSA's methodology as 'Remarks about something identified in relation to the implementation of the Directive that may lead to shortcomings if not addressed'.

The horizontal analysis framework

After a cycle of visits has been concluded, or when it is deemed appropriate, EMSA analyses the reports and produces a horizontal analysis (HA). The purpose of the HA is to assist the Commission and the Member States in assessing the level of implementation and effectiveness of related measures throughout the EU. The HA highlights those elements of a piece of legislation that do not appear to work efficiently and the difficulties of implementation by Member States due to their particular circumstances. It also highlights good practices and lessons learnt on the effectiveness and cost-efficiency of the measures in place that could be shared among Member States. HAs thereby contribute to the continuous improvement of European maritime safety.

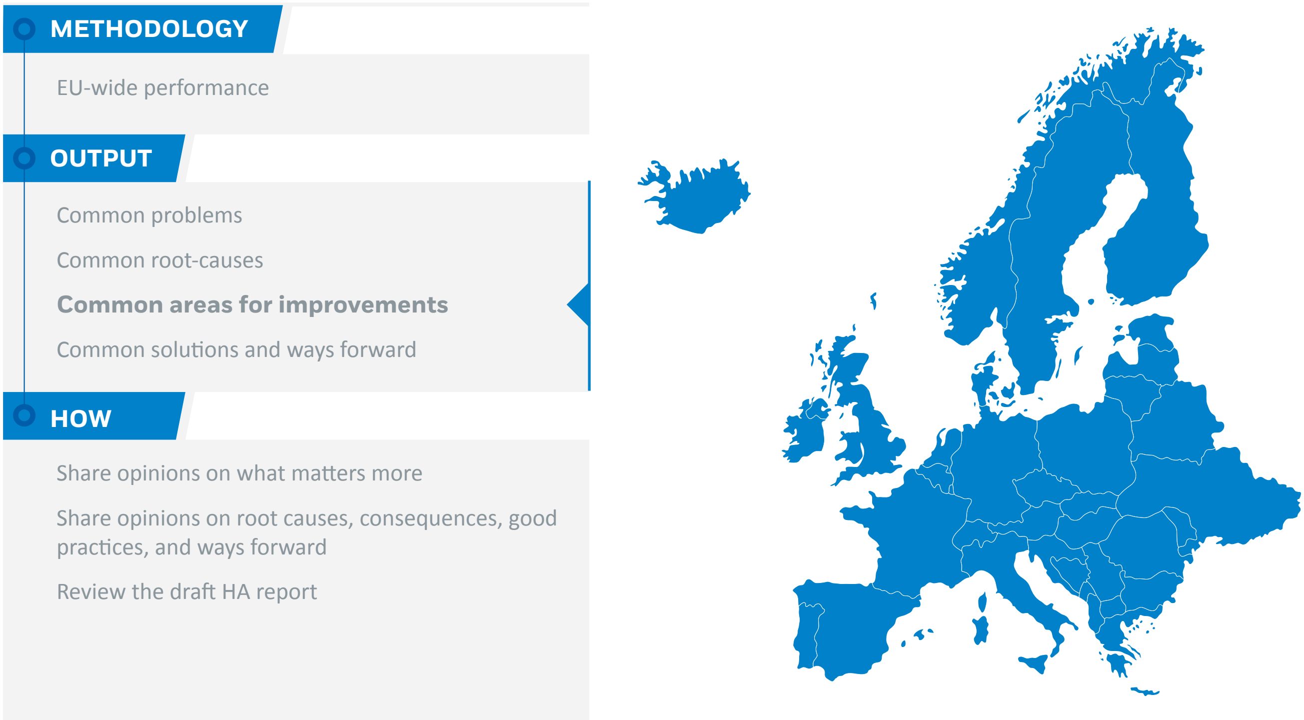
The HA does not assess the performance of individual Member States, but looks at the horizontal EU-wide dimension, based on issues and practices identified across all the Member States visited. Therefore, HAs help to establish a level playing field and to explore opportunities for further harmonisation.

An HA is an adapted risk assessment analysis to assess how an EU law is effectively implemented in the EU. EMSA follows an assessment matrix approach, whereby, as in a SWOT (strengths, weaknesses, opportunities and threats) matrix, the findings and issues are grouped into four categories: horizontal problematic issues (weaknesses); horizontal successful implementation areas (strengths); good practices; and ways forward.

A way forward is intended as a measure proposed or recommended to possibly consolidate strengths, minimise weaknesses or problematic areas and, generally, to improve implementation. The idea is that the strengths (elements that are well implemented across the EU and work well) are often witnessed through good practices established in some Member States that can support other states in addressing problematic areas (weaknesses or areas to improve). Each group of similar findings is then analysed with perspective, trying to identify possible root causes and potential consequences to highlight possible preventive and mitigating actions and, subsequently, ways forward.

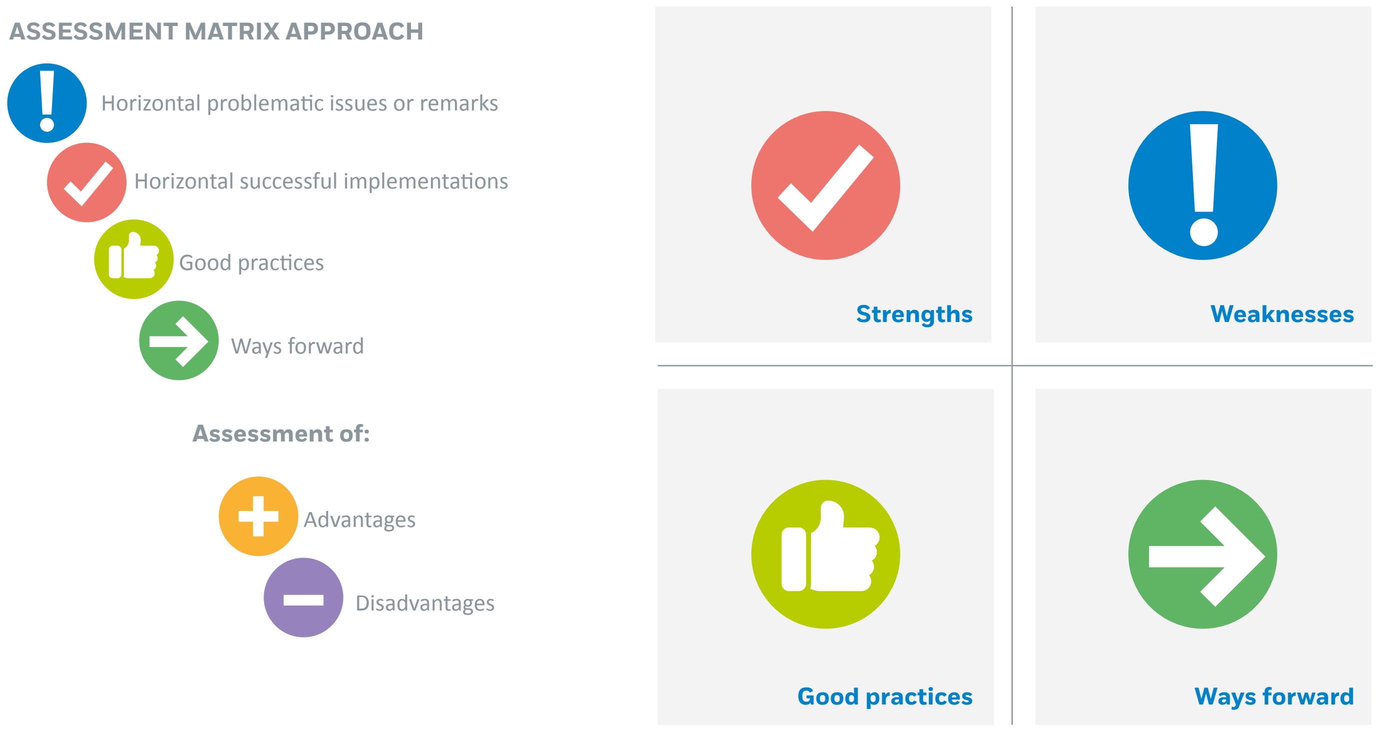
In summary, HAs are aimed at consolidating strengths, minimising weaknesses, making improvements by sharing examples of good practices taken from other Member States and presenting ways forward recommended by EMSA.

Figure 18: HAs look at the EU-wide performance of the implementation of a directive.



Source: EMSA services.

Figure 19: The assessment matrix used for HA.



Source: EMSA services.

Cost-effectiveness analysis

As an integral part of the HA, EMSA has developed a cost-effectiveness analysis (CEA) methodology based on the intervention logic applied to the initial phases of the policy cycle, for instance during the impact assessment work that precedes the formulation and adoption of a directive. The CEA model is a tool used to identify and assess the main cost elements put in place by Member States when implementing and enforcing EU law. The CEA does not evaluate the directive itself but the way in which the Member States have adapted their own national frameworks to implement its requirements. Therefore, the CEA provides a comparative analysis of the main outputs and associated cost indicators when it comes to implementing and enforcing a piece of legislation.

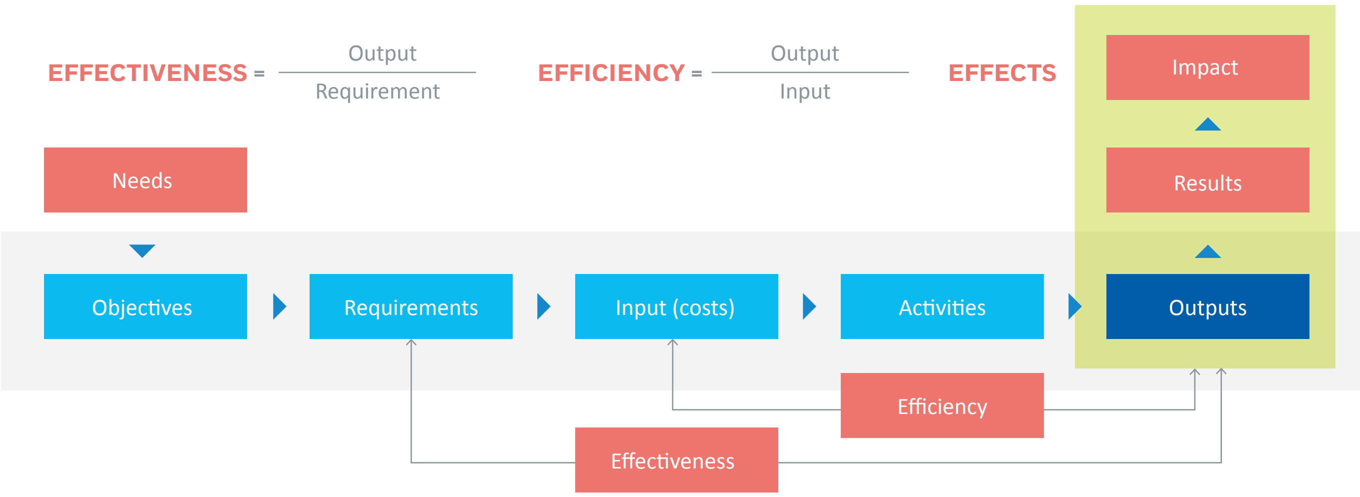
The word 'effectiveness' refers to the extent to which the different objectives and goals of a piece of legislation are met – the more goals achieved, the higher the effectiveness. When implementing and enforcing a piece of legislation, effectiveness is generally linked to the fulfilment of a set of requirements laid down in the legislation.

The word 'efficiency' relates to the way in which inputs (resources) are converted into outputs (results), thus characterising the transformation efficiency. To achieve the EU law's objectives (effectiveness), Member States need to comply with a number of minimum implementation and enforcement obligations, which involve the investment of their own resources.

The CEA model identifies several variables that may describe and differentiate the national institutional and operational environment and may feature in relevant cost-effectiveness ratios able to describe the extent to which a Member State is effective and efficient in implementing the requirements of each piece of legislation in comparison with other Member States.

The effects of the implementation, at the level of regulatory compliance, are the units of output that must comply with the requirements (measure of effectiveness). The effects, at a higher societal level, refer more to the impact that the piece of legislation should have in meeting the initial needs (measure of impact, e.g. reduce the risk of future marine casualties, enhance safety at sea, prevent maritime pollution).

Figure 20: The CEA model – The 'intervention logic' of a directive.



Source: EMSA services.

The conclusion of a cycle

Once the HA of a cycle of visits has been completed, a workshop is organised to present the results of the HA report while providing Member States with a forum in which to share both lessons learnt and best practices and to identify future training needs.

The possibility of an additional workshop following a mid-cycle HA is often considered on a case-by-case basis with a view to eliciting the benefits of the Member States sharing best practices.

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The most relevant results of the visit cycles

Fourteen HAs have been carried out to date, starting in 2016, aggregating some 2 416 findings and consolidating and evaluating information described in 256 reports of visits to EU and EFTA Member States in relation to the following directives:

- Directive 2014/90/EU on marine equipment (MED – end of first cycle, mid second cycle and end of second cycle);
- Directive 98/41/EC on passenger registration (PAX Directive) ([20]);
- Directive 2002/59/EC establishing a vessel traffic monitoring and information system, including places of refuge (VTMIS Directive) ([21]);
- Directive 2009/16/EC on PSC (PSC Directive – end of second cycle, mid third cycle and end of third cycle) ([22]);
- Directive 2009/18/EC on maritime accident investigation (AI Directive) ([23]);
- Directive (EU) 2022/993 on the training of seafarers, incorporating the STCW Convention into EU law (STCW Directive – mid cycle and end of cycle) ([24]);
- Directive 2001/96/EC on the safety of bulk carrier loading and unloading (Bulk Directive, mid cycle);
- Directive 2016/802 on sulphur content in marine fuels (Sulphur Directive, mid cycle and end of cycle) ([25]).

Another cycle of visits, relating to three directives on passenger ship safety, started in 2020 and is around its mid-cycle stage. Table 2 summarises the information on the abovementioned visit cycles.

20 Council Directive 98/41/EC of 18 June 1998 on the registration of persons sailing on board passenger ships operating to or from ports of the Member States of the Community (OJ L 188, 2.7.1998, p. 35, ELI: http://data.europa.eu/eli/dir/1998/41/oj).

21 Directive 2002/59/EC of the European Parliament and of the Council of 27 June 2002 establishing a Community vessel traffic monitoring and information system and repealing Council Directive 93/75/EEC (OJ L 208, 5.8.2002, p. 10, ELI: http://data.europa.eu/eli/dir/2002/59/oj).

22 Directive 2009/16/EC of the European Parliament and of the Council of 23 April 2009 on port state control (OJ L 131, 28.5.2009, p. 57, ELI: http://data.europa.eu/eli/dir/2009/16/oj).

23 Directive 2009/18/EC of the European Parliament and of the Council of 23 April 2009 establishing the fundamental principles governing the investigation of accidents in the maritime transport sector and amending Council Directive 1999/35/EC and Directive 2002/59/EC of the European Parliament and of the Council (OJ L 131, 28.5.2009, p. 114, ELI: http://data.europa.eu/eli/dir/2009/18/oj).

24 Directive (EU) 2022/993 of the European Parliament and of the Council of 8 June 2022 on the minimum level of training of seafarers (codification) (OJ L 169, 27.6.2022, p. 45, ELI: http://data.europa.eu/eli/dir/2022/993/oj).

25 Directive (EU) 2016/802 of the European Parliament and of the Council of 11 May 2016 relating to a reduction in the sulphur content of certain liquid fuels (OJ L 132, 21.5.2016, p. 58, ELI: http://data.europa.eu/eli/dir/2016/802/oj).

Table 2: Summary information on the visit cycles.

Visit cycle of directive	Period of visits	Status of the cycle	HA report issued on (date)	Visits to Member States [26]	Number of findings
MED (first cycle)	2010–2014	Completed	19 April 2016 (end-of-cycle report)	12	30
PAX Directive	2012–2015	Completed	20 May 2016 (mid-cycle report)	11	73
VTMIS Directive	2009–2016	Completed	21 March 2017 (end-of-cycle report)	49 [27]	390
PSC Directive (second cycle)	2012–2016	Completed	31 August 2017 (end-of-cycle report)	25	259
AI Directive	2012–2017	Completed	26 March 2018 (end-of-cycle report)	30	390
STCW Directive	2014–2021	Completed	o 19 September 2018 (mid-cycle report) o 21 April 2022 (end-of-cycle report)	28 [28]	492 [29]
PSC Directive (third cycle)	2017–2022	Completed	o 28 November 2019 (mid-cycle report) o 15 December 2022 (end-of-cycle report)	24	160
Sulphur Directive	2016–2022	Completed	o 25 June 2019 (mid-cycle report) o 25 May 2023 (end-of-cycle report)	25	232
MED (second cycle)	2017–2023	Completed	o 24 July 2020 (mid-cycle report) o 10 September 2024 (end-of-cycle report) / 29 /192	29	192
Bulk Directive	2018–2024	Completed	o 25 February 2021 (mid-cycle report) o 13 December 2024 (end-of-cycle report) / 23 / 214	23	198
Passenger ship safety directives	2020–2027	Ongoing	o Mid-cycle HA report planned for 2025 o 2 October 2025 (mid-cycle report) / 14 / 273	13	-

Source: EMSA services.

26 At the time of the HA report, including EU Member States, Iceland and Norway (EFTA states).

27 Some Member States were visited twice.

28 Covering 28 maritime administrations and 55 maritime education and training institutions.

29 Including those established in relation to the relevant maritime administration and those in relation to the maritime education and training institutions.

The HA reports are available to Member States' competent authorities on the EMSA e-Portal. The following subsections describe some of the relevant elements of the cycles of visits, including common areas such as organisational and cooperation aspects; training matters relating to the implementation of the various directives; issues relating to inspection and monitoring activities; enforcement; and some examples of good practices in terms of cost-effectiveness. There will not be an analysis of the implementation of each directive, but rather a more transversal approach looking at issues that have emerged during these visit cycles.

Organisational and cooperation aspects

The implementation and application phases are important segments in the life cycle of every piece of EU legislation. It is in those phases that Member States invest resources, for instance to acquire new assets – such as information and communications technology systems, equipment and facilities – and/or possibly to recruit new staff. In other cases, existing assets may be reused and adapted to the new purposes, and staff engaged in other parts of the administration may be reallocated to the new tasks. The purpose is to correctly apply the legislation's requirements in an effective and efficient way.

A horizontal implementation area, common to many directives, refers to the ways Member States arrange their organisational structure and allocate the necessary resources, not only to comply with the legislation requirements but to do so in the best and most cost-effective way. It includes all the activities that a Member State must carry out to put in place an organisational framework ensuring that the requirements of the piece of legislation under scrutiny are fulfilled. In most cases, this presupposes the existence, or requires the establishment, of a national competent authority and related systems to ensure compliance by the national authorities and other stakeholders with their respective requirements and responsibilities.

Organisational benefits deriving from implementing EU directives

In general, the implementation of a directive allows Member States to set up a legal framework and is an opportunity for them to rethink their organisational structure. This is a common strength established in many of the visit cycles. New organisational set-ups are redesigned in a more effective way. All visit cycles highlighted that the organisational arrangements established by the Member States, following the implementation of new directives, improved the EU-wide maritime safety level. Many examples can be put forward; the following is a non-exhaustive list.

- The implementation of the VTMIS Directive has contributed greatly to the development of policies relating to places of refuge, identifying competent authorities dealing with cases of ships in need of assistance. In some Member States, the same directive was the trigger for the creation of national systems for monitoring dangerous or potentially polluting goods.

- The implementation of the AI Directive contributed to improvements in the investigation of very serious casualties, to the publication of accident reports within prescribed deadlines and to the submission of data to the European Marine Casualty Information Platform (EMCIP). Most of the Member States have set up legal frameworks and allocated resources for independent investigation bodies, providing them with the necessary investigative powers.

- The implementation of the Bulk Directive contributed to improvements in the safety of bulk cargo loading/unloading procedures and to awareness of the risks involved with such operations. Thanks to the directive's implementation, Member States identified all terminals and bulk carriers that fall under the scope of the directive and established systems for communication and the exchange of information between bulk carriers and terminals. The required terminal representatives have been appointed in almost all Member States, indicating a good level of overall terminal management structures – an important condition for the effective management of loading and unloading procedures. The enhanced communication between vessels and operators and the correct completion of the documented procedures were among the major benefits relating to the implementation of the directive by Member States.

- The implementation of the MED produced, for instance, an EU-wide improvement as regards the surveillance of the marine equipment market and manufacturers and how the notified bodies are actually acting on behalf of the EU Member States' administrations, which was almost negligible before its adoption. By and large, most Member States now have organisational structures in place to conduct proactive market surveillance campaigns to ensure that barriers are in place against substandard marine equipment that could jeopardise safety on board. Member States organised themselves to cater for active participation in many international cooperation projects and platforms for the market surveillance of marine equipment, such as the Administrative Cooperation Group for Market Surveillance, and systems such as the Community Rapid Information System and the Information and Communication System on Market Surveillance.

Harmonisation of procedures and cooperation among EU Member States

The maritime business is a global one, and safety cannot be dealt with in isolation. Therefore, all EU maritime safety directives contribute to reducing the risks in the maritime business.

When the requirements of the various directives are correctly implemented and enforced, Member States contribute to a safer maritime sector and avoid the risk of safety competition within the EU.

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Member States have established competent authorities that, albeit with different organisational set-ups, are adapted to the national administrative and organisational features and share the same ultimate objective of the various maritime safety directives. This harmonised approach has proved to be the best way to ensure a safer maritime sector in the EU.

To ensure a level playing field regarding compliance with EU directives, the Member States, in various contexts, have established harmonised procedures that enhance cooperation and communication among themselves and with all stakeholders. An interesting example is the establishment of harmonised communication procedures for marine equipment with all market operators (e.g. the notified bodies and manufacturers, through activities such as conformity assessments, market surveillance, etc.). This facilitates both the free movement of marine equipment within the EU market and cross-border cooperation among Member States, while at the same time ensuring a level playing field in the marine equipment sector.

Another example of good cooperation among Member States is the permanent cooperation framework (PCF) for the investigation of accidents in the maritime transport sector (see also Section 5.3.3.3). The PCF made the development of various common guidelines possible and also formed an active and efficient framework for cooperation among investigation bodies to exchange and discuss a wide range of aspects.

The forum of the Cooperation Group on Places of Refuge (see also Section 4.2.3) is another example of how Member States have endowed themselves with a structure to exchange experiences, identify best practices and establish necessary contacts to proceed in situations leading to a request to grant a place of refuge.

Budget and staff

For some Member States, organisational problems relate primarily to budgetary and staff issues. There are significant differences between Member States relating to the number of personnel employed to ensure the implementation and application of the various directives. It is clear that, on some occasions, the number of staff is not proportional to the contextual factors that characterise the Member State, such as the number of port districts, the number of ship calls, the annual PSC inspection commitment, the length of the coastline, the registered fleet, the number of equipment manufacturers and the number of accidents. There are significant differences across the EU in relation to the number of full-time-equivalent personnel in competent authorities dedicated to the activities relating to the various directives. Some Member States have staff dedicated to the activities relating to each of the directives and some have staff pools dealing with various parts of directives, while others have appointed dedicated personnel tasked to perform close monitoring of all the information required to be recorded in the different information systems (national information system, SafeSeaNet ([30]), Thetis (The Hybrid European Targeting and Inspection System) ([31]), EMCIP ([32]), etc.).

30 https://www.emsa.europa.eu/ssn-main.html.
31 https://portal.emsa.europa.eu/web/thetis.
32 https://www.emsa.europa.eu/emcip.html.

Most Member States have partly or even fully delegated some activities – mainly relating to flag-state obligations – to private organisations, namely ROs. For instance, ROs are entrusted by Member States with the statutory surveys and the consequent renewal and/or endorsement of statutory certificates. Full delegation is a common practice used by maritime administrations to reduce personnel and related costs, while keeping a high level of technical knowledge by using the expertise of ROs.

The distribution of personnel in various locations, mainly port cities, was another organisational aspect that emerged during the visits to Member States. For instance, it was noted that the port state control officers (PSCOs) in some Member States were not efficiently distributed among port districts. As a result of this distribution, some PSCOs in some ports were overloaded with the large number of calls by ships eligible for inspection (leading to the risk of missed or less accurate PSC inspections during peak work periods), while other PSCOs in other ports were relatively less burdened. Very often, the organisational arrangements made to carry out these activities have an impact on the degree of flexibility of the geographical relocation of staff to where there is more need, for example when the coast guard is in charge of the activities.

Independence and conflicts of interest

Another key organisational aspect refers to the independence that entities involved in the maritime safety domain need to have. National investigation bodies, ROs and notified bodies responsible for the conformity assessment of marine equipment need to be fully independent of the organisations they assess; act in a confidential, objective and impartial manner; and have at their disposal personnel with the technical knowledge and sufficient experience to perform their tasks. For instance, in the case of accident investigation bodies (AIBs), independence from the maritime administration ensures impartial accident investigation and unbiased decision-making power that avoids a scenario in which other interests could conflict with the task entrusted to them. This implies the attribution of necessary powers, in terms of budget and staff, which for some Member States appears not to be proportional to their needs.

Technologies to improve organisational efficiency

In order to run their organisation efficiently and minimise the problem of reduced human resources, Member States have been implementing many of the directives' requirements by making extensive use of existing technologies to efficiently improve the functioning of their maritime administrations, and ultimately safety. Examples of technological improvement are represented by the extensive use of SafeSeaNet, which became the exchange platform through which Member States share their information and reuse information provided by other Member States. In addition, Thetis (for the PSC inspection regime) is now supported by efficient systems in place for the proper and complete recording of ship call information at national ports and anchorages in SafeSeaNet and Thetis, which, together with the close monitoring of these activities, resulted in 100 % availability of the information needed for PSC activities.

Capacity building

The implementation of any piece of legislation requires competent staff in the maritime administrations. Normally, Member States already have well-trained personnel in their administrations, skilled in carrying out many of the activities required. In other cases, or when skills must be periodically refreshed or updated, new training opportunities must be designed and implemented by the Member States.

The training of personnel represents an inevitable cost for the Member States, to ensure they are able to provide relevant staff with an adequate level of competence and knowledge to carry out the activities required by the various directives. In addition, training may also be useful to update the staff involved in relation to new legal or technological developments and good practices across Europe.

Harmonisation of training schemes

In general, a positive outcome of the implementation of EU maritime safety legislation has been the attempt to establish common training schemes, which are mostly harmonised at the EU level.

For example, in relation to the PSC Directive, Member States have made significant efforts to implement the harmonised EU training scheme, developed for the purposes of training and assessing the competence of PSCOs. In terms of compliance with this scheme, certain criteria have to be fulfilled, comprising both compulsory activities – such as carrying out at least 10 PSC inspections per year and conducting the distance learning programme's courses on inspection procedures under the Paris Memorandum of Understanding on Port State Control (Paris MoU) ([33]) – and others that contribute to gaining the minimum number of points required in a five-year period (see Section 3.5).

Training is carried out not only in a classroom but also through more informal exchanges among colleagues, such as periodic meetings involving all PSCOs to share experience gathered from their daily activities and facilitate the discussion of subjects relating to new legislation, changes in existing instructions, the outcome of meetings and training relevant to the Paris MoU, IMO, EMSA, etc.

However, there are still areas where the training of staff is not harmonised among Member States and where substantial differences are present in relation to the amount of time invested in both theoretical and practical training. There are Member States with fully fledged training schemes and others where there are no formal training standards, training achievement structures or proper qualification schemes (such as regular assessment of staff knowledge).

Each Member State may organise and deliver training as they deem most appropriate (e.g. internal, on-the-job or external training, training provided by EMSA), as long as their staff, particularly newly employed colleagues, have an adequate level of competence and technical knowledge to carry out the activities relating to the maritime safety directives.

Different approaches to training may create gaps in the EU-wide maritime safety enforcement framework, while better harmonisation of the national systems among Member States could improve the overall effectiveness and efficiency of the measures put in place, avoiding possible distortions and harmonising maritime safety practices across Member States.

EMSA's role as a training provider

In this context, EMSA also supports Member States by organising training for PSCOs, making the e-learning modules of the distance-learning programme available through the Maritime Knowledge Centre system and the activities of the EMSA Maritime Academy. Since 2008, EMSA has also provided RuleCheck, a digital library of all IMO and ILO conventions, for use by PSCOs and staff of maritime administrations at large to enhance the quality and accuracy of PSC inspections.

The EMSA Academy aims to become an EU-wide and global centre of excellence for the design, development and delivery of quality learning services outside formal education in the maritime domain.

It supports the acquisition and development of knowledge, skills and competencies through teaching and learning and by adopting curricula and professional development pathways to satisfy the learning needs and expectations of beneficiary individuals and organisations.

The learning services offered by the EMSA Academy cover a wide range of areas of maritime safety, maritime security, the human element in maritime operations, prevention of and response to marine pollution, and search and rescue (SAR). They include profiles for flag-state inspectors, PSCOs, auditors and assessors, accident investigators, vessel traffic service (VTS) operators and maritime rescue and coordination centre (MRCC) operators.

From the feedback received by Member States and from the high rates of attendance, it was noted that the training provided by EMSA is appreciated and considered useful. All the information gathered by the delegates participating in EMSA's training is later shared and distributed internally to other colleagues in their respective competent administration.

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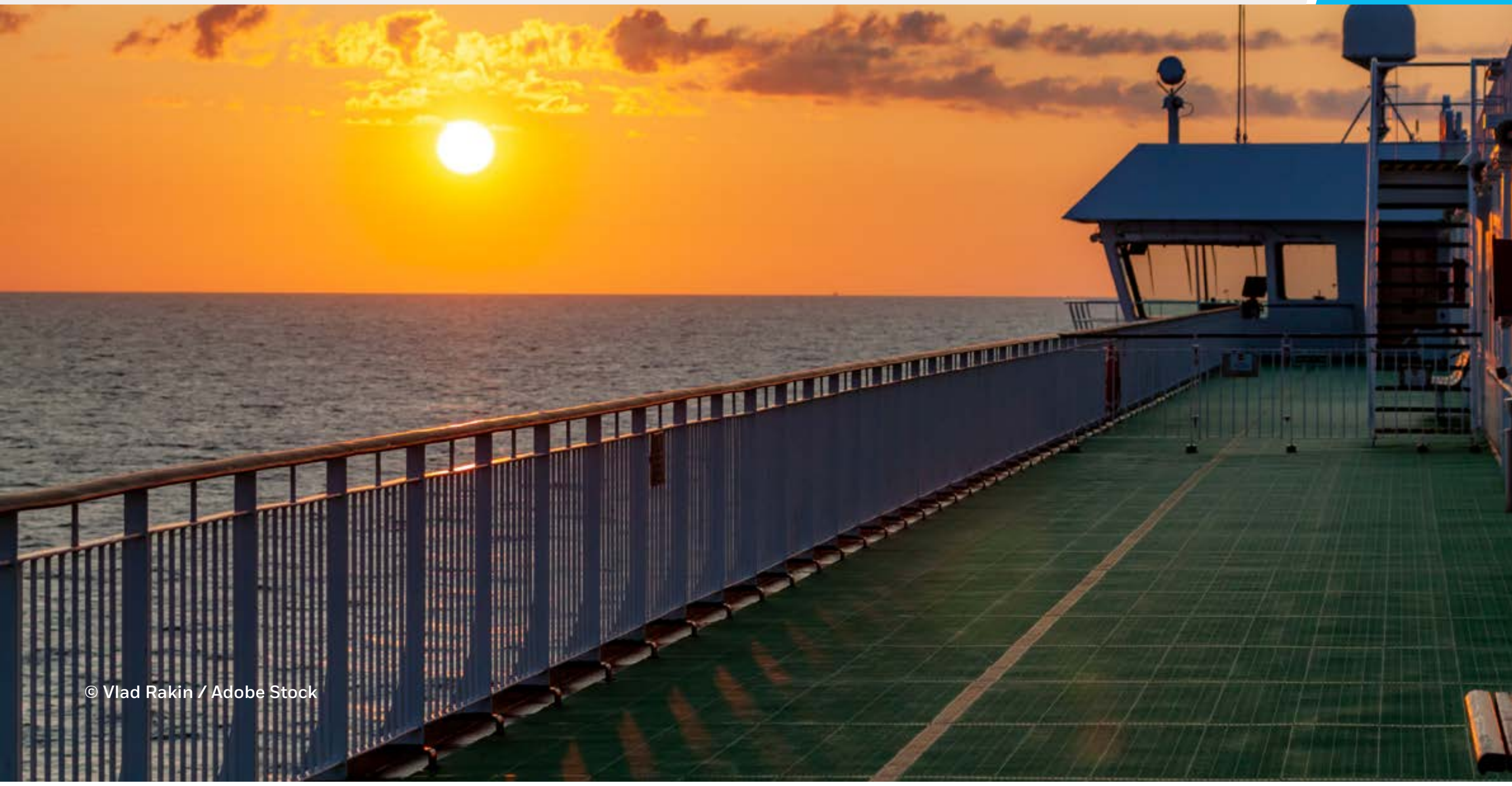
33 The Paris MoU is an administrative agreement between 27 maritime administrations covering the waters of the European coastal states and the North Atlantic basin from North America to Europe. It aims to eliminate the operation of substandard ships through a harmonised system of PSC. More information is available at https://www.parismou.org/.



Inspections and monitoring activities

There are common aspects in the various pieces of legislation on how Member States must monitor and check, directly or indirectly, all other maritime stakeholders, such as shipowners, ship builders, ship management companies, crew members, ships under other flags, equipment manufacturers, ports, terminals, notified bodies and ROs. It is of paramount importance that all involved parties correctly carry out their obligations and take their part in the safety chain. These monitoring and enforcement activities aim at reducing the risk of overall safety being jeopardised by failures or reduced quality applied by the various safety players. Monitoring also includes internal or self-monitoring by the national competent administration, ensuring that all the verification activities carried out in respect of external stakeholders are functioning correctly. In general, the proper implementation of the monitoring process by the Member States' competent authorities is key to ensuring other problems do not pass undetected due to loopholes or inefficiencies in the supervision of other stakeholders.

Monitoring can be realised in various forms, such as inspections on board ships under the PSC regime; flag-state inspections and surveys on board ships; inspections of terminals during the loading and unloading of bulk carriers; and audits of ROs and notified bodies, including checks on their subcontractors.

These inspections can be part of planned and periodic cycles or unannounced, and can be random or targeted, following various criteria specific to each field and piece of legislation.

One area in which inspections are key to ensuring safety is PSC. An efficient PSC system should seek to ensure that eligible ships calling at ports and anchorages within the EU are inspected regularly. The PSC system is implemented through the inspections performed under the Paris MoU PSC regime, with the aim of inspecting all ships with a frequency determined by their risk profile. Ships posing a higher risk are subject to more detailed inspection carried out at more frequent intervals.

Each Member State has specific targets in terms of the number of inspections to be carried out in a year, and this commitment depends on various factors including the annual number of ship calls at its ports. Member States' competent authorities must regularly monitor that this commitment is achieved.

Several good practices to improve the efficiency and effectiveness of the PSC system were established during the visits. For instance, in some Member States, the PSC head office closely monitored the PSC activities, even setting specific targets for the number of inspections to be carried out by each PSC office. These targets were monitored and adjusted by the PSC head office on a regular basis to ensure compliance with the national annual inspection commitment. In some Member States, the national PSC head office had appointed dedicated personnel to perform close monitoring of all the information required to be recorded in the different information systems (national information system, SafeSeaNet, Thetis). On other occasions, the inspection reports were validated by qualified PSCOs other than those who had performed the inspections and submitted the reports. Consequently, the validation tool in Thetis was being used as a quality control tool. In some Member States, the PSC head office, in close cooperation with the human resources department, continually monitored the PSCOs' qualifications to satisfy their needs in each local office.

This PSC self-monitoring activity proved to be effective, producing a significant improvement in the level of compliance with the Member States' inspection obligations between 2019 and 2023.

Monitoring private organisations with delegated functions

Some challenges relate to the proper monitoring of third parties to whom Member States have delegated crucial safety roles. For instance, in the marine equipment area, the designation and follow-up of notified bodies appears to be a crucial, yet also a challenging, process. Marine equipment certification is mainly in the hands of a few entities, highlighting again the critical role of proper monitoring carried out by the national notifying authority and coordination of the private companies carrying out certification. Notified bodies play a very important role in the process of marine equipment approval. If the technical assessment of the notified body were to fail, the whole system of the directive would fail. This aspect may be critical considering the relatively few personnel allocated by national competent authorities to the designation and follow-up of notified bodies. Limited human resources may, but should not, constitute an obstacle to Member States being able to ensure an adequate level of monitoring of notified bodies and guarantee a level playing field among them.

Member States carry out extensive verifications of marine equipment on board vessels primarily during the newbuild phase. After that, only random checks are performed in the subsequent verifications. These verifications are carried out by means of periodic or unannounced surveys, with a focus on ensuring that marine equipment is kept in satisfactory condition and suitable for the service for which the ship was certified.

Many good monitoring practices were established during the cycle of visits for the MED, such as Member States conducting on-site verifications of laboratories and test sites used for conformity assessment purposes and Member States carrying out audits of notified bodies, including checks of the conformity assessment procedures they use for marine equipment of manufacturers based in non-EU countries.

Every ship is made of hundreds or thousands of pieces of equipment, from the simplest to the most highly technologically sophisticated. Proper monitoring of these products is key to ensuring the safety of ships. Therefore, there is a need to designate national market surveillance authorities, endow them with related infrastructure and draw up market surveillance programmes that include checks on pieces of equipment (comprising documentary verification, tests on board and sample checks), the identification of specific equipment posing a potential hazard and all the related measures to communicate the outcome of these activities to interested parties. Another example of a successful implementation of the MED is the fact that most Member States currently have a market surveillance programme and perform many activities in this respect. Market surveillance programmes and activities are carried out to a varying extent and to differing levels of effectiveness. Some of these programmes are purely reactive, whereas in other Member States they are designed to be proactive.

Most Member States have adopted the partial or even the full delegation of various flag-state obligations to private organisations, namely the EU ROs. In some Member States, ships flying their flags are surveyed jointly by flag-state surveyors and RO surveyors. The larger number of verifications (and consequently the high annual person-hours for on-board verifications) undertaken by the personnel of these flag-state administrations indicates an attempt to verify the compliance with the international conventions on board and, at the same time, substantial monitoring of the RO's work. In other Member States the activities carried out directly by the flag-state authorities seem to be negligible in comparison to the activities delegated to and carried out by ROs. One possible reason for this approach seems to be the limited resources available to the maritime administrations concerned. Member State administrations regularly monitor and verify the activities carried out by ROs by directly auditing them and, in some cases, also by observing, or jointly carrying out, surveys on board with RO surveyors. In several Member States, however, the verifications and the monitoring [34] conducted by the flag-state authorities on ROs seem to be limited in comparison with the activities delegated to them.

Recalling that flag-state activities are assigned to Member States by the various directives, it is the responsibility of their administrations to properly verify and monitor their delegated work performed by the entrusted entities. This is also why correct audits and monitoring are crucial for Member States to ensure that the delegated functions are properly carried out.

Another significant example of monitoring activity is that of bulk carrier loading and unloading operations at terminals. This process covers all the inspection activities that a Member State must carry out to verify that loading and unloading operations are compliant with the Bulk Directive and all their relevant stakeholders meet their respective responsibilities. Member States must regularly verify that terminals comply with the requirements of the directive, whereby the verification procedure must include unannounced inspections during loading or unloading operations. It could not be established with objective evidence that regular or unannounced inspections of all bulk terminals were consistently and properly carried out in all Member States. At the same time, good practices were noted in some Member States, for example a national competent authority kept a detailed overview of the inspections carried out in its bulk terminals through good cooperation and periodic requests

34 As laid down in Directive 2009/15/EC of the European Parliament and of the Council of 23 April 2009 on common rules and standards for ship inspection and survey organisations and for the relevant activities of maritime administrations OJ L 131, 28.5.2009, p. 47, ELI: http://data.europa.eu/eli/dir/2009/15/oj).

for information to all its regional offices. Another Member State used a dedicated checklist to provide guidance to the attending inspectors, thus improving the quality of the verification and ensuring that no requirements remained unchecked. In a third Member State, the questionnaires used during the planned inspections also formed part of the quality management system and covered all the aspects of the abovementioned directive.

Enforcement and penalties

One area common to many pieces of legislation refers to the ways in which Member States make sure that the relevant mechanisms and legislative framework are used, and the requirements followed, by all stakeholders. Enforcement measures, including the setting up of penalty systems, are to be defined and enacted to ensure compliance.

According to the PSC regime, Member States may detain a ship for serious non-compliance, and in the most extreme case may ban it from calling at their ports. The number of detentions and their rates across inspections vary slightly across the Member States. Frequent serious non-compliance leading to repetitive detentions can result in a ship being banned from the ports in the Paris MoU PSC region for a certain period.

While detaining a ship is a universal measure, the number of detention days and the amount of various fees collected, such as to cover the beyond-normal costs for the inspection of the detained ships, vary significantly among Member States. In general, the total sum collected by each Member State does not seem to be proportional to its number of detentions (also due to the differing levels of severity of the breaches detected). Indeed, the average amounts of fees collected per detention seem to be quite small and variable across Europe.

Member States may apply fines and other criminal or administrative penalties for breaches that lead to detention, based on their national legislation.

Penalty systems for breaches of the requirements established in the directives are exclusively the competence of Member States, hence a variety of national systems exist in Europe. The various directives require Member States to lay down the rules on penalties but leave to them the choice of which type (administrative or criminal) to apply and what their severity should be. EU directives only state that the penalty system should be devised in an effective and dissuasive way, with payment amounts proportional to the economic advantage possibly gained by the operator by the act of not respecting the law.

There are some differences emerging from the comparison of the penalties for infringements adopted by the Member States. Some apply penalties based on general clauses in their national laws, while in others there are dedicated clauses adopted for the national implementation of the EU legal act. Some fines are issued directly by officials/inspectors using an administrative procedure. In other cases, fines are issued through a judicial procedure by a court (to which the official/inspector concerned must send the evidence), which is responsible for determining the administrative fine and/or the possible criminal sentence. In general, the application of the two different regimes depends on the seriousness of the infringement. Less serious infringements are mainly handled by the maritime administration, while more serious ones may fall under the competence of a court.

The financial amounts of fines imposed with penalties appears to differ greatly among Member States. Their proportionality and dissuasiveness are questionable considering that, in some Member States, the fines, even if they may theoretically be quite severe, appear to be moderate in practice.

In most Member States visited, a system of penalties had been established in relation to many pieces of legislation, but these penalties were rarely, if ever, issued for most of the violations of the national legislation implementing the EU legislation. When some stakeholders deliberately and continually take illegal action undermining the purpose of the legislation, a fair and effective penalty system may also be conducive to a culture of harmonised implementation and exemplary practices on the part of all the parties involved, proving to the compliant stakeholders that their efforts are worthwhile. In any case, a fair penalty system should always be accompanied by further awareness raising and the promotion of a fully fledged safety culture and quality shipping.

Flag state

02

2.1 Introduction

Maritime safety and marine environmental protection are primarily governed under UNCLOS. The EU, alongside numerous countries, is a contracting party to this convention. The convention not only provides a broad legal framework for maritime activities but also specifies the responsibilities of states, particularly in their role as flag states. These responsibilities form the basis for the creation of detailed international rules and standards that cover various aspects of maritime operations, including the design, equipment, operation, management, maintenance, qualification, manning and breaking (recycling) of ships.

As mentioned before, the development of these standards is undertaken at the international level by the IMO. Even when the standards are well defined and are proportional to the associated risks, if the enforcement of such standards and measures is weak, then the safety level drops. The responsibility for monitoring the compliance of ships with particular IMO conventions lies with the **state where the ship is registered and whose nationality the ship holds, known as the flag state** (35).

At the international level, flag-state obligations are summarised in the IMO Instruments Implementation (III) Code. Within the EU, Directive 2009/21/EC (36) regulates the enforcement of flag-state responsibilities with the objectives of enforcing safety rules and preventing pollution, as well as ensuring that Member States fulfil their obligations as flag states. Additionally, the directive aims to guarantee that EU Member States possess adequate resources to fulfil their responsibilities properly, effectively and consistently as flag states. This framework serves as the first line of defence in maritime safety, ensuring a robust and compliant maritime sector within the EU.

The 2024 amendment to Directive 2009/21/EC incorporates and consolidates relevant parts of the III Code, maintaining and aligning the requirement for Member States as flag states to undergo an IMO audit to maintain applicability and uniformity, and to ensure enforcement and the attractiveness of a high-quality EU Member State-flagged fleet. Additionally, the amendment focuses on digitalisation – with Member State flag electronic certification (e-certification) registers and e-certificates – and modernised criteria for measuring flag-state performance (both fleet and administration performance) through a common approach among Member States.

35 The 'flag state' of a vessel is the jurisdiction under whose laws the vessel is registered; it is the nationality of the vessel. UNCLOS stipulates that a ship can fly only one flag of a state and is subject to the exclusive jurisdiction of the flag state that is responsible for its conduct and its compliance with safety and environmental protection requirements.

36 Directive 2009/21/EC of the European Parliament and of the Council of 23 April 2009 on compliance with flag state requirements OJ L 131, 28.5.2009, p. 132, ELI: http://data.europa.eu/eli/dir/2009/21/oj).

In 1987, the IMO Assembly adopted Resolution A.596(15) (37). This resolution explicitly urged the MSC to formulate guidelines aimed at enhancing both shipboard and shore-based management practices. The ultimate goal was to ensure the safe operation of vessels, with a specific initial focus on ro-ro passenger ferries. This move set the stage for the development of what would become the International Management Code for the Safe Operation of Ships and for Pollution Prevention (International Safety Management (ISM) Code), a comprehensive framework designed to elevate safety standards and management practices across the maritime industry. The ISM Code, issued by the IMO through the SOLAS Convention, lays down essential safety and pollution-prevention standards. Its core requirement is the establishment of an SMS within maritime organisations. This SMS encompasses key elements, including defined roles and responsibilities, detailed procedures, comprehensive emergency response plans and an ethos of continual improvement. In tandem, Regulation (EC) No 336/2006 (38) provides additional specifications, especially for EU-flagged vessels, emphasising their alignment with international safety rules. The resolution and the regulation jointly reinforce a structured and accountable approach to maritime safety and environmental protection. By embracing these fundamental requirements, organisations not only ensure compliance with legal standards but also cultivate a culture of safety and environmental management within their maritime operations.

ISM and flag-state responsibilities are intrinsically linked to ensuring safety and environmental protection in maritime operations.

The flag state has a crucial role in enforcing maritime regulations and ensuring that vessels flying its flag comply with international conventions and standards. The flag state is also responsible for implementing and enforcing the ISM Code for vessels registered under its flag. This involves verifying that shipping companies and their ships comply with the requirements of the ISM Code.

Flag-state obligations include the surveying of vessels and the issuance and renewal of certificates. However, flag states can authorise classification societies to act on their behalf to carry out statutory surveys (39) and the certification work of their flagged fleet. The classification society, when performing this role, is known as an RO and should meet the minimum requirements established in the IMO Code for Recognized Organizations (RO Code – see Section 2.5). It is the responsibility of each flag state to verify that a classification society fulfils the conditions of the RO Code before recognising it.

However, the work of flag states is not over with this recognition. The process must be complemented with a regular oversight programme for the activities of the RO. The oversight programme is supported, but not replaced, by quality systems the RO must implement subject to independent third-party verification.

The III Code also requires flag states to provide an appropriate number of personnel for implementation and enforcement, and for investigations and surveys (40). In this respect, the flag state should implement a documented system for the qualification of personnel and the continuous updating of their knowledge (41). While the minimum qualifications (42) are not mandatory under the code, they should encompass the knowledge of the applicable national and international rules and regulations for ships, their companies, crew, cargo and operation, along with knowledge of the procedures to be applied in survey, certification, control, investigative and oversight functions, among other areas (43).

37 IMO Resolution A.596(15) adopted on 19 November 1987 – Safety of passenger ro-ro ferries, https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/AssemblyDocuments/A.596(15).pdf.

38 Regulation (EC) No 336/2006 of the European Parliament and of the Council of 15 February 2006 on the implementation of the International Safety Management Code within the Community and repealing Council Regulation (EC) No 3051/95 (OJ L 64, 4.3.2006, p. 1, ELI: http://data.europa.eu/eli/reg/2006/336/oj).

39 Statutory surveys refer to those survey activities that are mandatory according to the international conventions and that might imply the issuance or renewals of international navigation certificates.

40 Paragraphs 24 and 38 of the III Code.

41 Paragraph 35 of the III Code.

42 Paragraphs 29, 30, 31 and 32 of the III Code.

43 Paragraph 36 of the III Code.

2.2 Regulatory framework

Table 3 shows the regulatory framework at the international and EU levels on flag states and ROs.

Table 3: Legislation on flag states and ROs.

	Level	Instrument	What it regulates
Legislation	International	UNCLOS Article 94	Definition of flag state.
		III Code Part 2 Resolution A.1070(28)	Implementation. Delegation of authority. Enforcement. Flag-state surveyors. Flag-state investigations. Evaluation and review.
		RO Code	Minimum criteria against which organisations are assessed towards recognition and authorisation and the guidelines for oversight by flag states.
		ISM Code	SMSs on board ships, including identification of risks, establishment of appropriate safeguards and continuous improvement of safety to ensure compliance with mandatory rules and regulations.
	EU	Directive 2009/21/EC	Flag State Directive.
		Directive 2009/15/EC	Common rules and standards for ship inspection and survey organisations and for the relevant activities of maritime administrations.
		Regulation (EC) No 391/2009	Common rules and standards for ship inspection and survey organisations.
		Regulation (EU) 2019/492	Amending Regulation (EC) No 391/2009 with regard to the withdrawal of the United Kingdom from the Union.
		Commission Regulation (EU) 788/2014	Detailed rules for the imposition of fines and periodic penalty payments and the withdrawal of recognition of ship inspection and survey organisations pursuant to Articles 6 and 7 of Regulation (EC) No 391/2009 of the European Parliament and of the Council.
		Regulation (EC) No 336/2006	Implementation of the ISM Code within the Community.
		Regulation (EC) No 789/2004	The transfer of cargo and passenger ships between registers within the Community.

2.3 EU Member State fleet

The most important element to consider when analysing the level of maritime safety in the EU is the fleet. The number of ships is an important factor for those authorities whose role it is to assign proportional resources, as is an understanding of the likelihood of an accident occurring. Ship type also has a bearing on maritime safety, as the consequences of accidents and the prevention and response measures differ greatly depending on the ship type involved – the implications for a large passenger ship and an oil tanker are not the same, for instance.

This section analyses the fleet for which the safety level is under the direct responsibility of EU Member States, i.e. those ships flying the flag of an EU Member State, regardless of the location in which they are sailing.

The fleet information presented below focuses on ships in service as of 31 December 2023. It includes the 27 EU Member States, Iceland and Norway, but excludes fishing vessels, unless otherwise stated, as they are analysed separately.

The vessel groupings considered are based on EMSA's database, which uses commercial shipping data of ships with an IMO number (100 GT and above). Information was retrieved from this database for all merchant seagoing and self-propelled ships except fishing vessels. For these types of vessels, the database of the Commission's Directorate-General (DG) for Maritime Affairs and Fisheries [44] was used for this report, as it contains extensive information on the whole fishing fleet.

In summary, the main ship groups used are shown in Table 4.

Table 4: Main ship groups used to categorise the fleet.

Group	Description
Tankers	Including liquefied gas tankers, oil tankers, chemical and other liquid tankers, such as water tankers.
Bulk carriers	Including bulk dry, bulk dry/oil, self-discharging bulk dry and other bulk dry carriers.
General cargo ships	Including general cargo, palletised cargo and deck cargo ships.
Container ships	Fully cellular container ships and fully cellular container ships with ro-ro facilities.
Ro-ro cargo ships	Including ro-ro cargo ships, vehicle carriers, container/ro-ro cargo ships and landing craft.
Passenger ships	All passenger ships, including ro-pax and HSC, passenger/container ships and passenger/general cargo ships.
HSC	High-speed passenger craft.
Ro-pax	Passenger/ro-ro cargo ships and passenger/landing craft that are not HSC.
Other cargo ships	Refrigerated cargo ships and other dry cargo ships, such as livestock carriers, barge carriers, heavy load carriers and nuclear fuel carriers.
Other work vessels	All vessels carrying out offshore, research, towing/pushing, dredging and other activities.

44 https://webgate.ec.europa.eu/fleet-europa/index_en.

2.3.1 Number of ships registered under EU Member State flags

The size of the EU Member States' fleet is an important indicator of its relevance within the world maritime transport sector. Its distribution by ship type helps to place the safety focus on the specific areas of concern. In Table 5, the number of ships registered under EU Member State flags by ship type, except fishing vessels, is represented, including their evolution over the five-year period between 2019 and 2023.

The ship types representing the largest proportion of the EU Member States' fleet (not including fishing vessels) are other work vessels (31 %), followed by passenger ships (19 %) and tankers (16 %), of which, respectively, 44 % are ro-pax and 47 % are chemical tankers. Vessels in the category 'other work vessels', which includes tugs, barges, etc., usually work in ports in sheltered waters and are therefore not a priority for this report.

In terms of trends, the number of ships registered to EU Member State flags decreased by 2 % over the five-year reference period of this report.

This contrasts with the previous Emsafe report, where an increase had been observed in the 2016–2020 period.

Table 5: Number of ships registered under EU Member State flags by ship type in 2023 (excluding fishing vessels) and fleet evolution over the 2019–2023 period.

Ship type	2023	2019-2023	
Other work vessels	4,096	4,098	4,096
Passenger ships	2,496	2,412	2,496
Tankers	2,110	2,288	2,110
General cargo ships	1,579	1,642	1,579
Bulk carriers	1,105	1,314	1,105
Container ships	1,095	1,096	1,095
Ro-Ro cargo ships	418	394	418
Other cargo ships	110	89	110
Total	13,009	13,333	13,009

Source: EMSA services.

The 1.9 % increase in the number of passenger ships has not been accompanied by a decrease in their average age, which increased to 29 years in 2023 (see Section 2.3.4).

This means that the fleet growth is also caused by the transfer of old ships from non-EU-countries' flags (see Table 11).

This information can be analysed from a broader perspective by comparing it with the fleet evolution at the global level (see Table 6).

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Table 6: Number of ships in the world by ship type in 2023 (excluding fishing vessels) and fleet evolution over the 2019–2023 period.

Ship type	2023	2019–2023	
Other work vessels	37,810	35,495	37,810
Tankers	17,645	16,521	17,645
General cargo ships	15,682	15,434	15,682
Bulk carriers	13,443	12,003	13,443
Passenger ships	8,333	8,028	8,333
Container ships	5,927	5,300	5,927
Ro-Ro cargo ships	3,002	2,920	3,002
Other cargo ships	1,187	1,224	1,187
Total	103,029	96,925	103,029

Source: EMSA services.

There was an increase of approximately 6 % [45] in the global fleet from 2019 to 2023, corresponding to a 15 % increase since 2016, whereas the size of the Member State fleet is currently decreasing.

The proportion of EU Member State-flagged ships versus the global fleet dropped from 14.2 % in 2016 to 13.7 % in 2020 and to 12.6 % in 2023.

In Table 7 and Table 8, respectively, the fleet of tankers and passenger ships is further divided into subtypes.

Table 7: Number of tankers registered under EU Member States' flags and fleet evolution over the 2019–2023 period.

Tankers type	2023	2019-2023	
Gas tankers	376	331	376
Oil tankers	698	903	698
Chemical tankers	1,001	1,018	1,001
Other tankers	35	36	35
Total	2,110	2,288	2,110

Source: EMSA services.

Table 8: Number of ro-pax, HSC and other passenger ships registered under EU Member States' flags and fleet evolution over the 2019–2023 period.

Passenger ship type	2023	2019-2023	
Ro-Pax	1,102	1,082	1,102
HSC	248	212	248
Others	1,146	1,118	1,146

Source: EMSA services.

Looking at Table 7, it can be concluded that, since 2019, there has been a significant decrease, of 23 %, in the number of oil tankers, contrasting with a 14 % increase in the number of gas tankers (a 29 % increase since 2016). This is congruent with the efforts being made to transition sources of energy towards the use of alternative fuels and liquefied natural gas (LNG) in the EU.

The number of EU Member State-flagged HSC has continued to grow since 2016 (see Table 8), with a 17 % increase recorded in the five years between 2019 and 2023. The majority of the passenger fleet (57 %) in 2023 remained concentrated in four countries: Norway (19 %), Greece (14 %), Italy (13 %) and Croatia (11 %).

45 It is important to note that in the dataset the flag information is available for 92 % of the world fleet.

These numbers can also be put into perspective by comparing them with the global figures in Table 9 and Table 10.

Table 9: Number of tankers in the world by tanker type and fleet evolution over the 2019–2023 period.

Tankers type	2023	2019-2023	
Gas tankers	2,338	2,006	2,338
Oil tankers	9,114	8,741	9,114
Chemical tankers	5,973	5,550	5,973
Other tankers	220	224	220
Total	17,645	16,521	17,645

Source: EMSA services.

Table 10: Number of ro-pax, HSC and other passenger ships in the world and fleet evolution over the 2019–2023 period.

Passenger ship type	2023	2019-2023	
Ro-Pax	3,112	3,040	3,112
HSC	762	658	762
Others	4,459	4,330	4,459

Source: EMSA services.

The profile of the EU Member States' fleet is dynamic as there are several reasons why a ship might change its flag (Section 1.2.3). As can be seen from Table 11, from 2019 to 2023 there were 35 % more ships moving from an EU Member State flag to flags outside the EU than vice versa. Most ships leaving from EU Member States' flags to those of non-EU countries were bulk carriers, oil and chemical tankers and general cargo ships.

Table 11: Number of flag changes over the 2019–2023 period, in relation to EU Member States' flags, by ship type.

	EU Member State-flagged to EU Member State-flagged	non-EU Member State-flagged to EU Member State-flagged	EU Member State-flagged to non-EU Member State-flagged	Balance
Tankers	388	685	1,108	−423
Bulk carriers	125	404	769	−365
General cargo ships	475	577	687	−110
Container ships	380	683	729	−46
Ro-Ro cargo ships	51	57	71	−14
Passenger ships	254	97	118	−21
Other cargo ships	43	38	9	29
Other work vessels	642	505	612	−107
Total	2,358	3,046	4,103	−1,057

Source: EMSA services.

Looking closely at the passenger ships coming to EU Member States' flags, their average age at time of change was 18 years (21 years for ro-pax), and 36 % were more than 25 years old at time of flag change from a non-EU flag to that of an EU Member State.

EMSA's databases provide reliable data on cargo and passenger fleets. However, for fishing vessels, a more comprehensive database is managed by the Commission's DG Maritime Affairs and Fisheries ([46]). By the end of 2023, EU Member States had nearly 70 000 fishing vessels – a 6 % decrease from 75 000 in 2019. This excludes Iceland and Norway, as their data are not available in the DG Maritime Affairs and Fisheries database. Fishing vessels remain the most common type of ship in the EU. Further analysis of the EU Member States' fleet of fishing vessels is provided in Section 5.2.4.

46 https://webgate.ec.europa.eu/fleet-europa/index_en.

2.3.2 Size of ships registered under EU Member State flags

The analysis above only considers the number of ships. However, the size of these ships is also important, providing as it does an indication of transport capacity. In general, in the maritime transport sector, size is measured in GT. By the end of 2023, the total GT of ships registered under EU Member States' flags amounted to over 249.4 million, or 15.8 % of the GT worldwide – less than in 2019.

Table 12: Total GT of ships registered under EU Member States' flags by ship type (excluding fishing vessels) and fleet size evolution over the 2019–2023 period.

Ship type	2023	2019-2023	
Tankers	77.8M	82.7M	77.8M
Bulk carriers	47.2M	56.6M	47.2M
General cargo	9.4M	9.3M	9.4M
Container ships	67.5M	61.6M	67.5M
Ro-Ro cargo	15M	12.1M	15M
Passenger ships	20.8M	18.4M	20.8M
Other cargo ships	1.5M	1.1M	1.5M
Other work vessels	10.2M	9.9M	10.2M
Total	249.4M	251.6M	249.4M

Source: EMSA services.

Table 13: Worldwide GT of ships by ship type (excluding fishing vessels) and fleet size evolution between 2019 and 2023.

Ship type	2023	2019-2023	
Tankers	494.1M	430.4M	494.1M
Bulk carriers	532.2M	465.5M	532.2M
General cargo	64.7M	61.9M	64.7M
Containerships	294.1M	246.3M	294.1M
Ro-Ro cargo	52.8M	50.8M	52.8M
Passenger ships	49.6M	44M	49.6M
Other cargo ships	9.5M	8.9M	9.5M
Other work vessels	83.8M	81.8M	83.8M
Total	1.6B	1.4B	1.6B

Source: EMSA services ([47]).

Table 14 to Table 16 confirm a similar tendency to that of the number of ships. Whereas the global tonnage increased by 13.8 % from 2019 to 2023, the EU Member States' tonnage saw a 1 % decrease in the same period. **The proportion of the EU Member State tonnage in relation to the global equivalent dropped from 18.7 % in 2016 to 17.8 % in 2020 and 15.8 % in 2023.**

Ro-pax and HSC with EU Member State flags still represent more than 30 % of the world fleet of those ship types and more than 50 % in terms of GT.

This means that, on average, the ro-pax and HSC registered to EU Member State flags are the largest in the world.

47 In the first edition of Emsafe there was a miscalculation in the annual sum of container ships' GT in 2017, 2018 and 2019.

Table 14: Percentage of EU Member State-flagged vessels by ship type within the global fleet of each type in number of ships and GT – fleet of 2023.

Ship type	% No. of ships	% GT
Bulk carriers	8.2%	8.9%
Container ships	18.5%	23.0%
General cargo ships	10.1%	14.5%
Other cargo ships	9.3%	15.7%
Other work vessels	10.8%	12.2%
Passenger ships	30.0%	41.9%
Ro-Ro cargo ships	13.9%	28.5%
Tankers	12.0%	15.7%
Total	12.6%	15.8%

Source: EMSA services.

Table 15: Percentage of EU Member State-flagged tankers worldwide in number of ships and GT – fleet of 2023.

Tanker type	% No. of ships	% GT
Chemical tankers	16.8%	17.8%
Gas tankers	16.1%	20.8%
Oil tankers	7.7%	13.6%
Other tankers	15.9%	9.5%

Source: EMSA services.

Table 16: Percentage of EU Member State-flagged ro-pax, HSC and other passenger ships worldwide in number of ships and GT – fleet of 2023.

	% No. of ships	% GT
HSC	32.5%	53.6%
Others (Pax)	25.7%	31.6%
Ro-Pax	35.4%	58.4%

Source: EMSA services.

2.3.3 Fleet owned by EU-registered companies

Ships can be owned by a company registered in an EU Member State but still fly the flag of a non-EU country. From a safety perspective, the ownership of the ship is also important, as the owner often plays a key role in maintaining an appropriate level of safety. Table 17 includes a comparison, by ship type, of the percentages of the EU Member State-owned fleet versus the EU Member State-flagged fleet.

Table 17: Percentage of EU Member State-owned vessels worldwide in number of ships by ship type – comparison with percentage of EU Member State-flagged vessels – fleet of 2023.

Ship type	EU owned	EU Member State-flagged flagged
Bulk carriers	25.1%	8.2%
Container ships	34.3%	18.5%
General cargo ships	16.5%	10.1%
Other cargo ships	21.8%	9.3%
Other work vessels	12.8%	10.8%
Passenger ships	30.2%	30.0%
Ro-Ro cargo ships	15.5%	13.9%
Tankers	20.8%	12.0%
Total	19.0%	12.6%

Source: EMSA services.

Table 18: Percentage of EU Member State-owned tankers worldwide in number of ships by tanker type – comparison with percentage of EU Member State-flagged tankers – fleet of 2023.

Tanker type	EU owned	EU flagged
Chemical tankers	25.2%	16.8%
Gas tankers	25.7%	16.1%
Oil tankers	16.8%	7.7%
Other tankers	18.6%	15.9%

Source: EMSA services.

Table 19: Percentage of EU Member State-owned ro-pax, HSC and other passenger ships worldwide in number of ships – comparison with percentage of EU Member State-flagged vessels – fleet of 2023.

	EU owned	EU flagged
HSC	31.9%	33.6%
Others (Pax)	25.7%	25.7%
Ro-Pax	36.3%	35.4%

Overall, 60 % of the EU Member State-owned fleet in number of ships is flagged in the EU. For passenger ships, 94 % of the EU Member State-owned fleet in number of ships is flagged in the EU.

Through either ownership or flag, the EU Member States control around 30 % of the world's passenger ships by number.

The situation is different for cargo ships. Fewer than 20 % of the world's container ships are registered under an EU Member State flag, and 34 % are owned by EU-based companies. Owners based in EU Member States control around a quarter of the world's gas and chemical tankers.

This means that, from a global safety perspective, the performance of EU owners also plays a key role in the safety of these ships. **For container ships and gas and chemical tankers as a whole, around 50 % of the EU Member State-owned ships of these types are not flagged in the EU.**

It is also worth mentioning that from 2020 to 2023 there was a decrease of 1 % in the share of the world fleet owned by EU companies.

A comparison between Table 17 and Table 20 seemingly shows that companies based in the EU own larger ships than the average across all ship types.

Table 20: Percentage of EU Member State-owned vessels worldwide in sum of GT by ship type – fleet of 2023.

Ship type	% GT EU owned
Bulk carriers	26.9%
Container ships	36.9%
Other work vessels	19.3%
General cargo ships	28.6%
Ro-Ro cargo ships	30.7%
Other cargo ships	32.2%
Tankers	32.8%
Passenger ships	35.7%
Total	30.7%

Source: EMSA services.

2.3.4 Age of ships

The age of ships is also an important element to consider when looking at safety. As ships age, they require greater maintenance, and they need parts to be replaced and steelwork to be repaired. In general, ships can have a lifespan of 25–30 years, although with adequate maintenance this can be extended.

In addition, the age of the ship defines the applicable safety standards. On many occasions, newly approved safety requirements are not immediately applicable to existing ships, as explained in Section 1.3.1. Therefore, ships can operate on the same route even though they have different safety levels as a result of their age.

Table 21: Average age by ship type of ships with an EU Member State flag compared with that of the world fleet.

	EU Member State-flagged	World fleet
Passenger ships	29	28
Other work vessels	26	24
General cargo ships	22	26
Ro-Ro cargo ships	18	20
Other cargo ships	17	30
Tankers	14	18
Container ships	13	14
Bulk carriers	12	13

Source: EMSA services.

Table 22: Average age by tanker type of tankers with an EU Member State flag compared with that of the world fleet.

	EU Member State-flagged	World fleet
Other tankers	50	41
Chemical tankers	14	15
Oil tankers	14	20
Gas tankers	10	14

Source: EMSA services.

Table 23: Average age of ro-pax, HSC and other passenger ships with an EU Member State flag compared with that of the world fleet.

	EU Member State-flagged	World fleet
Others (Pax)	33	30
RoPax	28	27
HSC	15	13

Source: EMSA services.

In general, the average age of the ships registered under EU Member State flags is less than or similar to the world average, except for tankers other than gas, oil or chemical tankers, which are simple ships in terms of design and do not tend to carry harmful substances, and passenger ships, for which the same cannot be stated in terms of either design or accident criticality. The average age of EU Member State-flagged passenger ships has now surpassed that of the world fleet. The safety of passenger ships remains a priority for the EU, as outlined in the next chapter. It can be noted that the average age of passenger ships is more than double that of tankers, and is the highest out of all the ship-type categories. **Around 36 % of the passenger ships brought to the EU from 2019 to 2023 were more than 25 years old (see Section 2.3.1).**

2.3.5 Alternative fuels uptake

The type of fuel and the powering technology also have important implications for safety and show how the fleet reflects the most recent developments towards a more sustainable future for shipping.

According to the Alternative Fuels Insight platform, there are 320 ships equipped with batteries in the EU Member States' fleet (2.5 % of the fleet) (DNV, n.d.). Of these, 14 % are pure electric, 58 % are hybrid and 25 % are plug-in hybrid. By ship type, 48 % are passenger ships.

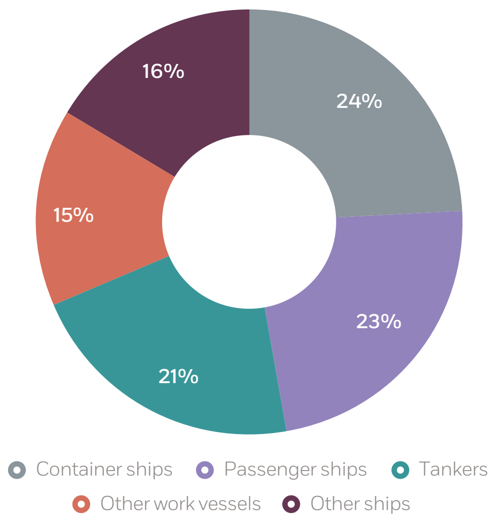
There are also 11 ships with fuel cell technology in the order books for delivery within the next five years and planning to fly the flag of an EU Member State. These are mainly cruise ships, some of which will also be LNG ready.

There are 26 ships in operation flying the flags of EU Member States that can run on methanol (63 % of the world fleet of methanol fuelled vessels, greater than 100 GT and excluding fishing vessels), 12 of which are container ships installed with dual-fuel engines.

In 2024, 46 % of the fleet of LNG-ready vessels in operation (excluding LNG carriers) were flying the flag of an EU Member State. In terms of the type of consumption, 84 % of these ships had installed dual-fuel internal combustion engines (ICEs) and 10 % used pure gas engine concepts. The average fuel tank capacity was 3 718 m³.

In respect to ship type, 24 % of the fleet corresponded to container ships, 23 % to passenger ships and 21 % to tankers, as shown in Figure 21.

Figure 21: LNG-ready ships in operation by ship type – EU Member State-flagged (excluding LNG carriers).



Source: Alternative Fuels Insight platform (DNV, n.d.).

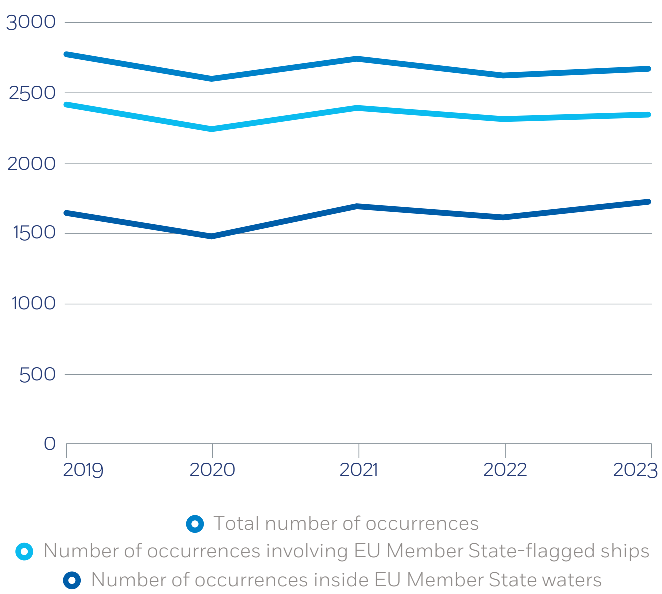
Information about the regulatory and technology developments supporting the uptake of alternative fuels and technologies is provided in Section 5.5.

2.4 EU Member State fleet performance

2.4.1 Marine casualties and incidents

This section provides general information about the number of reported marine casualties and incidents, in terms of their severity, the ships involved, fatalities and injuries, along with safety indicators. The relevant data in this section contain statistics on marine casualties and incidents under the scope of the AI Directive, reported in EMCIP, which are those involving at least one of the current EU Member States and the two maritime European Economic Area (EEA) / EFTA states as a flag state, coastal state or substantially interested state. The data cover the period from 1 January 2019 to 31 December 2023 and may be subject to change over time as EU Member States add or update information on older cases. Over the 2019–2023 period, an average of 2 685 accidents took place every year.

Figure 22: Number of occurrences during the 2019–2023 period – breakdown of occurrences within EU waters and involving at least one EU Member State-flagged ship.



Source: EMCIP (EMSA, n.d.).

Looking at occurrences involving only EU Member State-flagged ships, over the 2019–2023 period, an average of 2 344 accidents took place every year.

Over the same period, an average of 2 449 ships were involved in accidents annually.

Ships involved in marine casualties are organised by ship type (see Figure 23), divided into cargo ships, fishing vessels, passenger ships, service ships and other ships [48]. Fishing vessels have been categorised by their length overall according to the relevant legislative threshold as indicated in the ship safety section, but only those with length overall greater than or equal to 15 metres fall within the scope of the AI Directive.

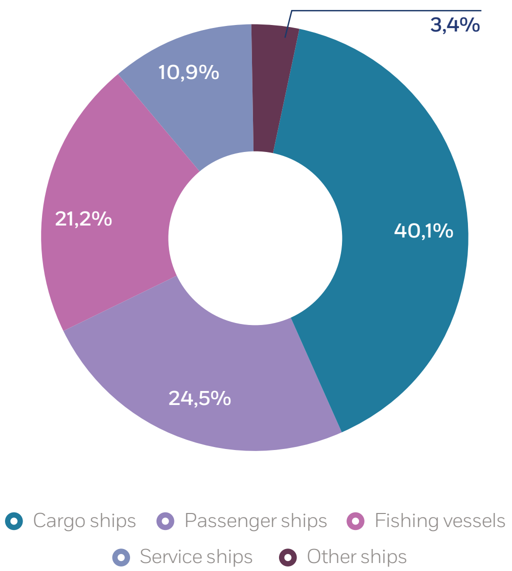
48 The AI Directive does not apply to marine casualties and incidents involving only ships of war, troop ships or other ships owned or operated by a Member State and used only on government non-commercial service; ships not propelled by mechanical means; wooden ships of primitive build; pleasure yachts and pleasure craft not engaged in trade, unless they are or will be crewed and carrying more than 12 passengers for commercial purposes; inland waterway vessels operating in inland waterways; fishing vessels with a length of less than 15 metres; or fixed offshore drilling units. Such vessels are considered to fall within the scope of the AI Directive only when they are involved in an occurrence together with a ship that is covered by the AI Directive (e.g. a collision between a cargo ship and a recreational craft or a fire on board an inland waterway vessel while sailing in internal waters).

Cargo ships were the main category of ships involved in accidents (40.1 %), a finding that was anticipated, considering that they represent around 49 % of the fleet (see Section 2.3).

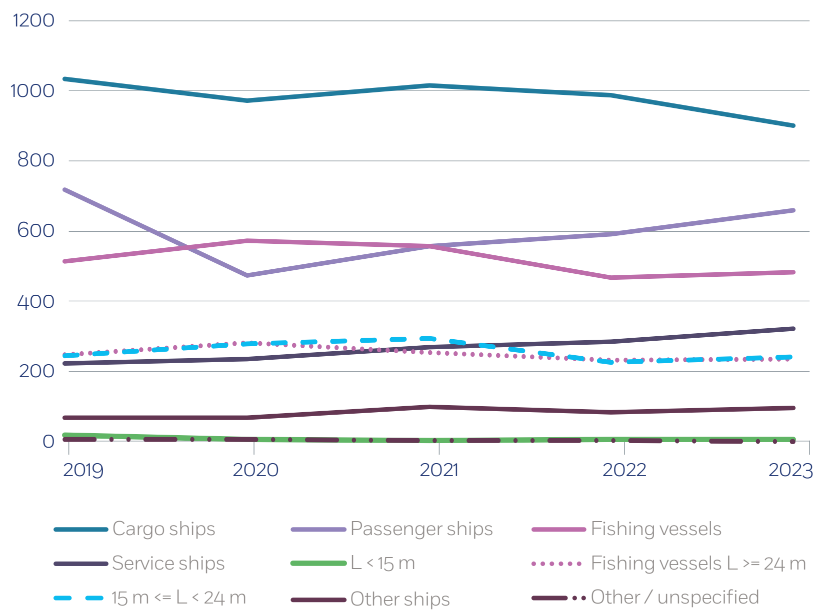
Marine casualties are catalogued by severity into the following categories: very serious, serious, less serious and marine incidents. Figure 24 shows the evolution in the total number of occurrences and their distribution by severity between 2019 and 2023.

Figure 23 (a) and (b): Number of EU Member State-flagged ships involved in marine casualties – average distribution by ship type and evolution between 2019 and 2023.

(a)

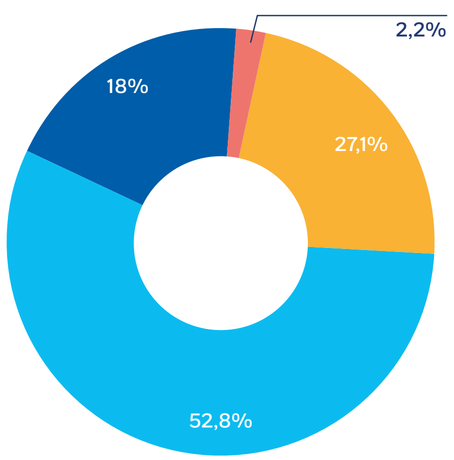


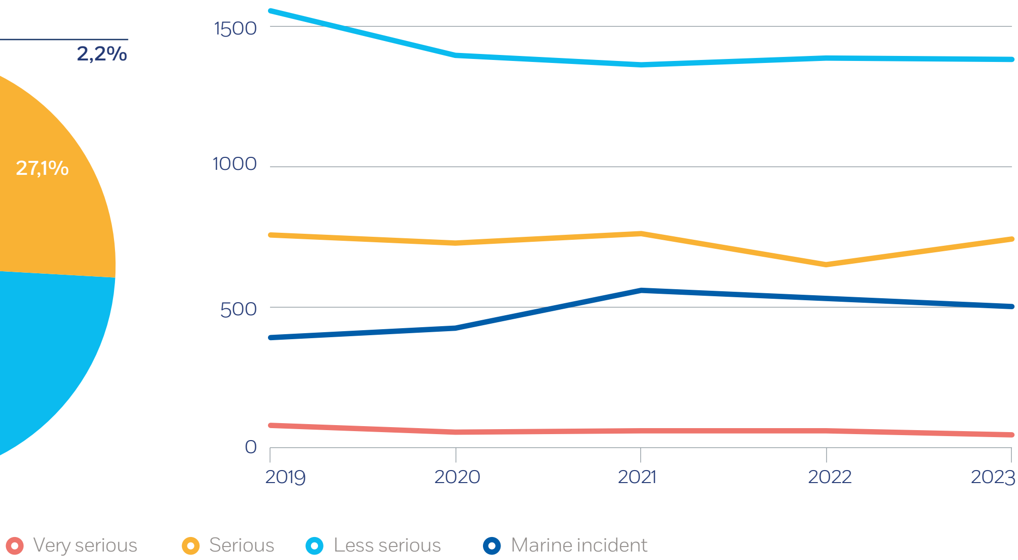
(b)



Source: EMCIP (EMSA, n.d.).

Figure 24: Total number of occurrences – evolution and average distribution by severity between 2019 and 2023.

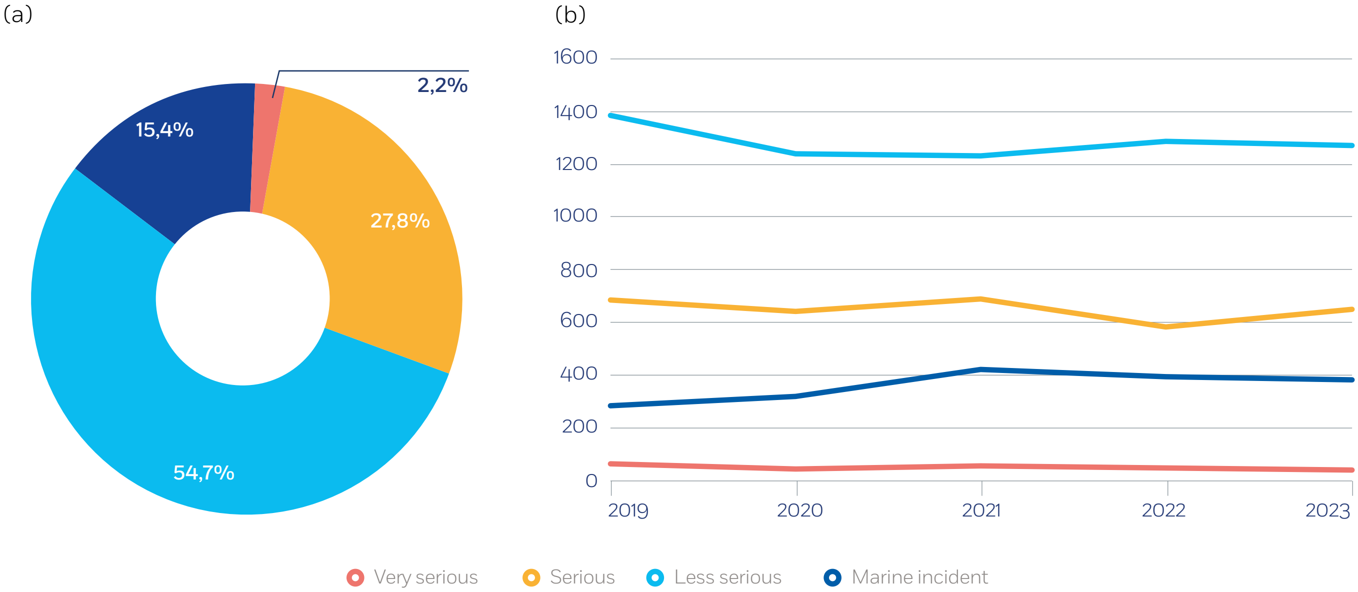




Source: EMCIP (EMSA, n.d.).

Figure 25 shows the number of occurrences involving only EU Member State-flagged ships, their evolution and average distribution by severity between 2019 and 2023.

Figure 25: Number of occurrences involving EU-Member States flagged ships – evolution and average distribution by severity between 2019 and 2023.



Source: EMCIP (EMSA, n.d.).

Occurrences with consequences such as loss of life, loss of ship or severe damage to the environment (very serious) represented 2.2 % of all occurrences recorded between 2019 and 2023. Accidents with consequences such as damaged ships unfit to proceed, serious injuries or non-severe damage to the environment (serious) totalled 27.1 % (27.8 % for occurrences involving only EU Member State-flagged ships). Incidents that led to consequences not mentioned above represented 52.8 % (54.7 % for occurrences involving EU Member State-flagged ships) of all incidents reported over the same period. Finally, the percentage of accidents where there were no such consequences (marine incidents) was 18 % (15.4 % for EU Member State-flagged ship occurrences). Some variations over the period are visible in the figure, but the proportion in terms of the number of occurrences and their severity remained reasonably constant.

Of all the ship types included in the graphs above, the ISM Code, which governs safety management on board ships, including occurrence recording and reporting, does not apply to fishing vessels. It is questionable whether fishing vessels report all occurrences or only those with the worst consequences. For example, the number of occurrences reported for fishing vessels above 24 metres is the same as that for ships between 15 and 24 metres, even if the fleet of the latter group is three times bigger.

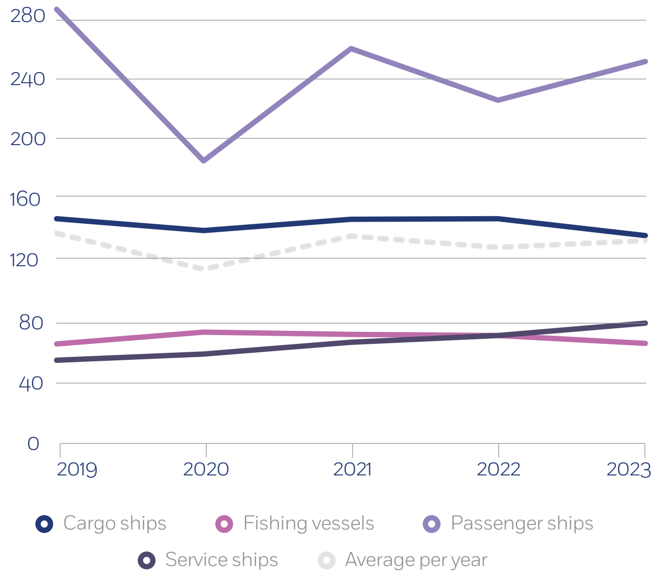
To draw more objective comparisons between the number of occurrences involving different ship types and the fleet evolution, the following ratios between the number of occurrences involving a ship type and the corresponding fleet sizes were calculated.

Table 24: Occurrence indicators – number of occurrences compared to fleet size.

	2019	2020	2021	2022	2023	Average by ship type
Cargo ships	148	141	148	148	137	145
Fishing vessels	66	74	72	71	66	70
Passenger ships	286	187	261	227	252	242
Service ships	55	59	67	71	80	67
Average per year	139	115	137	129	134	131

Source: EMCIP (EMSA, n.d.).

Figure 26: Indicator on the number of occurrences by ship type – evolution between 2019 and 2023.



Source: EMCIP (EMSA, n.d.).

This ratio indicates the annual probability for an EU Member State-flagged ship of the relevant category to have an occurrence. Obviously, this is not a risk indicator as such, as the consequence of the incident can vary from very severe (e.g. a fatality or the loss of a ship) to non-severe (e.g. a minor injury where there is less than 72 hours of incapacitation).

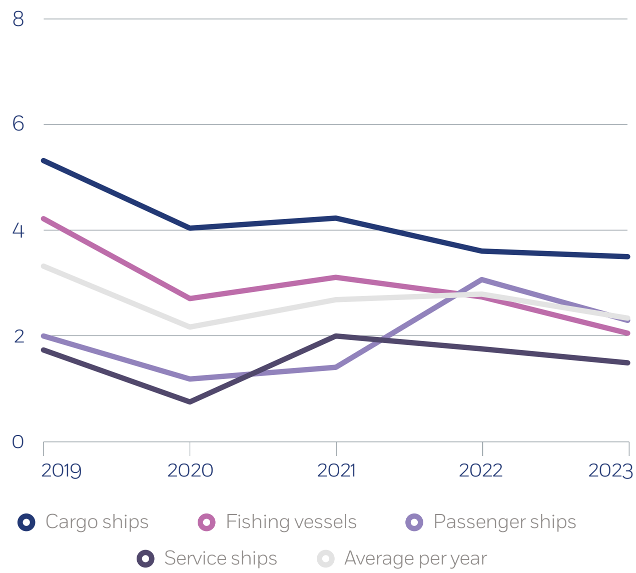
Looking at the indicators, it appears at first glance that passenger ships are at higher risk, which is not the case in reality, as can be seen in Table 25 and Figure 27, where the indicator is calculated only for very serious casualties.

Table 25: Occurrence indicators – number of very serious occurrences compared to fleet size (×1 000).

	2019	2020	2021	2022	2023	Average by ship type
Cargo ships	5.3	4.0	4.2	3.6	3.5	4.1
Fishing vessels	4.2	2.7	3.1	2,7	2.1	3.0
Passenger ships	2.0	1.2	1.4	3.1	2.3	2.0
Service ships	1.7	0.8	2.0	1.8	1.5	1.5
Average per year	3.3	2.2	2.7	2.	2.3	2.7

Source: EMCIP (EMSA, n.d.).

Figure 27: Indicator on the number of very serious occurrences by ship type – evolution between 2019 and 2023.



Source: EMCIP (EMSA, n.d.).

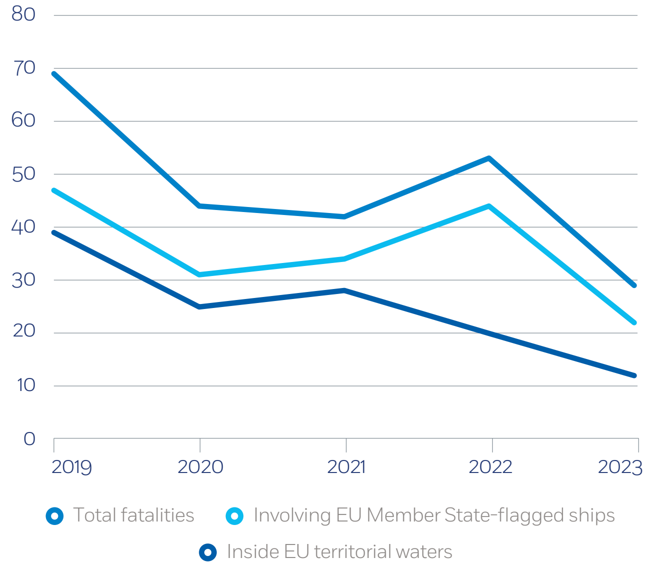
A likely main cause of the higher ratio is greater reporting of passenger ship casualties, based on more advanced SMSs and staff availability, whereas fishing vessels will most probably report only those incidents that are more severe, or that have more significant consequences. It must be noted that the reporting of accidents has an associated administrative burden, and in cases where resources are scarce, the incentives to avoid it are significant.

The evolution in the total number of reported fatalities is presented in Figure 28, with a breakdown of those occurring within EU territorial waters and those involving EU Member State-flagged ships.

In 2023, 29 people lost their lives – a number that has been decreasing over the years.

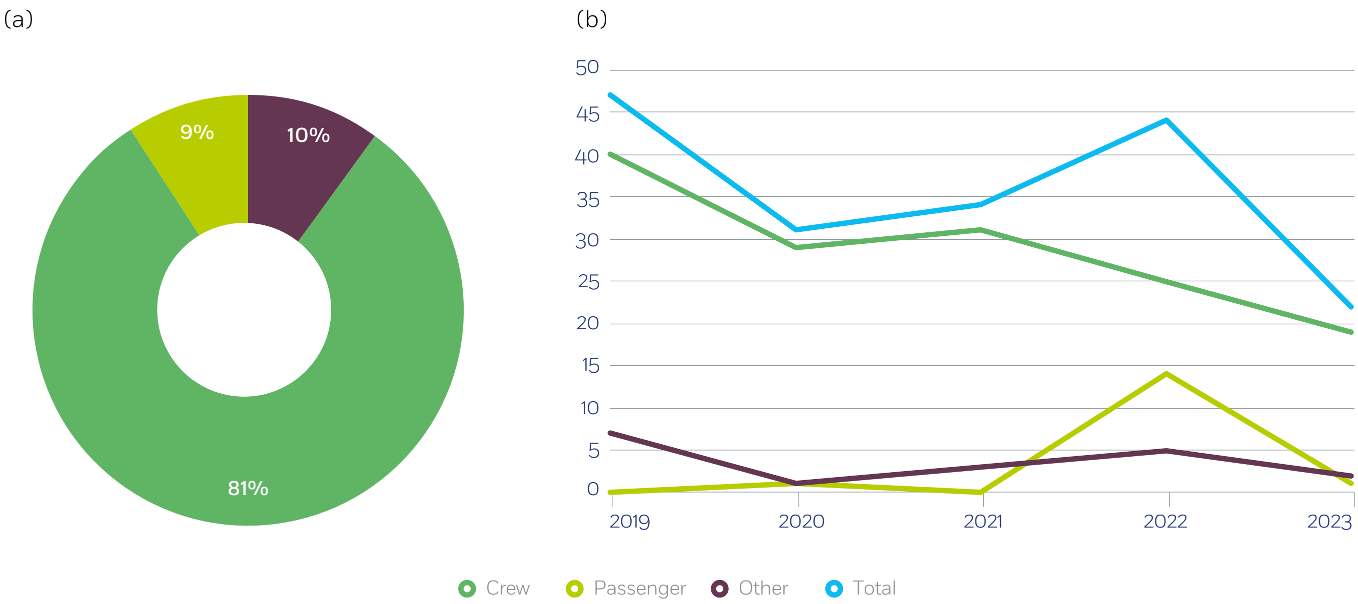
Most of these casualties did not occur in accidents inside EU territorial waters.

Figure 28: Number of fatalities during the 2019–2023 period – breakdown of those occurring within EU waters and involving at least one EU Member State-flagged ship



Source: EMCIP (EMSA, n.d.).

Figure 29 (a) and (b): Number of fatalities in occurrences involving EU Member State-flagged ships – average distribution by category of person and evolution between 2019 and 2023.

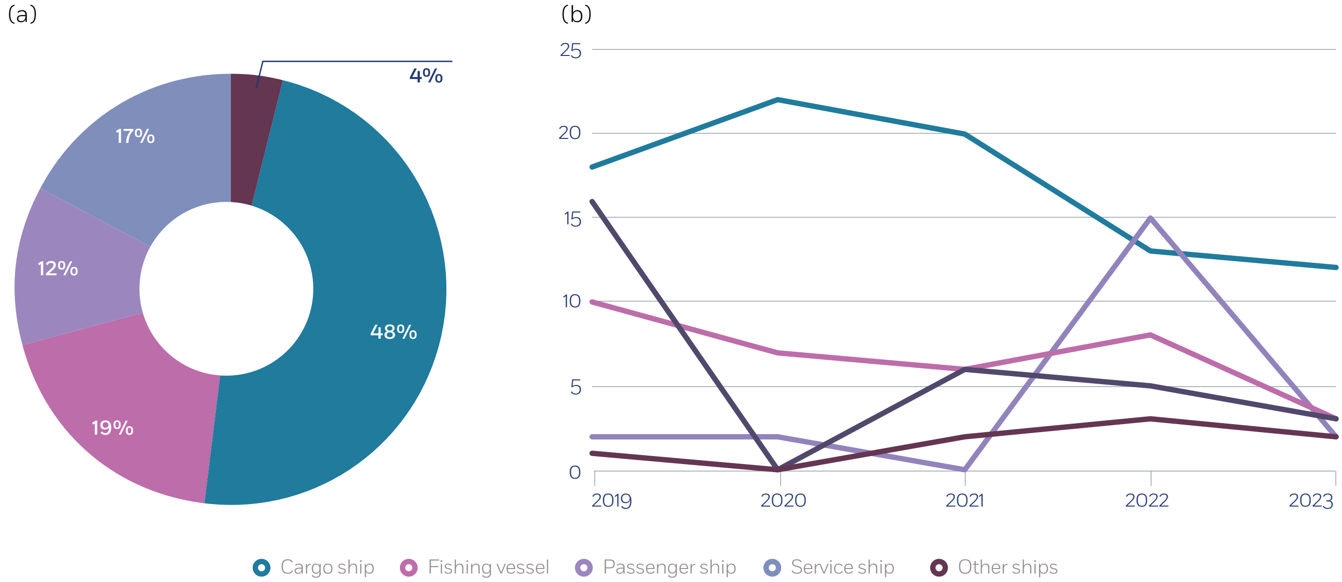


Source: EMCIP (EMSA, n.d.).

Fatalities in marine casualties are catalogued by the category of the affected person: crew members, passengers or others (e.g. port workers or stevedores). Figure 30 considers only those linked to occurrences with EU Member State-flagged ships. 81 % of those affected by marine casualties involving EU Member State-flagged ships between 2019 and 2023 were crew members, as they perform operational tasks, some of them with associated risks. With regard to passengers, the annual number of fatalities must be put into perspective when comparing it with the almost 400 million passengers transported to or from EU ports annually.

Figure 30 shows the distribution of fatalities linked with EU Member State-flagged vessels by ship type and evolution between 2019 and 2023. The largest number of fatalities occurred in accidents involving cargo ships, followed by fishing vessels and service ships.

Figure 30 (a) and (b): Number of fatalities in occurrences involving EU Member State-flagged ships – average distribution by ship type and evolution between 2019 and 2023.

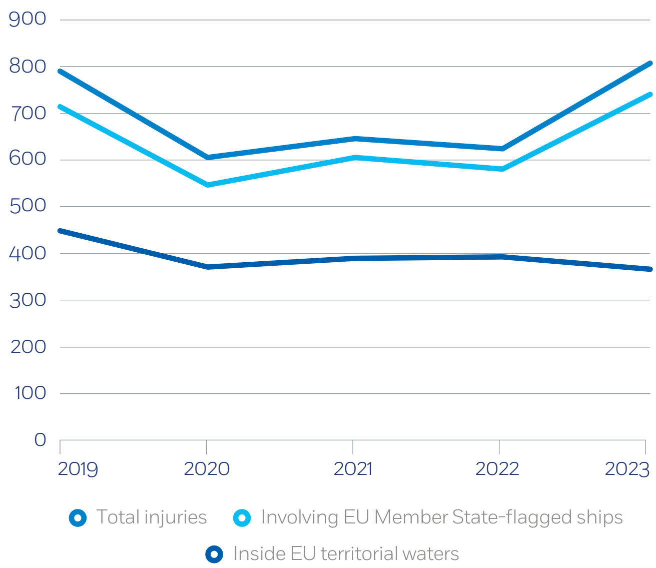


Source: EMCIP (EMSA, n.d.).

Figure 31 shows the evolution in the total number of reported injuries, with a breakdown of those occurring within EU territorial waters and those involving EU Member State-flagged ships. In 2023, 808 people were injured in accidents reported to EMCIP. Most of those injuries did not occur in accidents inside EU territorial waters.

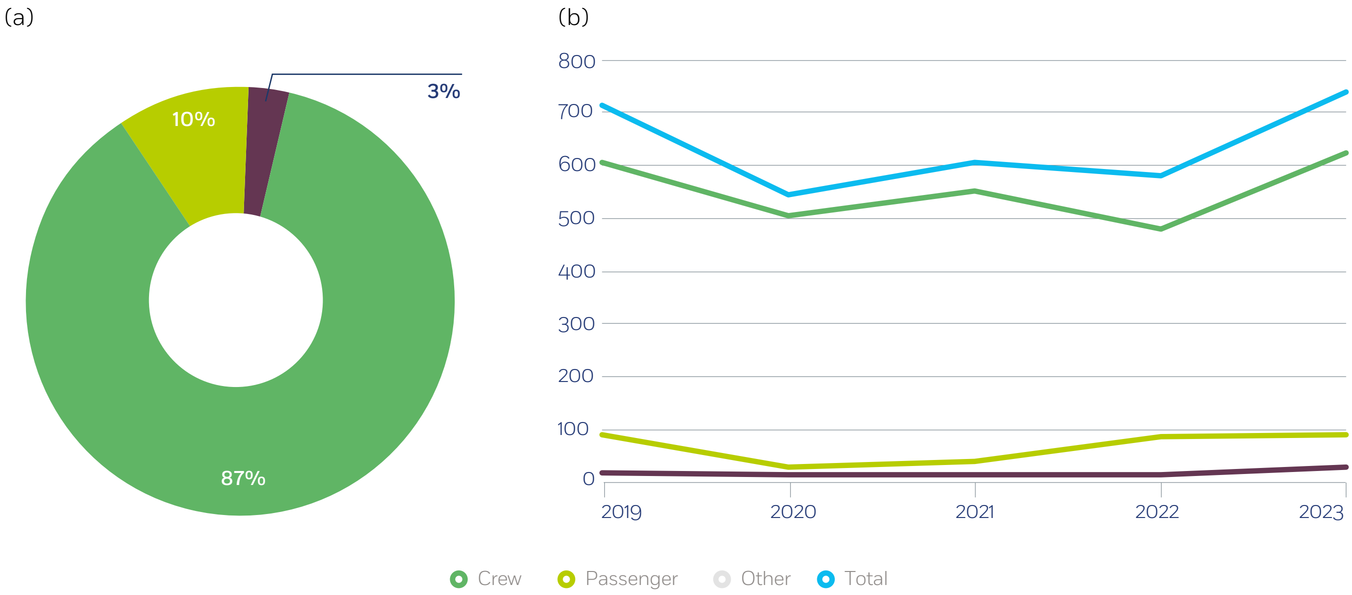
Injuries in marine casualties are catalogued by the category of the affected person: crew members, passengers or others. Figure 32 illustrates the number of injuries in occurrences involving EU Member State-flagged ships, its evolution between 2019 and 2023 and its distribution by category of person.

Figure 31: Number of injuries during the 2019–2023 period. Breakdown of those occurring within EU waters and involving at least one EU Member State-flagged ship.



Source: EMCIP (EMSA, n.d.).

Figure 32 (a) and (b): Number of injuries in occurrences involving EU Member State-flagged ships – average distribution by category of person and evolution between 2019 and 2023.

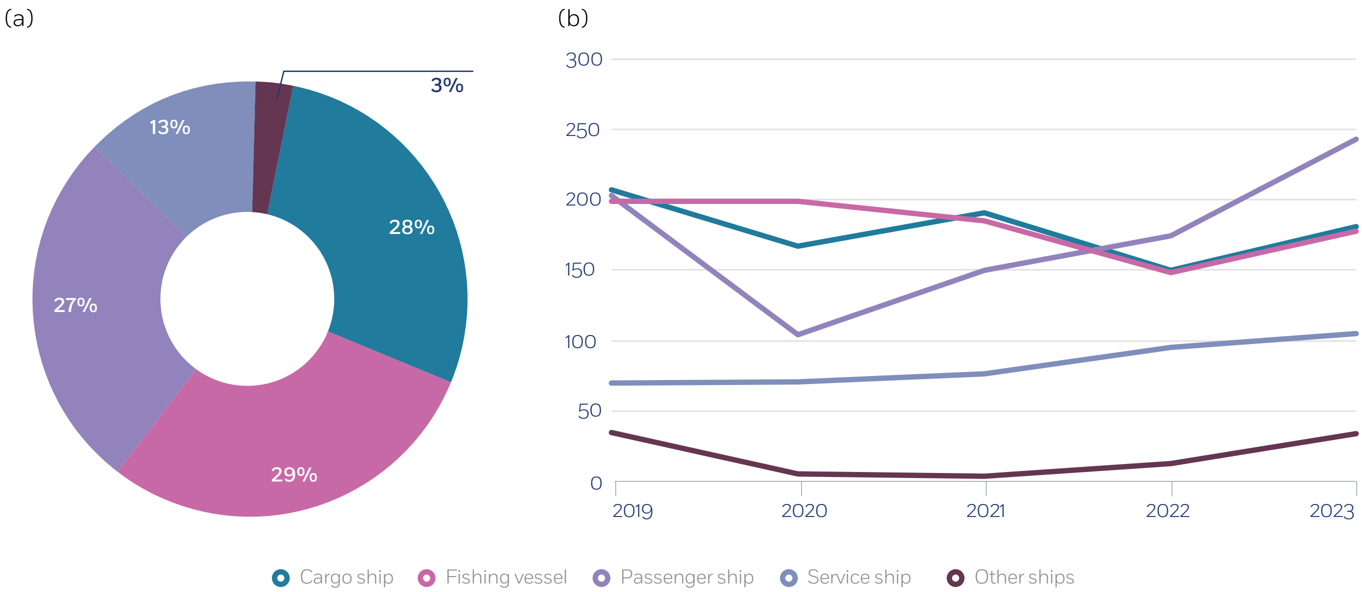


Source: EMCIP (EMSA, n.d.).

As expected, the conclusions on injuries are similar to those on fatalities: the largest numbers correspond to crew members, as they are the ones performing riskier tasks at sea.

Figure 33 shows the distribution of injuries by ship type and evolution between 2019 and 2023. Over this period, the largest number of injuries occurred in accidents involving fishing vessels, followed by cargo ships and passenger ships. In the post-pandemic years, similarly to what was shown in the last edition of Emsafe, most injuries were reported to have taken place on board passenger vessels. This can be explained by the same argument indicated above – the more developed SMSs that report even the slightest injury – and also by the large number of people carried on board these ships, both passengers and crew.

Figure 33 (a) and (b): Number of injuries in occurrences involving EU Member State-flagged ships – average distribution by ship type and evolution between 2019 and 2023.

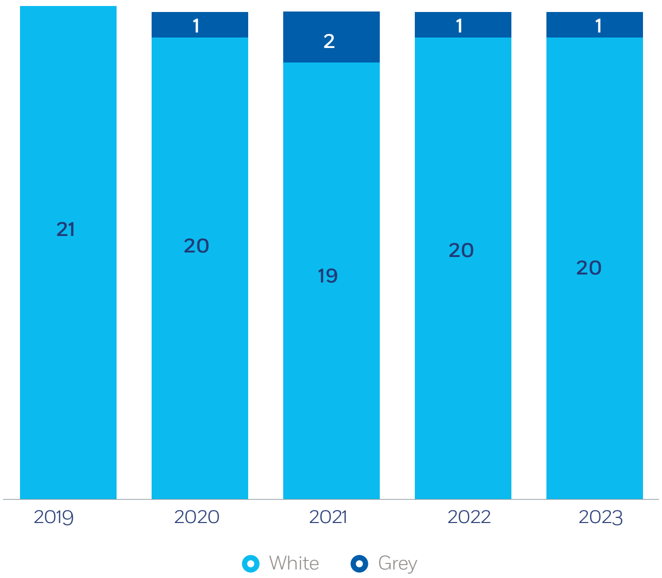


Source: EMCIP (EMSA, n.d.).

2.4.2 Port state control results

The 'White, grey and black' (WGB) list represents the flag-state performance in the context of PSC in the Paris MoU. It is calculated using a statistical formula based on the total number of inspections and detentions over a three-year rolling period for flags that have been inspected at least 30 times during that period. In the graph below, the evolution of the EU Member States' flags within this classification is represented, based on the performance list valid at the end of each year. Currently, only one EU Member State flag is on the grey list.

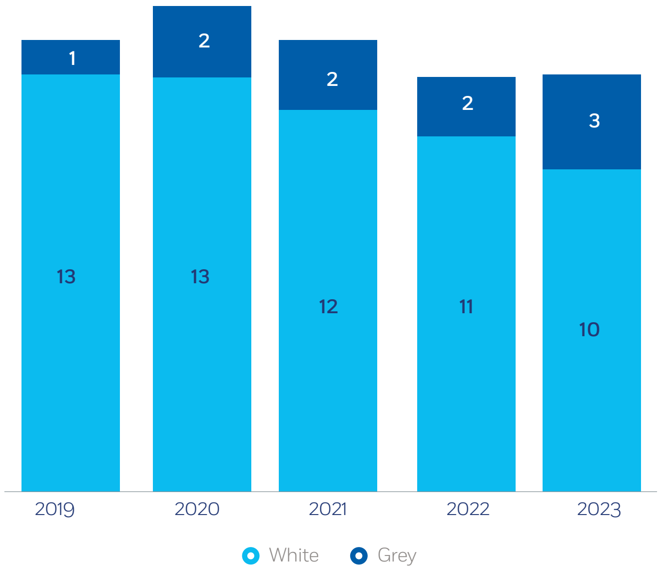
Figure 34: EU Member State flags' performance according to the Paris MoU WGB list – data for the 2019–2023 period.



Source: Paris MoU (n.d.b).

The Tokyo MoU[49] uses the same method to assess the performance of flags in their region. Figure 35 shows that at the end of 2023 there were three EU Member State flags on the grey list – the largest number since 2019. The United States Coast Guard (USCG) uses a different system for flag performance certification under their regional agreement; however, the EU Member States had, at the end of 2023, two of their flags in the high-risk group (Figure 36). The remaining regional agreements do not have a system for flag performance classification.

Figure 35: EU Member State flags' performance according to the Tokyo MoU classification.

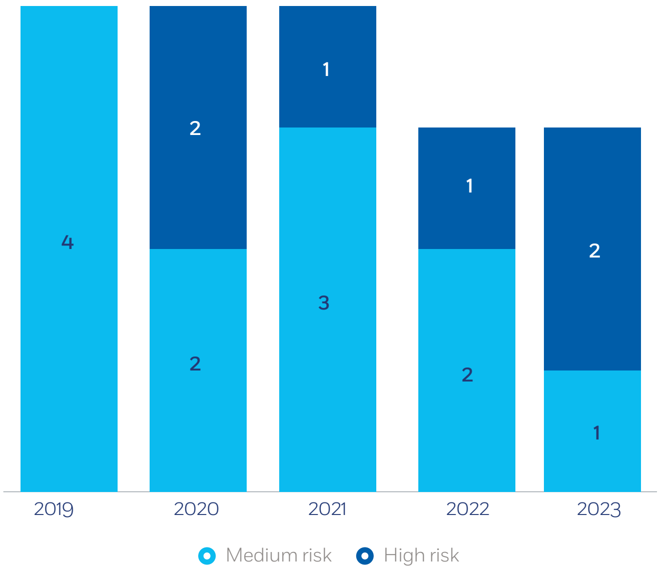


NB: The Tokyo MoU uses the same method as the Paris MOU to assess the performance of flags.

Source: Tokyo MoU annual reports.

49 The Tokyo Memorandum of Understanding port state control regime consists of 22 member Authorities in the Asia-Pacific region (www.tokyo-mou.org)

Figure 36: EU Member State flags' performance according to the USCG's classification.

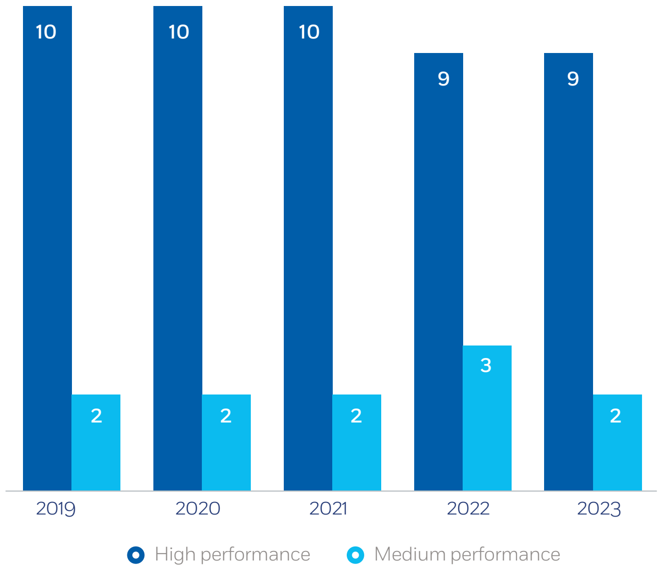


NB: Flags are categorised as medium risk if their overall three-year detention ratio is between 1.0 % and 2.0 %, and as high risk if it is greater than 2.0 %.

Source: USCG annual reports.

The Paris MoU establishes the RO performance based on the number of inspections, detentions and deficiencies recorded, as shown in Figure 37.

Figure 37: Performance of EU ROs – data for the 2019–2023 period.



Source: Thetis (EMSA, 2023b).

2.5 Recognised organisations

2.5.1 Recognition of recognised organisations

When a classification society has been delegated specific tasks on behalf of a flag state, it becomes an RO for that flag state. The flag state may authorise the RO to issue certificates on its behalf. However, the ultimate responsibility for ensuring compliance with international and national regulations remains with the flag state and cannot be delegated. The use of ROs by flag states is optional. The decision to use ROs depends on various factors, such as the size and type of the fleet and the resources available to the flag state. The delegation of authority from the flag state to the RO can be as follows.

- Full delegation of authority to a RO.
- Partial delegation, i.e. certain tasks are not delegated and remain the exclusive competence of the flag administration. These particularities are defined on a case-by-case basis in the agreement between the RO and the flag state.
- No delegation, i.e. the flag state has not delegated any competences to the RO.

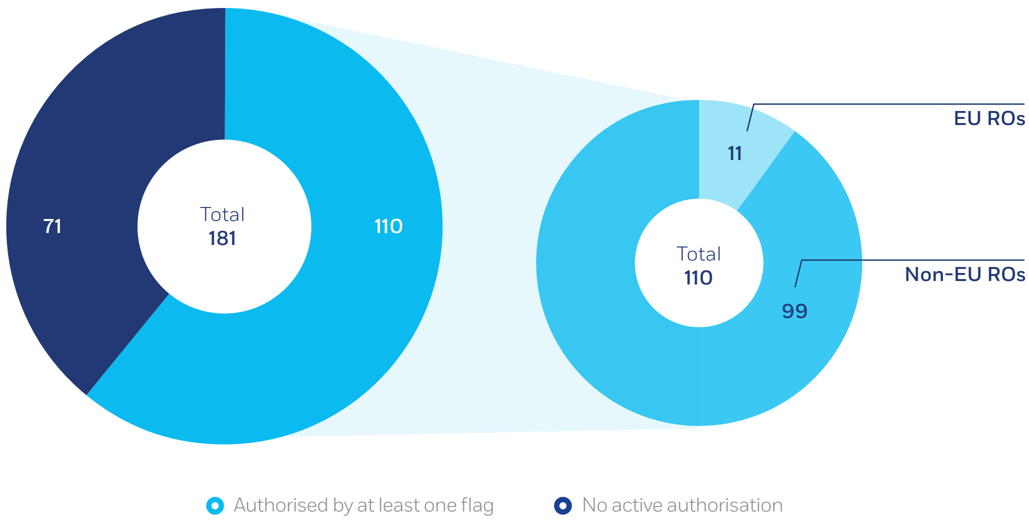
At the EU level, the approach differs depending on the Member State. While some administrations have a large number of flag-state surveyors and an approval office for drawings, others have effectively delegated all their approval and survey tasks to ROs and simply have an RO oversight programme. Equally, other EU Member States have chosen to retain the approval and survey responsibility for certain types of ships, for example passenger ships, in view of the number of persons on board, or newbuild ships.

Currently, almost all EU Member States, acting as flag states, have opted to use ROs for various technical tasks. This practice is permitted and regulated under EU law. To ensure consistency and reliability, the Commission has provided a list of approved classification societies from which Member States can choose. This regulatory framework helps maintain high standards of safety and environmental compliance within the EU maritime sector while allowing flexibility for individual Member States to manage their fleets effectively.

Delegation can only be granted to organisations that fulfil the minimum requirements stipulated in the RO Code, which serves as the international standard for the minimum criteria against which organisations are assessed for recognition and authorisation.

Flag states must report to the IMO the specific responsibilities and conditions of authorities delegated to ROs through the Global Integrated Shipping Information System (GISIS) [50], which currently lists 181 ROs, 110 of them being authorised by at least one flag (a 15 % increase compared to 2020) and only 11 being recognised by the Commission.

Figure 38: Number of ROs listed in GISIS with active authorisation by at least one flag and number of authorised ROs that are EU ROs.



Source: GISIS (IMO).

50 https://gisis.imo.org/public/default.aspx/.

The 11 EU ROs belong to IACS, but IACS membership does not entail EU recognition. In fact, one of the IACS members is not an EU RO.

Until 2022 there were 12 EU ROs, but the EU withdrew the recognition of the Russian Maritime Register of Shipping to act as a recognised ship inspection and survey organisation in the EU in October 2022 ([51]). The society also had its IACS membership withdrawn earlier that year.

EU Member States can only authorise a classification society recognised by the Commission to act on their behalf, but there is no restriction on accepting in EU ports a ship that is surveyed and certified by a non-EU RO.

For the system to work properly at the international level, flags should only recognise classification societies that ensure an appropriate safety level. However, the information available indicates that certain combinations of flags and ROs result in ships not fulfilling the safety and pollution-prevention requirements of the conventions. The Paris and Tokyo MoUs prepared a joint submission to the IMO (III 5/5/5) indicating those combinations that consistently presented the worst safety performance. This paper quotes the Declaration of the second Joint Ministerial Conference of the Paris and Tokyo Memoranda of Understanding on Port State Control, as follows.

To invite the Port State Control Committees to develop criteria for the identification of the flag states and their recognised organizations that jointly have poor performance and to investigate options, including the possibility of changing the relevant international conventions so that certificates issued by these recognised organisations on behalf of these flag states are not recognised as valid.

At the EU level, it was decided to harmonise the process by centralising the recognition of such entities at the Commission with support from EMSA. This makes a significant difference with respect to the international recognition system, which can, on occasion, be abused, as indicated in the previous paragraph. Member States can participate in the assessment of the RO they have authorised and join in the EMSA inspections as observers.

At the beginning of each calendar year, EMSA invites the EU Member States to share information on the number of ships surveyed and/or certified by an RO on their behalf in the previous year. Table 26 shows the information available to EMSA in 2024 corresponding to the reporting of 17 Member States. In total, 8 621 ships (around 66 % of the total number of ships in the EU Member States' fleet in 2023) were reported to have been surveyed and/or certified by the RO on behalf of the EU Member States.

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51 Council Regulation (EU) 2022/1904 of 6 October 2022 amending Regulation (EU) No 833/2014 concerning restrictive measures in view of Russia's actions destabilising the situation in Ukraine (OJ L 259I, 6.10.2022, p. 3, ELI: http://data.europa.eu/eli/reg/2022/1904/oj).

Table 26: Number of ships surveyed and/or certified by the RO on behalf of the EU Member States in 2023 – as reported to EMSA by 17 Member States in 2024.

Recognised Organisation	No. of ships surveyed and/or certified by the RO on behalf of the EU Member State-flagged
American Bureau of Shipping (ABS)	748
Bureau Veritas S.A. (BV)	1,495
China Classification Society (CCS)	61
Croatian Register of Shipping (CRS)	33
DNV AS (DNV)	1,697
Indian Register of Shipping (IRClass)	25
Korean Register of Shipping (KR)	67
Lloyd' s Register (LR)	966
Nippon Kaiji Kyokai (ClassNK)	284
Polish Register of Shipping (PRS)	229
RINA Services S.p.A. (RINA)	3,016

Source: EMSA services based on questionnaire to Member States.

It is often the case that the classification society of the ship acts as the RO for its survey and certification. In this regard, Table 27 shows the number of EU Member State-flagged ships classed to an EU-recognised RO in 2023. Despite the overall decrease in the number of ships (see Section 2.3.1), there was a slight increase in the sum of GT in most classification societies. This means that larger ships remain classed with societies that are EU ROs.

Table 27: Number of EU Member State-flagged ships classed with EU ROs – fleet of 2023.

Classification Society	No. Ships	GT sum
American Bureau of Shipping (ABS)	754	47M
Bureau Veritas S.A. (BV)	2,706	40M
China Classification Society (CCS)	98	8M
Croatian Register of Shipping (CRS)	351	1M
DNV AS (DNV)	2,767	74M
Indian Register of Shipping (IRClass)	22	346K
Korean Register of Shipping (KR)	58	2M
Lloyd' s Register (LR)	1,441	46M
Nippon Kaiji Kyokai (ClassNK)	322	11M
Polish Register of Shipping (PRS)	130	480K
RINA Services S.p.A. (RINA)	1,789	25M

NB: Class information is not available for 19 % of the fleet. Double-classed ships are counted twice.
Source: EMSA services.

In Table 28 the 11 ROs are listed with the number of EU Member State-flagged ships under their class and divided by type of ship.

Table 28: Number of classed ships by type of each EU RO.

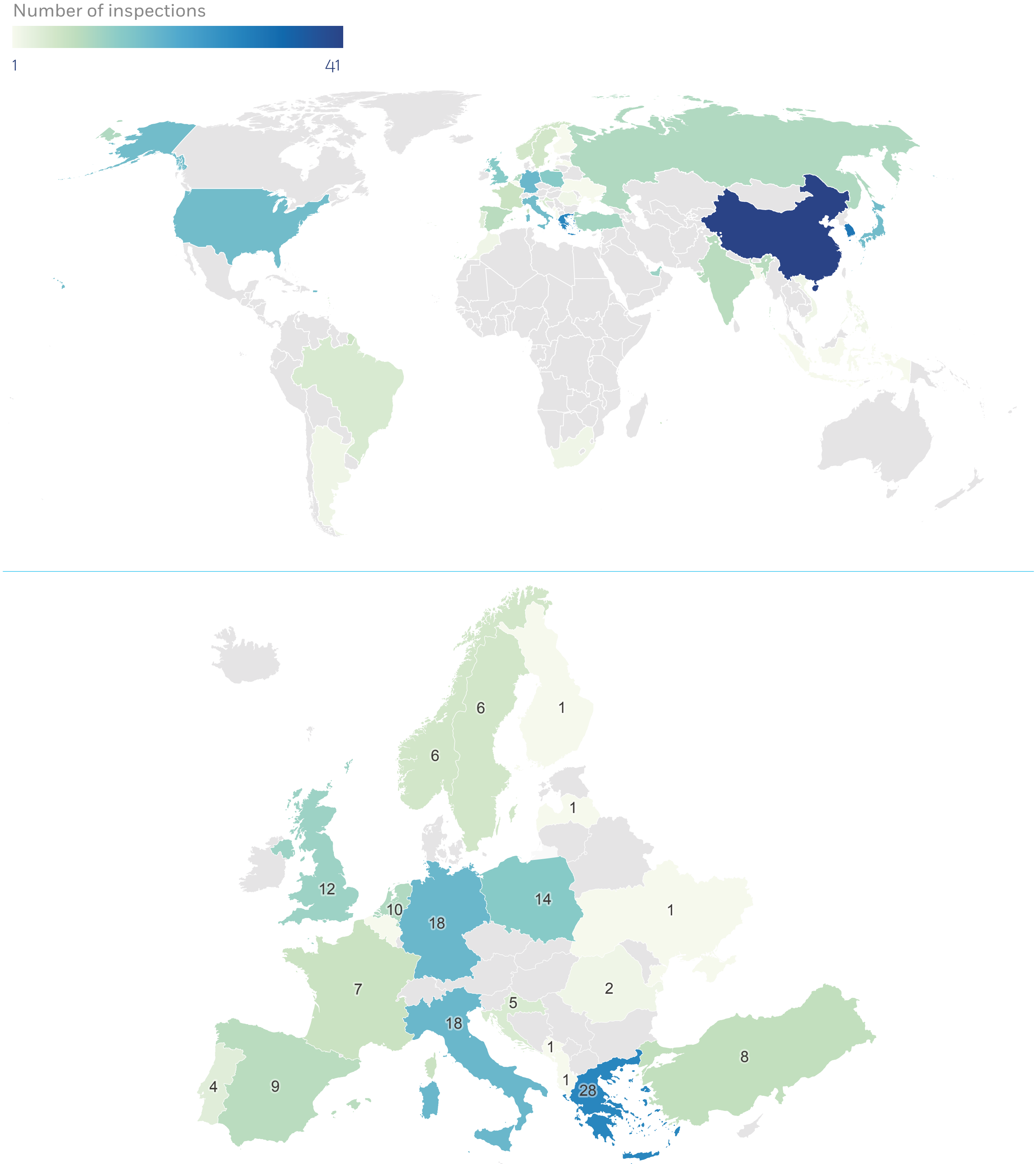
Per ship type	Tankers	Bulk carriers	General Cargo Ships	Container ships	Ro-Ro Cargo	Ro-Pax	Other cargo ships	Other work vessels
American Bureau of Shipping (ABS)	315	180	1	156	10	4	0	88
Bureau Veritas S.A. (BV)	485	138	463	230	37	218	21	1114
China Classification Society (CCS)	16	37	10	30	0	0	4	1
Croatian Register of Shipping (CRS)	16	9	11	4	2	272	0	37
DNV AS (DNV)	530	173	393	493	142	306	48	682
Indian Register of Shipping (IRClass)	5	0	0	0	0	16	0	1
Korean Register of Shipping (KR)	21	15	15	5	1	1	0	0
Lloyd' s Register (LR)	368	218	182	137	71	127	10	328
Nippon Kaiji Kyokai (ClassNK)	57	231	4	26	2	0	0	2
Polish Register of Shipping (PRS)	3	2	20	1	0	34	2	68
RINA Services S.p.A. (RINA)	242	120	226	54	120	468	28	531

NB: Class information is not available for 19 % of the fleet. Double-classed ships are counted twice.

Source: EMSA services.

The process of recognising a classification society at the EU level is triggered by a request from a Member State. This initial assessment is carried out by the Commission based on reports from EMSA, which has been entrusted with the task of carrying out the required inspections. In addition, there is a regular assessment of each RO – in principle once every two years – also based on reports from EMSA. The inspections take place in the head offices and selected regional, field and site offices of the classification societies and include visits to ships. In 2022–2023, EMSA conducted 39 inspections, reaching a total of some 350 inspections since starting operations in 2004. The inspections were conducted in different geographical areas (Europe, Asia, North and South America, Middle East and Africa) as indicated in the map in Figure 39.

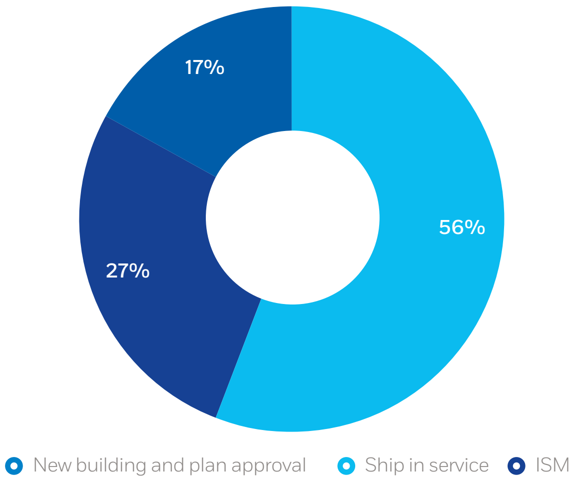
Figure 39: Geographical distribution of EMSA's inspections of ROs from 2004 to 2023.



Source: EMSA services.

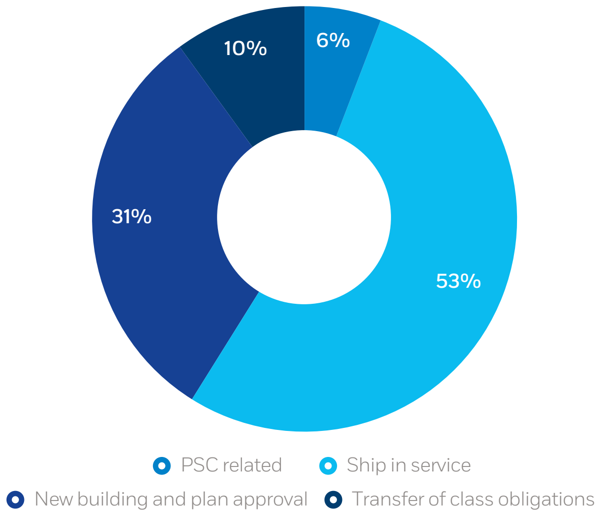
Since 2009, EMSA has carried out more than 200 inspections under Regulation (EC) No 391/2009 ([52]) and established close to 4 000 findings. Looking into the findings established in the inspections of the 11 ROs currently holding EU recognition ([53]), most of them relate to compliance with classification rules and procedures (27 %), compliance with statutory requirements during the survey (23 %) and compliance with requirements for the verification of ISM (9 %). There is also room for improvement regarding the training and monitoring of surveyors, with 8.5 % of the findings falling into this category. A distribution of the findings regarding non-compliance with statutory and class requirements can be seen in Figure 40 and Figure 41, respectively.

Figure 40: RO inspections – findings on non-compliance with statutory requirements (including ISM) by category.



Source: EMSA Internal Data

Figure 41: RO inspections – findings on non-compliance with own class rules and procedures by category.



Source: EMCIP (EMSA, n.d.).

As a consequence of the findings, ROs have adopted corrective actions, either on a voluntary basis or at the Commission's request. At least once every two years, the consolidated results of the visits, inspections and assessments are discussed with the Member States, thereby providing valuable information to national administrations for the purpose of their own monitoring of the ROs they authorise within the framework of the directive.([54])

These findings come from the inspections of organisations that are also IACS members, which have the highest reputation within classification societies worldwide in terms of professionalism, knowledge and quality of procedures. For example, according to Electronic Quality Shipping Information System (Equasis) ([55]) statistics, ship detention rates are in general higher for ships not classed by IACS members. In this regard, it is important to note that, according to the same source, a substantial part of the world fleet is classed by classification societies that are not IACS members and, therefore, not subject to the same internal quality systems and external inspections as those of EMSA. Therefore, it is not possible to know how the remaining 170 classification societies implement the relevant conventions on board ships.

In terms of the inspections carried out, there are certain elements that need to be noted. One of them is related to the obligations regarding the transfer of class set out in Article 10 of Regulation (EC) No 391/2009, which aims, among other things, to prevent ships from changing class in order to avoid carrying out necessary repairs. It also obliges the EU ROs to set common standards concerning

52 Regulation (EC) No 391/2009 of the European Parliament and of the Council of 23 April 2009 on common rules and standards for ship inspection and survey organisations OJ L 131, 28.5.2009, p. 11, ELI: http://data.europa.eu/eli/reg/2009/391/oj). This regulation replaced Directive 94/57/EC.

53 List of organisations recognised on the basis of Regulation (EC) No 391/2009 of the European Parliament and of the Council of 23 April 2009 on common rules and standards for ship inspection and survey organisations (2022/C 466/07) (OJ C 466, 7.12.2022, p. 24, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.C_.2022.466.01.0024.01.ENG&toc=OJ%3AC%3A2022%3A466%3ATOC).

54 Directive 2009/15/EC of the European Parliament and of the Council of 23 April 2009 on common rules and standards for ship inspection and survey organisations and for the relevant activities of maritime administrations https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A32009L0015

55 https://www.equasis.org/EquasisWeb/public/HomePage.

cases of transfer of class where special precautions are necessary, such as ships older than 15 years and transfers from a classification society that is a non-EU RO to an EU-recognised one.

As can be seen in Table 29, there are many class transfers between EU ROs.

Table 29: Number of ships transferred between classification societies that are EU ROs between 2019 and 2023, based on the date of request for transfer.

EU RO	No. lost ships	Gained	Net Gained-Lost	Fleet size 2023
ABS	1,940	1,090	-850	8,334
BV	1,773	2,013	240	10,602
CCS	286	695	209	5,314
CRS	17	74	57	92
DNV	2,716	1,274	-1,442	8,098
IRS	133	663	530	1,315
KR	378	598	220	2,077
LR	1,763	1,326	-437	7,497
NK	1,559	705	-854	7,766
PRS	53	289	236	482
RINA	599	2,484	1,885	4,895

Source: IACS (Safer and Cleaner Shipping - IACS). Data downloaded on 03/09/2024. Fleet size presented for reference from IACS Annual Review 2023.

A ship may change its classification society for various reasons, including a change of owner and other commercial reasons. However, another potential cause may be a disagreement between the shipowner and the classification society on the extent of any ship repairs or maintenance that may be required. Consequently, the shipowner may wish to appoint a classification society that imposes less stringent requirements.

Although IACS requirements and EU regulation have tightened the procedures, this area still needs continuous monitoring and the acceptance into class of ships not built under the supervision of an EU RO. EMSA inspections continue to establish findings in these areas, in particular regarding compliance with class rules and statutory requirements during the class entry surveys.

Finally, it is also worth mentioning that the regulation lays down a system of penalties in case of non-compliance, although so far, no penalties have been imposed.

2.5.2 Degree of delegation

Table 30 illustrates the different degrees of delegation of authority by EU flag states to ROs in the process of issuing the main regulatory safety certificates required by the SOLAS Convention, as reported by the Member States to the IMO up to 2024.

Table 30: Degree of EU Member States' delegations of authority to ROs in the issuing process of the main regulatory safety certificates required by SOLAS.

		Full Delegation	Partial Delegation	No delegation
Passenger ship safety	Survey	74%	4%	7%
	Issue of certificate	59%	7%	19%
Cargo ship safety equipment	Survey	82%	4%	4%
	Issue of certificate	67%	11%	11%
Cargo ship safety radio	Survey	82%	4%	4%
	Issue of certificate	70%	11%	7%
Cargo ship safety construction	Survey	89%	0%	0%
	Issue of certificate	78%	7%	4%
Load line	Survey	85%	4%	0%
	Issue of certificate	78%	7%	4%

NB: No information is provided by the Member States for 15 % of passenger ship safety certificates and 11 % of other certificates. Full delegation is considered when indicated in GISIS without reservations for at least one RO.

Source: GISIS (https://gisis.imo.org) on 16/07/2024. No information is provided by the MS for 15% of the Passenger Ship Safety certificates and 11% of other certificates. Full delegation is considered when indicated in GISIS without reservations for at least one RO.

As can be seen, on many occasions, EU flag states delegate the survey work, but not the certificate issuance, to maintain some control over the process. The surveys carried out for cargo ships within the SOLAS framework are delegated in more than 80 % of cases, while for passenger ship safety the authority on surveys and certificates remains the least delegated (largest shares of 'No delegation').

However, it is worth noting the **overall increase in the delegation of authority from EU Member States' flags to ROs, particularly for issuing certificates**. In 66 % of cases, the task of issuing the passenger ship safety certificate is either fully or partially delegated to an RO, which is a 10 % increase in comparison with the degree of delegation in 2020.

2.5.3 Oversight of recognised organisations

The flag state's responsibilities do not end with the recognition of a classification society. There should be a thorough and consistent oversight programme to ensure that the work carried out by the RO is kept within the authorisation conditions and that the safety performance is satisfactory.

The RO Code includes guidelines on the oversight programme to be followed by flag states.

The summary results of audits under the IMO's Member State Audit Scheme (IMSAS – see Section 2.9.1) indicate that the most common issues faced by states regarding the delegation of authority were the lack of an oversight programme in accordance with the provisions of the III Code; issues regarding the formal agreement between the administration and ROs; the absence of RO evaluation as a basis for delegating authority; and the lack of instructions issued to ROs and not providing ROs with national laws and interpretations thereof.

Table 31: Shortcomings by category on delegation of authority – summary results of IMSAS audits.

Area of findings/observations	Category of findings/observations	Number of shortcomings
Delegation of authority	Evaluation of ROs	39
	Agreement	44
	Instructions to ROs	39
	Providing ROs with national legislation	32
	ROs' records	17
	Oversight programme	49
	Nominating surveyors	9

Source: IMO: Sub-Committee on Implementation of IMO Instruments (2024).

Under the area of implementation, the most frequent categories of root cause for the audit findings were a lack of technical capability and poor technical instructions/guidelines, and a lack of training programmes, which significantly contributed to ineffectiveness in the areas of implementation, enforcement and delegation of authority. This information indicates that inadequate oversight of ROs leads to an increased risk to safety and pollution prevention.

To support flag states in their oversight efforts, the 100th session of the MSC (MSC 100), in December 2018, agreed to a proposal for the establishment of a fully independent International Quality Assessment Review Body (IQARB) for the ongoing review of IACS's Quality System Certification Scheme. The IQARB was subsequently established in 2019 to review the certification process for the quality management systems of those IACS members that act as both classification societies and ROs [56].

The IQARB reviews the adequacy of the Quality System Certification Scheme in meeting the objectives set before classification societies for compliance with the requirements of the RO Code, in relation to the relevant provisions of IMO mandatory instruments, such as SOLAS 1974 Regulations I/6, II-1/3-1 and XI-1/1, along with the III Code.

The IQARB does not certify ROs, but the factual statement it issues annually to each RO may provide confidence to interested parties in relation to the independence, integrity and robustness of the RO's quality management system certification by the accredited certification bodies.

The IQARB will expand its role to cover quality oversight of other, non-IACS, classification societies and ROs.

At the EU level, the oversight programme is regulated by Directive 2009/15/EC on common rules and standards for ship inspections and survey organisations, which stipulates that each Member State shall, on a biennial basis, monitor every RO acting on its behalf and share the results of this monitoring with the Commission and the other Member States. The *ex post* impact assessment on

56 https://iqarb.org/.

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the implementation and effects of the third maritime safety package indicated that the implementation of Directive 2009/15/EC did not result in a change of the monitoring process of the ROs by Member States (European Parliament: European Parliamentary Research Service et al., 2015).

Quality assessment and certification entity

At the EU level, Regulation (EC) No 391/2009 required ROs to set up and maintain an independent quality assessment and certification entity with the main objective of assessing and certifying the RO quality management system. The entity was founded in November 2010 with the name Entity for the Quality Assessment and Certification and of Organisations Recognised by the European Union (QACE). One of the recognition criteria that an RO must fulfil is to have its quality management system certified by the abovementioned entity.

The Commission, with EMSA's assistance, assesses the development and operation of QACE, which is also ISO certified, and reports on the results of and follow-up to its assessments to the Member States at the Committee on Safe Seas and the Prevention of Pollution from Ships.

QACE publishes an annual report every year ([57]) with collective recommendations for ROs. Based on the analysis of audit findings from 2023, QACE concluded that the ROs' processes for the management of technical knowledge, plan approval, survey management, activity monitoring, fleet quality and supplier services were well managed. In contrast, the ROs' processes for the management of new construction, ISM auditing, health and safety, follow-up of PSC detentions and root-cause analysis had scope for improvement.

For 2024, QACE recommended that all ROs:

- focus on improving their reporting and monitoring processes to ensure that errors are minimised in job execution and reporting thereof;
- review their provision of resources to ensure that the job execution, reporting and monitoring processes are performed efficiently and effectively to the required quality and standard.

It is also envisaged that the IQARB will become a legal entity with its own dedicated permanent secretariat through a merger between the IQARB and QACE. This merger will result in a single legal entity that continues to fully meet the requirements specified in Article 11 of Regulation (EC) No 391/2009.

57 https://iqarb.org/documents/.

2.6 International Safety Management Code

2.6.1 Objectives

The ISM Code provides an international standard for the management of the safe operation of ships and pollution prevention. The code is drawn up by the IMO and made mandatory through Chapter IX of SOLAS. The ISM Code is an essential part of the IMO framework in its efforts to ensure, maintain and effect safety at sea and prevent damage to property, people and the environment.

The ISM Code is one of the most significant steps the IMO has taken in the field of maritime safety as it provides the framework through which IMO conventions can be effectively implemented.

It sets goal-based mandates, requiring shipping companies to develop and implement their own SMSs based on their individual operations. The code is flexible, designed to apply to all types of ships and companies.

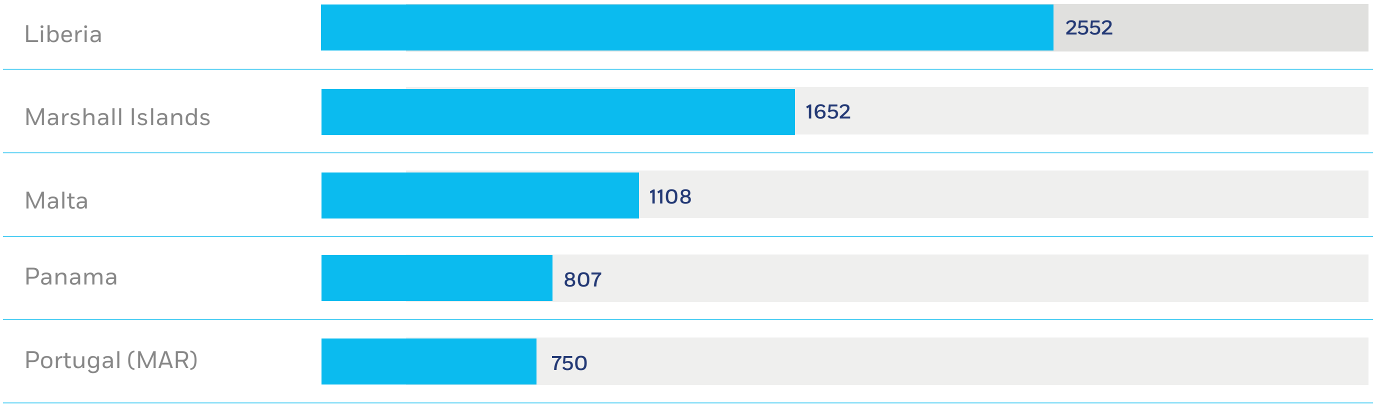
It is important to remember that the ISM Code is focused on a systems approach to management – an SMS. More specifically, it is a systematic approach to managing safety that includes the organisational structure, management responsibilities, safety policy and processes needed for the identification of hazards and the management of safety risks. It is this management system that should ensure compliance with MARPOL, SOLAS, IMDG Code, STCW and all the other conventions, statutes, rules and regulations. Nevertheless, the value of the ISM Code should be distinguished from the existing operational requirements, as they are merely focused on specific shipboard activity and take an incomplete approach. This makes the ISM Code one of the most comprehensive and effective tools for ensuring the implementation of flag-state obligations.

Under the code, each ship must have an internal SMS that should include all the relevant safety procedures. Each ship must be certified by the flag, in accordance with the ISM Code, through the safety management certificate, and its SMS must be audited internally by the company responsible for the safety management of the ship. This company must also hold the document of compliance (DoC) with the ISM Code, issued by the flag. In addition, both the ship and the company holding the DoC must be subject to regular audits by the flag or the RO acting on its behalf.

The company holding the DoC is responsible for the safety management of the ship, but it need not necessarily be either the ship's commercial operator or the company owning the ship. Moreover, they do not need to be located or registered in the flag state, unless otherwise stated in the national law.

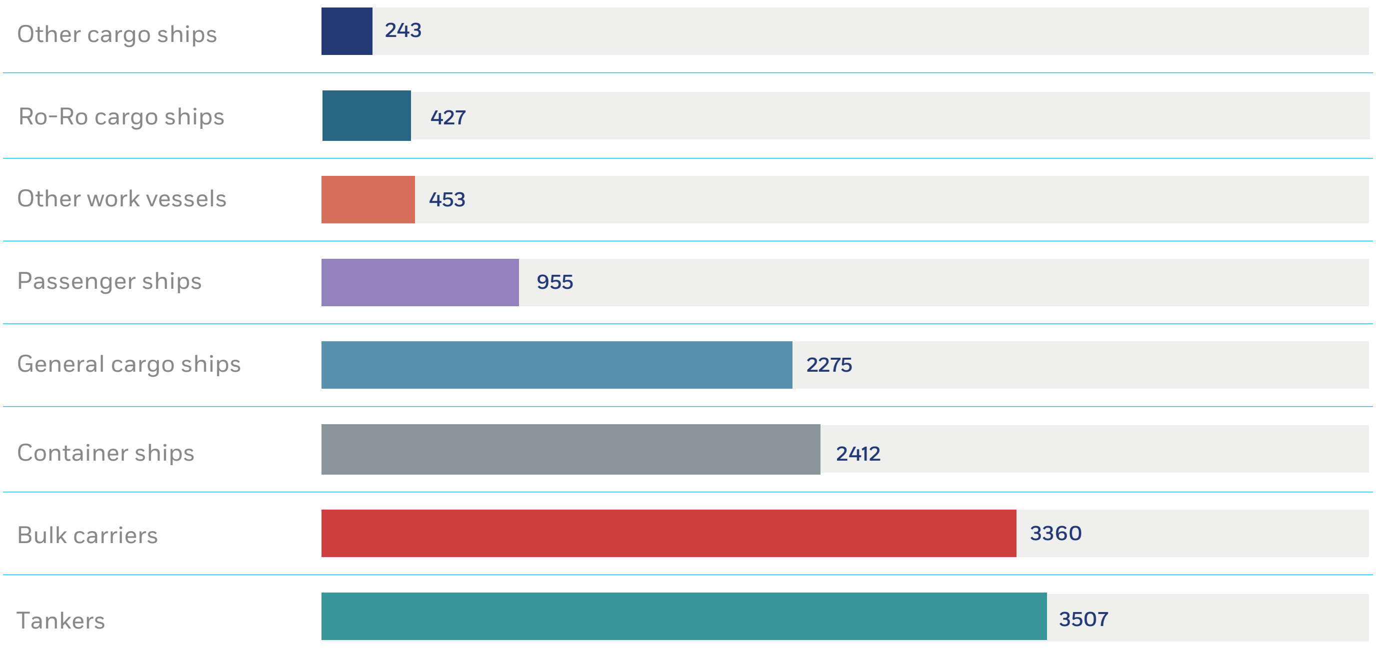
Figure 42 shows the top five flags of ships managed by a company registered in the EU, and Figure 43 the distribution by ship type of ships managed by companies registered in the EU.

Figure 42: Top five flags of ships managed by a company registered in the EU, based on number of ships.



Source: EMSA services.

Figure 43: Distribution by ship type of ships managed by companies registered in the EU, based on country of registration of DoC company.



Source: EMSA services.

Table 32 shows the number of companies registered to the EU Member States, independently of location, and having a DoC, and the number of ships for which they manage safety from an ISM perspective. The ISM Code is an overarching safety framework; therefore, if the DoC of a company is withdrawn, all the associated safety management certificates become invalid.

Table 32: Number of ISM managers registered per country and number of ships for which they hold a DoC.

Country	No. companies (ISM managers)	No. ships
Greece	754	5,086
Germany	193	2,304
Norway	139	1,326
Netherlands	127	1,018
Italy	92	674
Cyprus	45	929
Sweden	36	172
Denmark	34	602
Romania	33	83
Spain	30	148
Croatia	25	169
Bulgaria	23	89
Poland	22	186
Malta	20	46
Finland	19	97
France	19	205
Estonia	17	116
Latvia	17	120
Lithuania	8	62
Portugal	8	48
Belgium	5	88
Iceland	3	9
Ireland	3	44
Luxembourg	2	4
Slovakia	1	1
Slovenia	1	6
Total	**1,676**	**13,632**

NB: This table is not comparable to Table 22 in the previous Emsafe report. Companies counted by country of registration. Only companies holding DoCs for ships within the scope of the ISM Code, i.e. passenger ships > 100 GT and cargo and offshore ships > 500 GT, excluding fishing vessels and other work vessels.

Source: EMSA services.

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The incorporation of the ISM Code into EU law (by means of Regulation (EC) No 336/2006) and its application to all main shipping operations within EU Member State waters represents a commitment to raising the bar for maritime safety and environmental protection. This decision enhances the uniformity of standards, strengthens enforcement mechanisms and emphasises the EU's commitment to global maritime safety efforts while addressing Member States' considerations. The regulation extended the scope of the ISM Code to cover cargo and passenger ships engaged in domestic voyages (with some exemptions), and to mobile offshore drilling units. Regulation (EC) No 336/2006 replaced Regulation (EC) No 3051/95 ([58]), which was the response to a number of very serious accidents in EU waters caused by a combination of human action on board and management failings on shore ([59]). This in effect provided for the anticipated application of the ISM Code (only) to ro-ro ferries and companies operating such ships.

To strengthen safety and environmental standards within the maritime industry, the application of the ISM Code to ships outside of the current scope, such as ships engaged exclusively in domestic voyages operating to or from ports of the Member States, was considered.

Expanding the ISM Code's applicability to domestic voyages and regular services could pose implementation challenges, particularly for smaller vessels and operators. It allows the Member State, as indicated in the preamble (recital 11) to to the regulation, to derogate totally or partially from those provisions, imposing measures that guarantee compliance with the objectives of the code and establish alternative certification verification and verification procedures.

While Member States can implement more stringent rules within their own jurisdiction, harmonising these regulations with international standards and guidelines, such as those set by the IMO, is essential in order to ensure consistency and avoid potential conflicts with other states' regulations.

Still, smaller domestic vessels and their companies may face greater compliance burdens if subjected to the full requirements of the ISM Code. Special provisions or transitional periods may be necessary to support their adaptation to the ISM's requirements. In fact, the regulation excludes passenger ships operating domestically in sea areas closer to the coast, where smaller vessels are typically expected to be found.

Any decision to expand the ISM Code's applicability should be considered carefully, taking into account the specific circumstances and needs of the Member State and its maritime industry. It may also require EU coordination and collaboration to ensure a consistent and effective approach to maritime safety and environmental management.

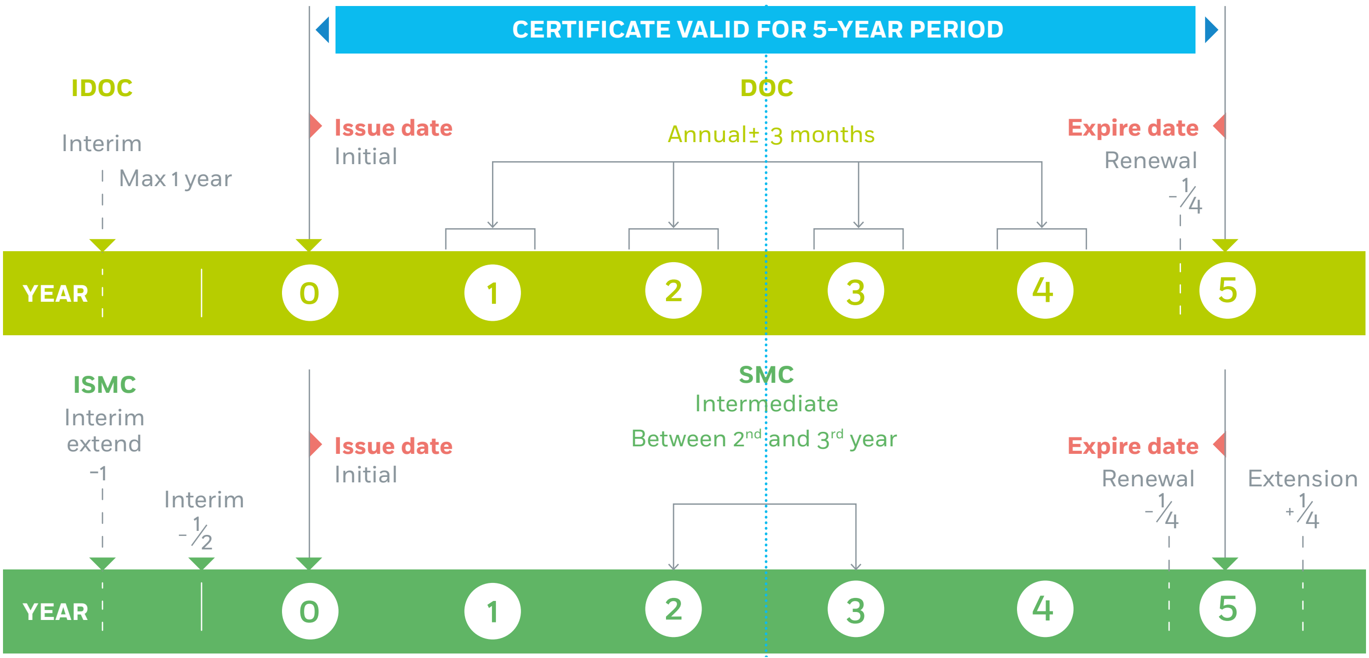
58 Council Regulation (EC) No 3051/95 of 8 December 1995 on the safety management of roll-on/roll-off passenger ferries (ro-ro ferries) (OJ L 320, 30.12.1995, p. 14, ELI: http://data.europa.eu/eli/reg/1995/3051/oj).

59 Ro-ro ferry *Herald of Free Enterprise*, capsized in Zeebrugge, Belgium (1987); passenger ferry *Scandinavian Star*, fire on board (1990); cruise ferry *Estonia*, ingress of water into the vehicle deck, capsizing and ultimately sinking the ship (1994).

2.6.2 Verification and certification

The ISM Code requires shipping companies to establish an SMS that allows verification of the implementation status of various sets of international instruments. To maintain the compliance of both ships and companies, it must be verified regularly by the flag administration, or the RO on the latter's behalf. The SMS covers a wide variety of areas, from company policies on safety and pollution prevention to procedures for management reviews.

Figure 44: Verification and certification SMSs.



Source: EMSA services.

The importance given to this code can also be seen in the delegation rate, which remains lower than that of the major safety conventions, as can be seen by comparing Table 33 with Table 30. However, a similar tendency towards an increase in the delegation of both audits and issuance of certificates can be observed. For example, there has been an increase of 27 % in the full delegation of authority for the issuance of DoCs (from 44 % in 2021 to 56 % in 2024).

Table 33: Degree of EU Member States' delegations of authority to ROs in the issuing process of ISM certificates.

Certificate		Full delegation	Partial delegation	No delegation
DoC (ISM company)	Survey	70%	4%	15%
	Issue of certificate	56%	11%	22%
Safety Management Certificate (ISM ship)	Survey	70%	11%	7%
	Issue of certificate	56%	19%	15%

NB: No information is provided by the Member States for 11 % of ISM certificates. Full delegation is considered when indicated in GISIS without reservations for at least one RO.

Source: GISIS (https://gisis.imo.org) on 16/07/2024. No information is provided by the MS for 11% of ISM certificates. Full delegation is considered when indicated in GISIS without reservations for at least one RO.

2.6.3 Work at the International Maritime Organization

At MSC 84, member governments, intergovernmental organisations and non-governmental organisations were invited to submit proposals to make the guidelines and the ISM Code more effective and more user-friendly, and to introduce greater clarity where there may be ambiguity. Within this framework, and taking advantage of the opportunity to promote improvements in the implementation of the ISM Code, the EU Member States and the Commission agreed to propose the revision and clarification of several ISM Code elements.

The Committee on Safe Seas and the Prevention of Pollution from Ships, at its 10th meeting on 13 November 2008, agreed to set up an ISM working group, chaired by the Commission and facilitated by EMSA, to examine possible improvements in the ISM Code and related guidelines. It was agreed that the ISM Code should be preserved as much as possible and not be changed into a prescriptive rule.

Within this framework, EU Member States and the Commission made a number of joint submissions to the IMO on the improvement of the ISM Code. It was considered appropriate to make a joint submission to ensure that non-EU ships would also comply. The outcome was a set of EU submissions ([60]) that led to the amendment of the ISM Code and related guidelines, which entered into force on 1 January 2015. In 2017, newly revised guidelines on the implementation of the ISM Code by administrations were adopted through Resolution A.1118(30) ([61]). In the same year, a set of guidelines on maritime cyber risk management was adopted (which has since been updated ([62])).

In 2023, at MSC 107, Norway proposed a new output on a 'Comprehensive review of the ISM Code and its related guidelines' with the aim of aligning the code with modern management system standards and enhancing its effectiveness and implementation, nearly 25 years after its entry into force. The MSC agreed to keep the proposal in abeyance until the results of relevant studies, including the Secretariat's study on the ISM Code and related instruments, and the outcome of the Joint ILO/IMO Tripartite Working Group, are available.

In 2024, at MSC 109, the Secretariat presented the final report of the 'Study on the effectiveness and effective implementation of the ISM Code' ([63]). The study was based on a multi-method approach, combining quantitative and qualitative data to incorporate diverse perspectives from stakeholders across the industry. Stakeholders included flag-state administrations and ROs representing respectively 30 % and over 50 % of the global fleet; PSC regimes, companies and company representatives covering more than 80 % of the global fleet; and representatives of 1.2 million seafarers. The analysis also utilised ISM verification data from ROs and PSC data from the Tokyo MoU, ensuring a thorough and globally representative evaluation.

The main issues identified through the findings of the study include, but are not limited to:

- the industry's poor safety culture, in which safety procedures are not taken seriously and are characterised by a culture that blames seafarers for issues identified on board and a lack of reporting;
- minimum safe manning determinations not reflecting actual operational requirements and tending to underestimate the number of crew required to operate safely, leading to inadequate management of crew fatigue and excessive workloads;
- a lack of training on non-technical skills, familiarisation with the SMS and emergency procedures;
- excessive paperwork, voluminous documentation, irrelevant checklists and procedures – all developed to support SMS implementation;
- a lack of PSC procedures for identifying manning problems and ISM-related deficiencies;
- inconsistencies in ISM verification and certification pointing to inadequate flag-state oversight of delegated functions;
- issues with the ISM Code being too vague, leading to inconsistencies in implementation.

Accordingly, the report includes six recommendations that could be used as basis for further work.

1. **Reviewing the guidelines on the implementation of the ISM Code** to ensure consistent application and interpretation; involving seafarers in SMS development; enhancing risk management; occupational health and safety; continuous improvement; and clarifying roles and responsibilities.

60 STW 43/10, STW 43/10/1, STCW 43/10/2, STW 43/10/3, STW 43/10/4, STW 43/10/5.

61 IMO Resolution A.1118(30) adopted on 6 December 2017 – Revised guidelines on the implementation of the International Safety Management (ISM) Code by administrations, https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/AssemblyDocuments/A.1118(30).pdf.

62 https://wwwcdn.imo.org/localresources/en/OurWork/Security/Documents/MSC-FAL.1-Circ.3-Rev.3.pdf.

63 https://maritimecyprus.com/wp-content/uploads/2024/10/IMO-MC24124-Annex-A-Study-on-the-effectiveness-and-implementation-of-the-ISM-code_c.pdf.

2. **Reviewing the guidelines on PSC in relation to the ISM Code** to ensure consistent identification and coding of ISM Code-related deficiencies, support appropriate manning levels and ensure flag-state administrations apply due diligence in manning determinations.

3. **Reviewing some specific elements of the ISM Code** to reflect modern company structures, clarify company responsibilities, strengthen top management accountability, add provisions for change management, enhance the master's authority and promote a safety culture.

4. **Initiating a holistic review of IMO instruments dealing with resources and personnel** to ensure manning determinations reflect actual operational requirements and consider fatigue and workload.

5. **Promoting the development of training guidance for non-technical skills** to optimise human contributions to safety, including training in risk assessment, decision-making, incident analysis, open reporting, communication, handling non-conformities, task management and fatigue.

6. **Enhancing capacity building on the effective implementation of the ISM Code and its related instruments** by improving the sharing of safety information, organising workshops and forums for safety learning, and promoting best practices and continuous improvement in SMSs.

2.6.4 Considerations reported by Member States

Member States report to the Commission every two years on the implementation of the ISM Code. One of the main topics reported in the latest two-year period was the difficulty experienced during the COVID-19 pandemic. The implementation of the ISM was still mandatory during that period and solutions had to be found, including remote audits. The approach taken was not harmonised, as quick ad hoc solutions were needed. In addition, it was seen that the remote audit possibilities had improved, and therefore they should be considered. To address this issue, the EU is working in the IMO to develop harmonised remote audit requirements.

In terms of digitalisation, Member States recognised, in general, the importance of having well-developed information technology (IT) tools to explore the SMSs of the companies and ships remotely before the audit. This saves time during the on-site audit and allows a focus on the core issues. The more general adoption of e-certificates could also boost the efficiency of the preliminary checks.

Cyber risks were also mentioned as a topic on which increased support and guidance is needed. Their inclusion in the ISM Code makes their audit a challenge for Member States.

Some Member States suggested the need to develop guidance on various topics to support auditors, including on the duration and programming of the audits. Other Member States suggested that Regulation (EC) No 336/2006 should be amended to align it with the newest version of the ISM Code.

According to some Member States, certain companies do not fully understand the concept of root-cause investigation. Consequently, the corrective action plan only addresses the deficiencies described in the objective evidence (which is based on samples) rather than adequately investigating the causes of the problem. As a result, the corrective action is a correction of the deficiencies identified, rather than a systematic improvement of the management system and its implementation.

It is also worth noting that the IMO Sub-Committee on Implementation of IMO Instruments indicates that a considerable number of accidents are caused by the incorrect implementation of the ISM Code. However, this is a topic that should be carefully considered, as the ISM is very much linked to the human element and associated conventions, such as the STCW and the MLC.

Finally, it must be considered that Member States and the maritime industry are undergoing significant technological changes, including the development of autonomous ships, digitalisation and advanced navigation systems. While these advancements have the potential to improve safety, they also introduce new complexities and require robust risk management and safety measures to prevent failures and accidents relating to these technologies. These changes will have a direct impact on the implementation of the ISM Code.

2.7
Remote surveys and audits

During the COVID-19 pandemic, regular mandatory surveys still had to be carried out to ensure the safe and effective functioning of maritime activity. A high level of safety had to be ensured, while at the same time protecting the health of everyone involved in the survey process, including surveyors and crews. Accordingly, in this extraordinary situation, ROs, when authorised by the relevant flag state, carried out remote surveys and audits of ships where the physical attendance on board of surveyors was not possible.

This created a new situation in the maritime world in which remote surveys came to replace physical surveys.

Accordingly, EMSA conducted a focused campaign in 2020–2021 on how EU ROs were deploying remote surveys in response to the COVID-19 pandemic. The results of the campaign highlighted:

- the urgent need for the harmonisation of requirements for the use of remote methods for surveys, audits and other services offered by ROs, to define what could be considered as a remote survey or audit and to precisely describe the conditions and circumstances under which these activities could be performed;
- that the verification and validation of remote surveys and audits during subsequent physical inspections should be mandatory, until the level of assurance and equivalence compared to the services and activities performed with the (physical) attendance of a qualified exclusive surveyor or auditor could be ensured.

To address these issues, the EU, together with other co-sponsors, proposed two new outputs at MSC 104 – one to regulate remote surveys and ISM Code audits, the other to develop guidelines for remote inspections and verifications in the field of maritime security – which were accepted and added to the agenda of the IMO Sub-Committee on Implementation of IMO Instruments as a single item.

The ninth session of the IMO Sub-Committee on Implementation of IMO Instruments finalised guidelines for remote surveys and ISM Code audits in extraordinary circumstances. The guidance for surveys was included in the guidelines adopted by Resolution A.1186(33) ([64]). The guidance for remote ISM Code audits was included in the guidelines adopted by Resolution A.1188(33) ([65]).

The guidance focuses on the circumstances, scope and type of survey (e.g. annual, renewal, intermediate) or audit in which remote technology may appropriately be employed and provides circumstances where an in-person survey or audit must be used either as a supplement to remote methods or, when remote technology is not suitable, as the only appropriate method.

Regarding ISM audits, there should be a distinction between the audit of the company and the audit on board the ship. Certain substantial elements of verification of the implementation of the SMS on board, such as observations of activities and conditions on board, may not be suitable for remote audit. Therefore, periodic audits on board should not be fully replaced by remote activities.

Remote audits can be a valuable tool, especially for office audits or certain aspects of SMS assessments. However, they may not fully replace the in-person observations that auditors conduct on board ships, particularly when assessing the condition and implementation of SMS procedures.

Remote audits have limitations, especially when it comes to verifying the practical implementation of safety procedures and assessing conditions on board ships. Physical inspections, observations and interactions with crew members are often necessary to evaluate the effectiveness of SMSs and security measures.

64 IMO Resolution A.1186(33) adopted on 6 December 2023, Survey guidelines under the Harmonized System of Survey and Certification (HSSC), 2023, https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/AssemblyDocuments/A.1186%2833%29.pdf.

65 IMO Resolution A.1188(33) adopted on 6 December 2023, 2023 guidelines on implementation of the International Safety Management (ISM) Code by administrations, https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/AssemblyDocuments/A.1188(33).pdf.

Consideration should be given to implementing a secure and reliable technology solution for remote audits, considering data privacy and confidentiality.

Auditors conducting remote audits should be adequately trained and experienced in using remote audit techniques. They should also have a clear understanding of when on-site visits are required.

SMS effectiveness often relies on on-site observations, and the decision to use remote audit methods should be made after careful consideration of the specific circumstances and risks involved in each audit activity. Due consideration should be given to aspects such as the roles, responsibility, impartiality and liability of the parties involved, including personnel involved in physical inspection on board the ship (e.g. tests, examinations, gathering of evidence on the condition of the ship). In general terms, the current liability regime regulating the surveys and audits between flags', ROs' and shipowners' obligations will not be changed.

The EU will continue working at the IMO level to ensure that remote surveys do not lead to reduced assurance and effectiveness compared to physical surveys.

2.8 Training and qualification of flag-state inspectors

Enforcement activities by flag states – such as inspections, surveys and audits – to ensure the observance of international rules are carried out by authorised officers of the administration. Otherwise, as explained before, the administration may entrust such activities either to surveyors/auditors nominated for the purpose or to ROs (66).

The flag state should implement a documented system for the qualification of its personnel and the continuous updating of their knowledge (67). Such systems for the qualification of flag and port states' personnel (see Section 3.6) are generally referred to as professional development schemes (PDSs). The inclusion of these provisions on training and qualification in the III Code make such provisions auditable when a state is undergoing an audit under IMSAS.

At the EU level, matters concerning flag states are in part covered by Directive 2009/21/EC on compliance with flag-state requirements. However, as the legislation was first approved in 2009, before the entry into force of the III Code, it does not embed flag-state-relevant parts of the III Code into EU legislation. One of the specific objectives of the 2024 revision of Directive 2009/21/EC (Directive (EU) 2024/3100 (68)) was to update and align the directive with the latest international rules, particularly in relation to the flag-state-relevant parts of the III Code. By aligning the directive with the Code, the EU aims to enhance compliance, strengthen oversight and enforcement mechanisms and promote better coordination and cooperation with Member States' maritime authorities, ensuring that the EU's maritime policies are consistent with international obligations.

The development, establishment and administration of a PDS for personnel involved in implementation and enforcement is only required at the IMO level, and the Member States are responsible for enacting these measures. Nevertheless, in order to foster common capacity building and harmonised training, and to support those EU Member States that do not have a fully fledged PDS for flag-state inspectors, EMSA launched a common core curriculum for flag-state inspectors in 2022, at the basic and intermediate levels, and a common core curriculum for maritime auditors in 2023.

The basic level of the curriculum for flag-state inspectors serves as an entry point for individuals aspiring to become flag-state inspectors, covering foundational elements.

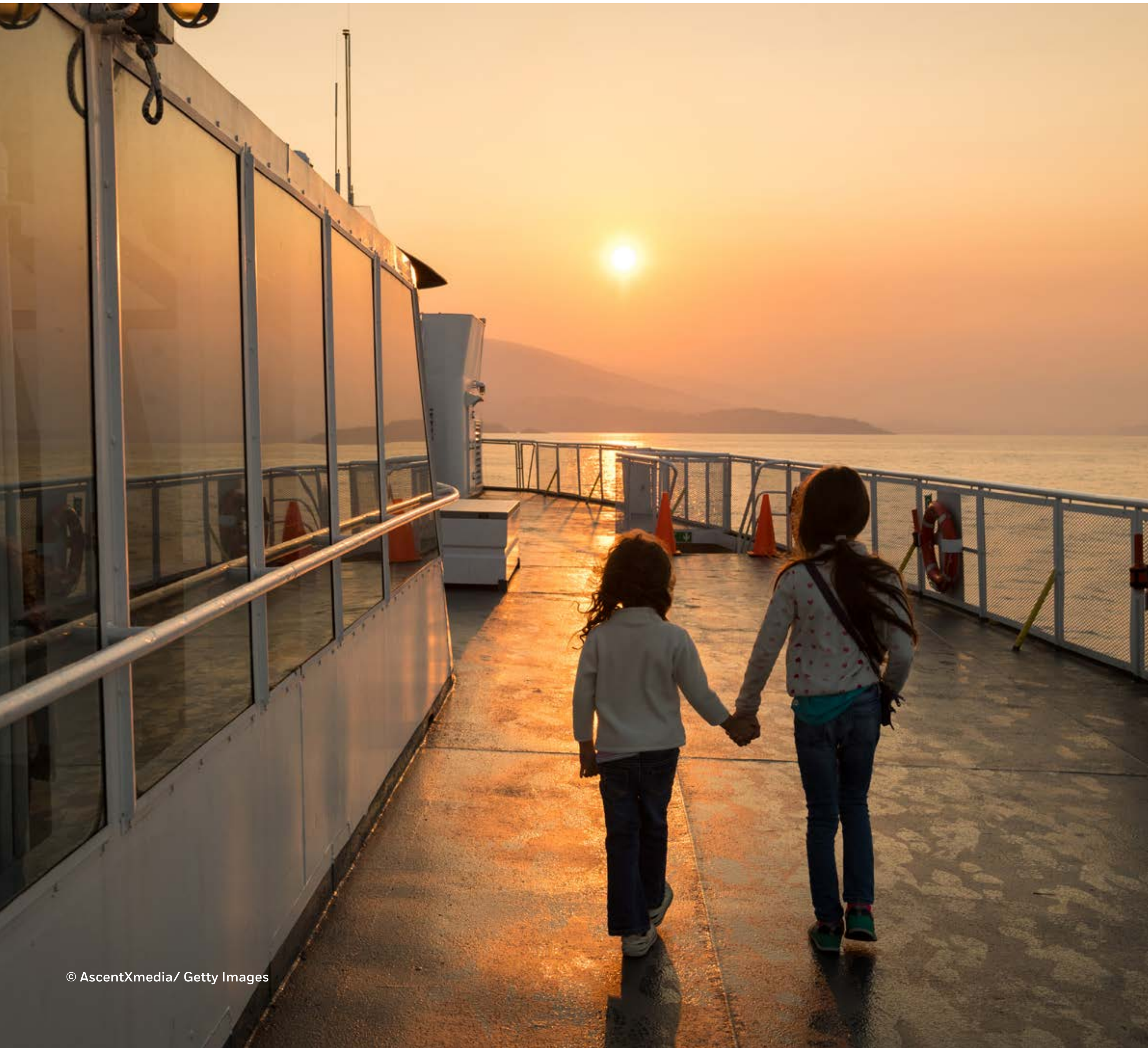
66 SOLAS Regulation I.6, SOLAS Regulation IX.6, MARPOL Annex I Regulation 3.1, MARPOL Annex II Regulation 8, MARPOL Annex IV Regulation 4.3, MARPOL Annex VI Regulation 5.3.1, International Convention on Load Lines Article 13.

67 Paragraph 35 of the III Code.

68 Directive (EU) 2024/3100 of the European Parliament and of the Council of 27 November 2024 amending Directive 2009/21/EC on compliance with flag state requirements (OJ L, 2024/3100, 16.12.2024, ELI: http://data.europa.eu/eli/dir/2024/3100/oj).

The intermediate level targets those who have completed the basic level or have some prior experience as flag-state inspectors, delving into the practical aspects of inspection. The basic level of the curriculum was launched twice, in 2022 and 2024, while the intermediate level was launched for the first time in May 2024. Since 2023, 88 flag-state inspectors have completed the curriculum.

Adding to the support provided to Member States in matters of capacity building, the curriculum for maritime auditors has been designed to develop the knowledge and skills necessary to plan, conduct and follow up on ISM audits and ISPS verifications. It addresses the conduct of any type of audit/verification in the context of the two codes so that authorised officials can carry out their oversight functions. The curriculum for auditors was launched for the first time in 2023, with 38 participants having so far completed this learning journey.



2.9 Meeting flag-state obligations

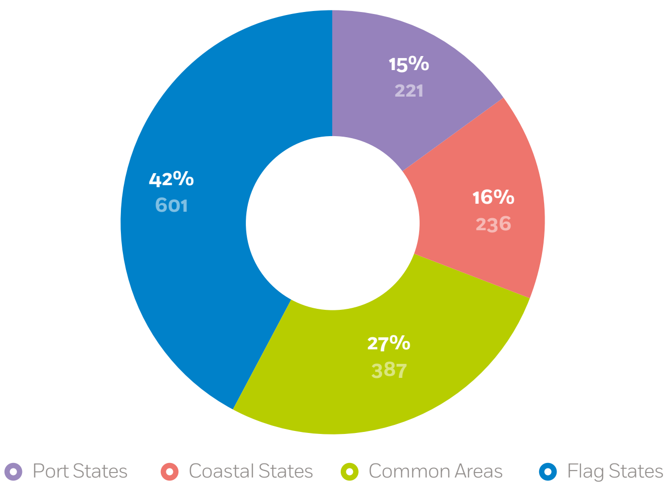
Under Directive (EU) 2024/3100, the obligations for Member States also emphasise the need to maintain and align with IMSAS, which is supported by independent visits and inspections carried out by EMSA on behalf of the Commission and complemented by quality management system ISO audits and possible internal audits by Member States. Additionally, Member States are invited to share the results of the inspections with other Member States in a systematic way, and to monitor via e-reporting. In this way, flag-state administrations will be able to identify issues of common concern and take common action to correct such issues. This also applies to the oversight of ROs performing statutory work on behalf of the Member States (see Section 2.5). The current practice of measuring flag-state performance mostly relates to non-compliance following events, rather than being proactive and based on risk assessment / profiling. The new directive also requires flag states to further develop their performance measurement indicators, not only by including their 'fleet' but also to measure the performance of the 'administration'.

2.9.1 Findings of the IMO's Member State Audit Scheme

Unlike port-state inspections, there is no system for the public reporting of flag surveys in terms of numbers or deficiencies found, therefore it is not possible to provide an analysis in this regard. However, some data come from the IMSAS audits. IMO note III 10/INF.6 (IMO: Sub-Committee on Implementation of IMO Instruments, 2024) includes an analysis of six consolidated audit reports from the audits of 82 IMO member states and one associate member conducted between 2016 and 2022. The IMSAS audits are divided into four main areas to assess the performance of a state in its different capacities: common areas, coastal state, flag state and port state. The largest share of the findings and observations related to flag-state obligations (42 %).

Within the flag-state category, the findings recorded are classified by area of responsibility, as shown in Figure 46. The largest share of the findings (33 %) remains related to implementation, followed by enforcement (17 %) – the same ranking in comparison with the report of 2021, despite the larger number of audits.

Figure 45: Total number and share of findings and observations by parts of the III Code.



Source: IMO: Sub-Committee on Implementation of IMO Instruments (2024).

Figure 46: Number of findings and observations under Part 2 of the III Code – flag states.

Source: IMO: Sub-Committee on Implementation of IMO Instruments (2024).

As referred to in IMO: Sub-Committee on Implementation of IMO Instruments (2024), in the area of implementation, the main findings relate to the lack of policy implementation by issuing national legislation and guidelines and to the assignment of responsibilities to update and revise any relevant policies that are adopted. In addition, various elements need to be addressed by flag states, including the issuance of guidance to assist in the implementation and enforcement of the requirements; administrative instructions to implement applicable international rules and regulations; documentation and guidance concerning those mandatory requirements that are left to the satisfaction of the administration or equivalent; and type-approval processes. Furthermore, there are findings relating to resources to ensure compliance with the requirements of the mandatory IMO instruments, along with findings relating to the determination of minimum safe manning, taking into account relevant and existing measures such as the principles of safe manning adopted by the organisation.

In the area of enforcement, the main findings relate to the absence of appropriate national legal provisions, internal directives and human resources to ensure effective enforcement and compliance with international obligations. In addition, in the national laws and regulations, a lack of penalties of adequate severity to discourage violation of international rules and standards was observed in many cases.

Concerning flag-state surveyors, recurrent findings and observations refer to training programmes, qualification, authority and interrelations among surveyors, and to a documented system for the qualification of personnel and the continuous updating of their knowledge.

With respect to flag-state investigations, most recurrent findings and observations relate to the independence and impartiality of the investigations; the decision to open an investigation; the powers of the investigators, including to board a ship and to initiate an investigation; reporting to the IMO; the release of reports to the public; and other requirements of the Casualty Investigation Code and the III Code.

With respect to the delegation of authority, most recurrent findings relate to the administration's programme for the oversight of ROs, agreements between the administration and the RO, and compliance with other relevant provisions of both the RO Code and the III Code.

With respect to evaluation and review, most recurrent findings relate to the absence of a system to evaluate, on a periodic basis, the performance of the state in its conduct of flag-state activities, regarding the implementation of administrative processes, procedures and resources necessary to meet its obligations as required by mandatory IMO instruments to which the state is a party.

Port state

03

3.1 Introduction

In short, PSC involves the inspection of ships flagged in a different state from that of the port visited, to verify that the condition of the ship, its equipment and its crew comply with the requirements of international conventions and applicable EU legislation. The purpose of PSC is also to ensure that the ship is properly manned and operated to maintain maritime safety, security and pollution prevention. Although the responsibility for compliance mainly lies with the flag state, PSC is intended to be a second line of defence against substandard shipping in the EU and around the globe.

The PSC regime was established by the IMO through Resolution A.466(XII) ([69]), and is applied through international cooperation agreements – the memoranda of understanding (MoU). Regional MoUs on PSC have been created around the world with the aim of sharing information, best practices and procedures to harmonise ship inspection processes. Nine regional agreements on PSC have been concluded: Europe and the North Atlantic (Paris MoU); Asia and the Pacific (Tokyo MoU); Latin America (Acuerdo de Viña del Mar); the Caribbean (Caribbean MoU); West and Central Africa (Abuja MoU); the Black Sea region (Black Sea MoU); the Mediterranean (Mediterranean MoU); the Indian Ocean (Indian Ocean MoU); and Riyadh MoU. The USCG has also established a specific PSC regime.

At the European level, the main regime is the Paris MoU, established in 1982 after the grounding of the very large crude carrier *Amoco Cadiz*, which caused a massive oil spill along the French coast. This incident raised considerable political and public concerns in Europe and resulted in demands for much more stringent maritime regulations covering living and working conditions on board ships, the safety of life at sea and the prevention of pollution from ships. Nowadays, the Paris MoU has 27 active members, including all EU Member States with seaports, along with Canada, Iceland, Norway, Montenegro and the United Kingdom. Russia's membership has been suspended since 2022.

Following the *Erika* and *Prestige* oil tanker accidents in 1999 and 2002, EU safety standards for maritime transport were considerably strengthened with the adoption of maritime safety legislation known as the Erika packages. In this context, Directive 2009/16/EC on PSC, recasting the existing Directive 1995/21/EC, was adopted in 2009 as part of the third package. While the Paris MoU expects its Member States to apply the international conventions on ship safety, pollution prevention, and working and living conditions developed by the IMO and the ILO, the EU PSC regime goes further by legally enforcing the application of international and relevant EU standards.

69 IMO Resolution A.466(XII) adopted on 19 November 1981, Procedures for the control of ships, https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/AssemblyDocuments/A.466(12).pdf.

PSC in the EU is based on the idea of targeted inspections by establishing a harmonised priority system that factors in risk elements for each ship, for example the type of ship, its age, whether its RO is EU or non-EU, etc. The directive shares the inspection effort by stipulating the related duties of each EU port state through annual quantitative inspection targets, also known as the annual inspection commitment. EMSA provides all EU Member States and Paris MoU member states with the necessary technical support to decide which ships should be inspected and to report the results of the inspection via the Thetis inspection database. At the same time, in collaboration with the Paris MoU Secretariat, EMSA offers initial and ongoing training for PSCOs to ensure that inspections are carried out following a harmonised approach at all European ports.

3.2 Regulatory framework

Table 34: Legislation on PSC.

	Level	Instrument	What it regulates
Legislation	International	SOLAS Chapter XI-1 Regulation 4 Resolution A.1185(33) III Code	Procedures for PSC.
		Paris MoU	A harmonised system of PSC involving 27 states (coastal EU Member States, EFTA states, Canada, Montenegro and the United Kingdom). The system covers the waters of the European coastal states and the North Atlantic basin from North America to Europe.
	EU	Directive 2009/16/EC	PSC regime at EU level.

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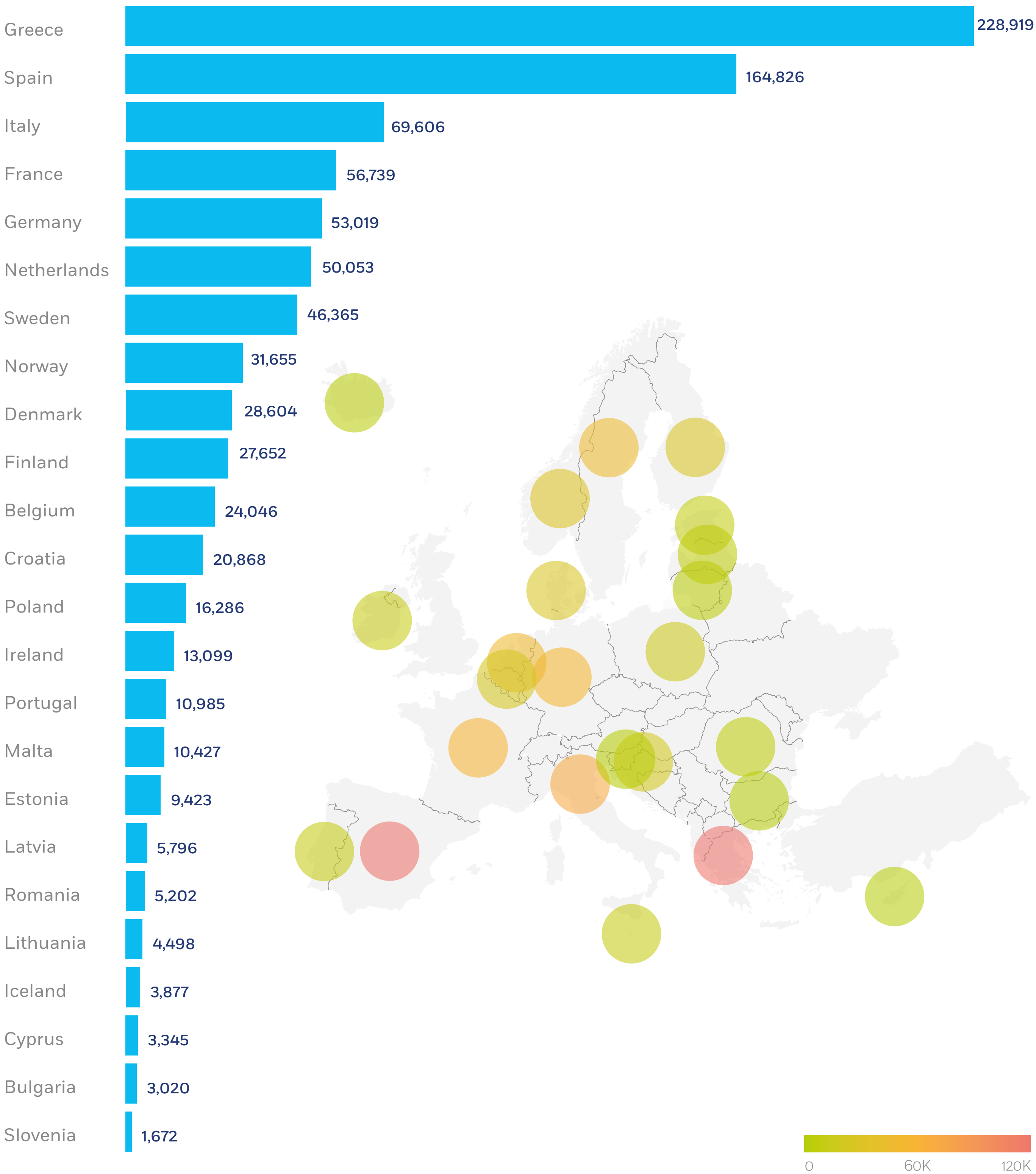
3.3 Maritime traffic in the EU

This section analyses another relevant type of fleet for maritime safety issues in the EU, i.e. the fleet calling at EU ports, regardless of their flag. This is the whole fleet that is subject to PSC and that could be, for example, in distress or involved in an accident in EU waters. For these reasons, it is also important to consider the number and type of ships calling at EU ports. The main source used in this section is SafeSeaNet, the European network for maritime data exchange managed by EMSA.

3.3.1 Number of port calls

The number of port calls has important implications for the reporting, monitoring and inspection efforts of EU Member States. Figure 47 presents the number of port calls per Member State for 2023. The data provide a clear picture of the Member States managing the most port calls.

Figure 47: Number of ship calls at each EU Member State in 2023 – geographical distribution of port calls.



Source: EMSA services (SafeSeaNet).

Greece and Spain are the Member States with the largest number of port calls; in 2023, Greece took the lead from Spain as it recovered from the impact of COVID-19 in 2020. The next Member State in the list is Italy. These numbers are mainly due to passenger ship traffic, including ro-pax, and the highly developed tourism industry of these Member States, which receive millions of visitors each year. Both Greece, due to the large number of islands offering tourism facilities, and Spain, with the high demand relating to the Balearic and Canary Islands and connections with Morocco, receive numerous port calls from passenger ships.

Overall, there were more than 880 000 calls to EU ports in 2023 – an increase of around 30 % compared with 2020 and with pre-pandemic numbers.

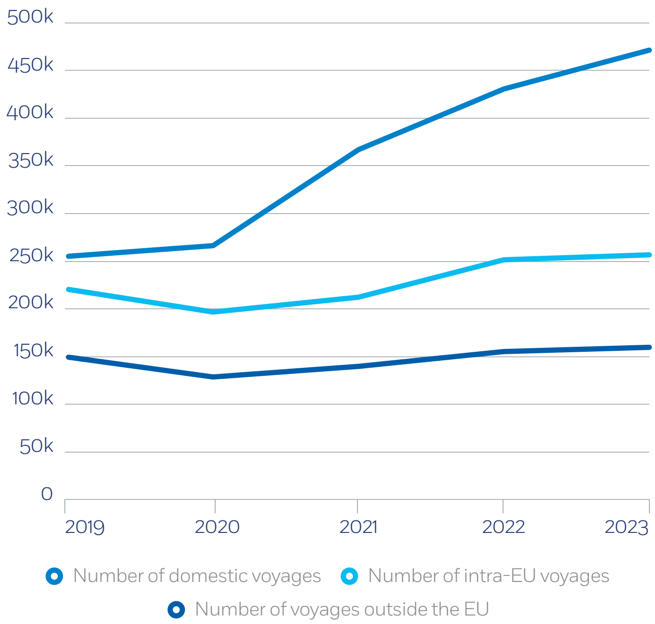
3.3.2 Number of port calls by type of traffic

The type of traffic determines the legislation that is applicable to a certain ship, and, in general, international legislation differentiates between international and domestic voyages. The EU, in addition to these categories, has legislation applicable to ships visiting EU ports. In this subsection, the type of traffic is divided into three categories: outside EU, domestic and intra-EU ([70]). Outside EU includes those voyages departing from a non-EU port and arriving at the EU, while intra-EU refers to those voyages departing from a port in one EU Member State and arriving at a port in another EU Member State. Finally, domestic voyages include voyages departing from an EU Member State and arriving in the same EU Member State. Therefore, the voyages labelled as outside EU and intra-EU are international voyages.

The data clearly show a reduction in 2020 due to the COVID-19 restrictions and the subsequent recovery of the maritime traffic once the situation stabilised. This is clearer when looking at domestic traffic, a significant share of which involves passenger transport, which was one of the most affected sectors. Intra-EU traffic and traffic coming from outside the EU has now stabilised.

From 2020 to 2022, EMSA provided information to the public, thorough weekly reports, about the impact of the COVID-19 outbreak on shipping activities based on vessel traffic data. These figures became available to assist regulators and the industry in defining the recovery strategy to overcome the lasting effects of the pandemic.

Figure 48: Evolution of domestic, intra-EU and outside EU traffic based on number of ship calls at EU ports.



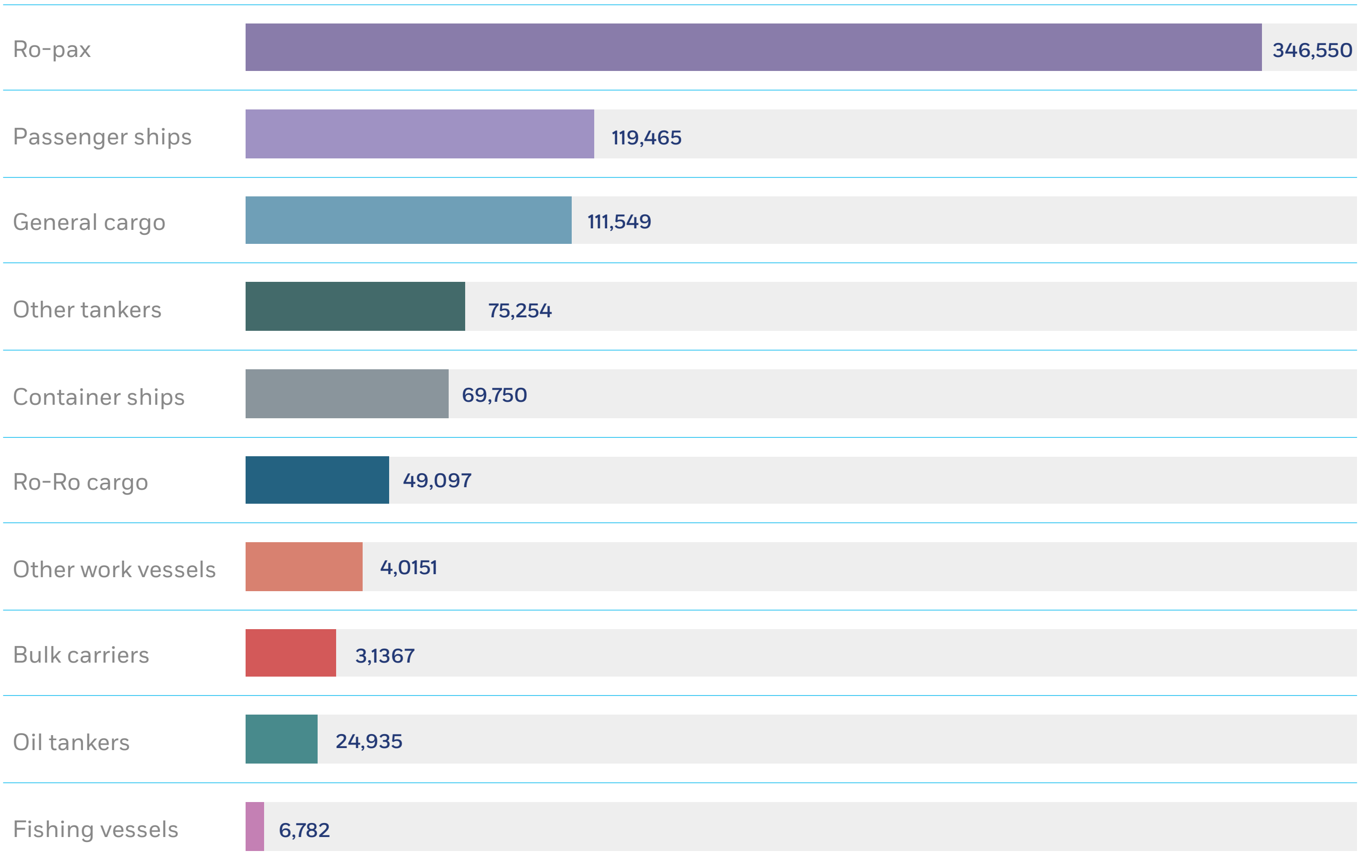
Source: EMSA services (SafeSeaNet).

70 It is not mandatory for Member States to provide information on the last port of call.

3.3.3 Number of port calls by type of ship

Figure 49 presents the number of calls at EU ports per ship type:

Figure 49: Number of calls at EU ports in 2023 by ship type.



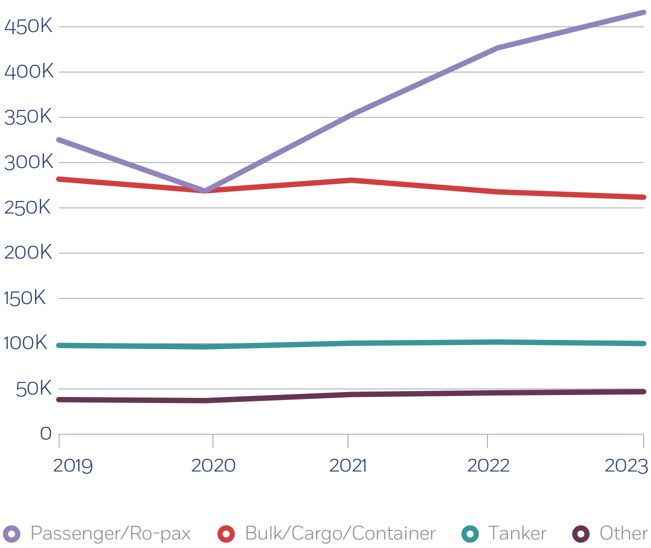
Source: EMSA services (SafeSeaNet).

Unsurprisingly, ro-pax and passenger ships are the ship types calling in the largest numbers at EU ports; these ships usually operate on regular routes with tight timetables and short turnaround times. For that reason, the number of accidents involving these types of vessels is higher than the number involving cargo ships. Given the high activity levels of passenger ships, especially ro-pax, the EU has implemented specific legislation for them, as detailed further in Section 2.2 of this report.

In terms of trends, Figure 50 and Figure 51 show that the mix of ships calling at EU ports was relatively stable between 2019 and 2023, except for passenger ships, which saw a sharp decrease in port calls due to the COVID-19 situation, during which the biggest cruise ships all but ceased operations. Excluding the COVID-19 quarantine years of 2020 and 2021, there has been a steady increase for passenger ships, especially in terms of GT, meaning that the passenger ships that visit EU ports are growing in size. This is an important point to factor in to the contingency plans of EU Member States.

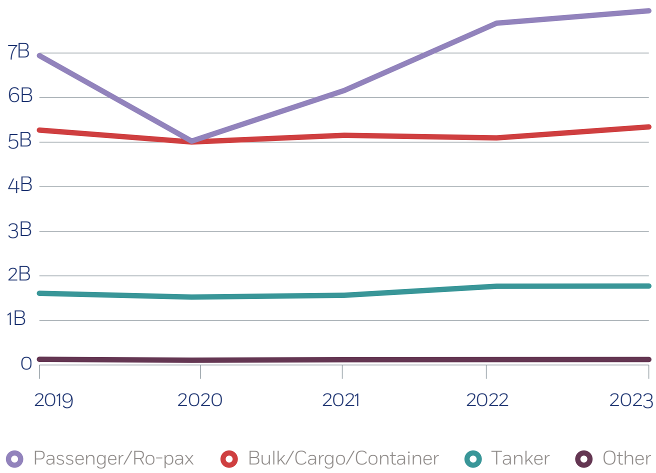
The maps in Figure 52 to Figure 55 show the traffic density in EU waters in total and by ship type.

Figure 50: Evolution of ship types in number of calls at EU ports.



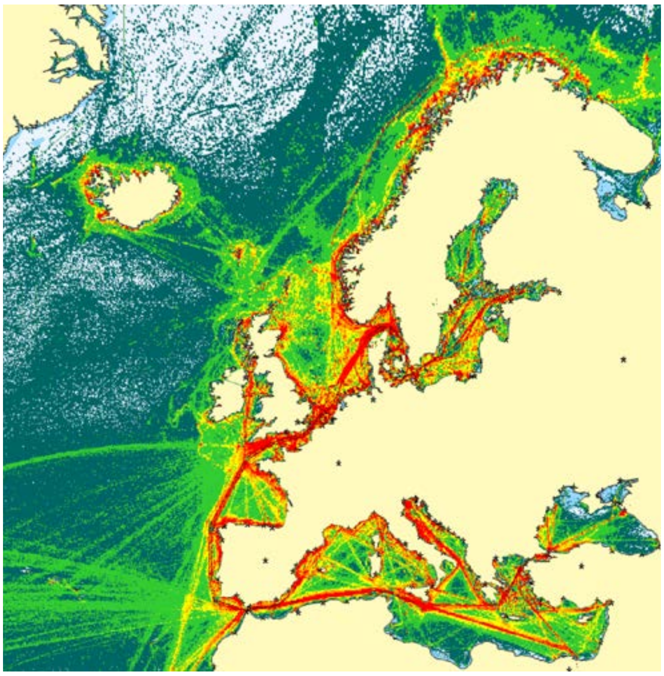
Source: EMSA services (SafeSeaNet).

Figure 51: Evolution of ships calling at EU ports in billions of GT.



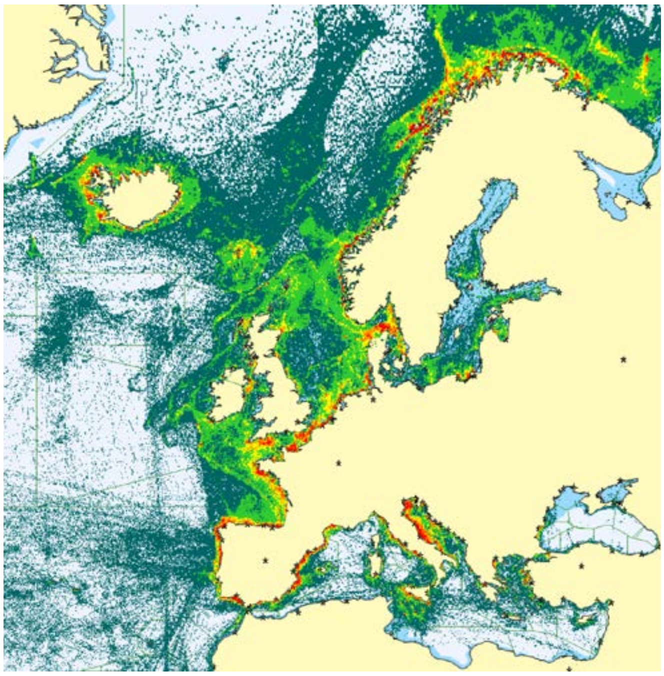
Source: EMSA services (SafeSeaNet).

Figure 52: Traffic density map – all ships in 2023.



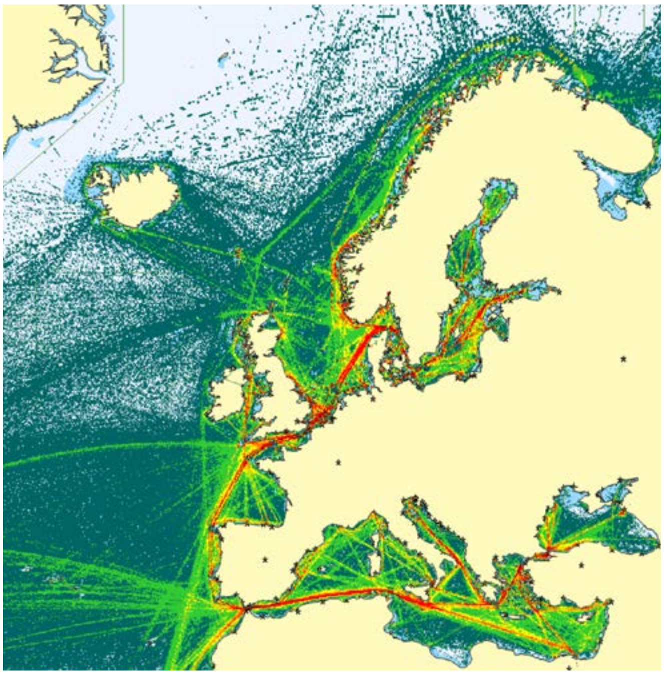
Source: EMSA services.

Figure 53: Traffic density map – fishing vessels in 2023.



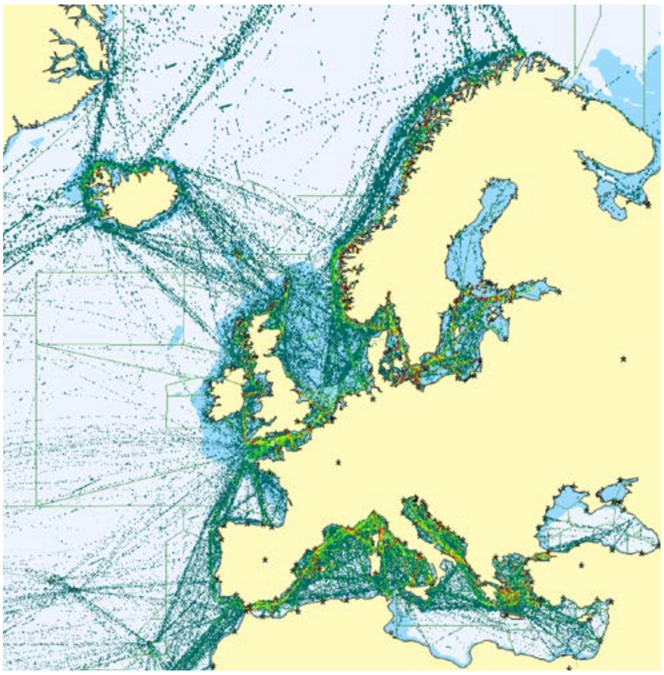
Source: EMSA services.

Figure 54: Traffic density map – cargo ships in 2023.



Source: EMSA services.

Figure 55: Traffic density map – passenger ships in 2023.

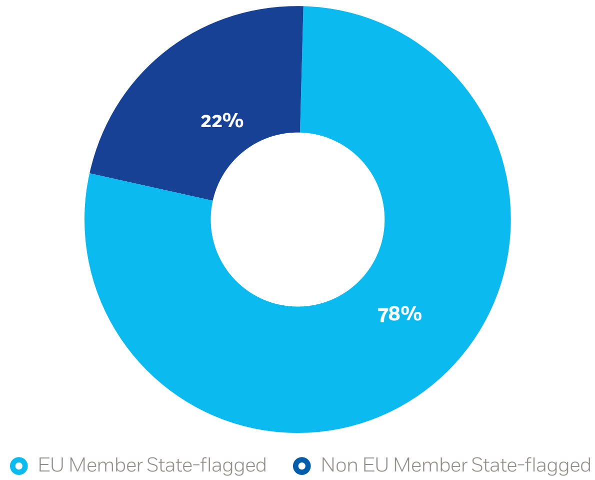


Source: EMSA services.

3.3.4 Number of port calls by flag

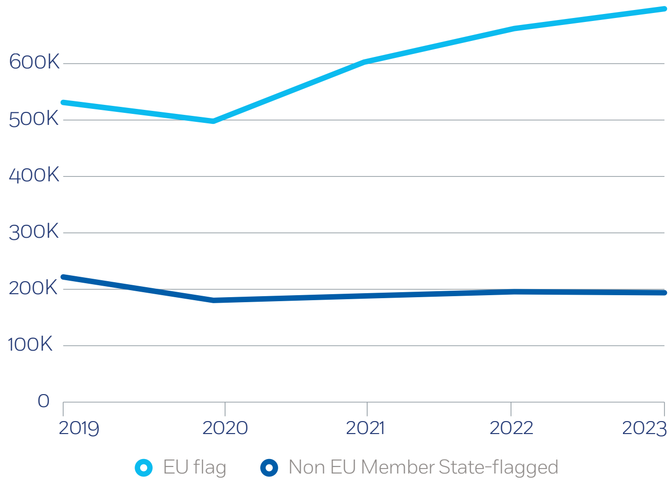
EU Member States, as flag states, are responsible only for those ships flying their flag. However, as the EU is an open market, ships flying under many other flags also call at EU ports, which affects Member States in their capacity as port states. The following charts show the proportion of EU Member State-flagged versus non-EU-flagged ships visiting EU ports over the 2019–2023 period, considering the flag at the time of arrival.

Figure 56: EU Member State / non-EU flag distribution for ships calling at EU ports in 2023.



Source: EMSA services (SafeSeaNet).

Figure 57: Evolution of ship arrivals by EU Member State / non-EU flag at EU ports in the 2019–2023 period.

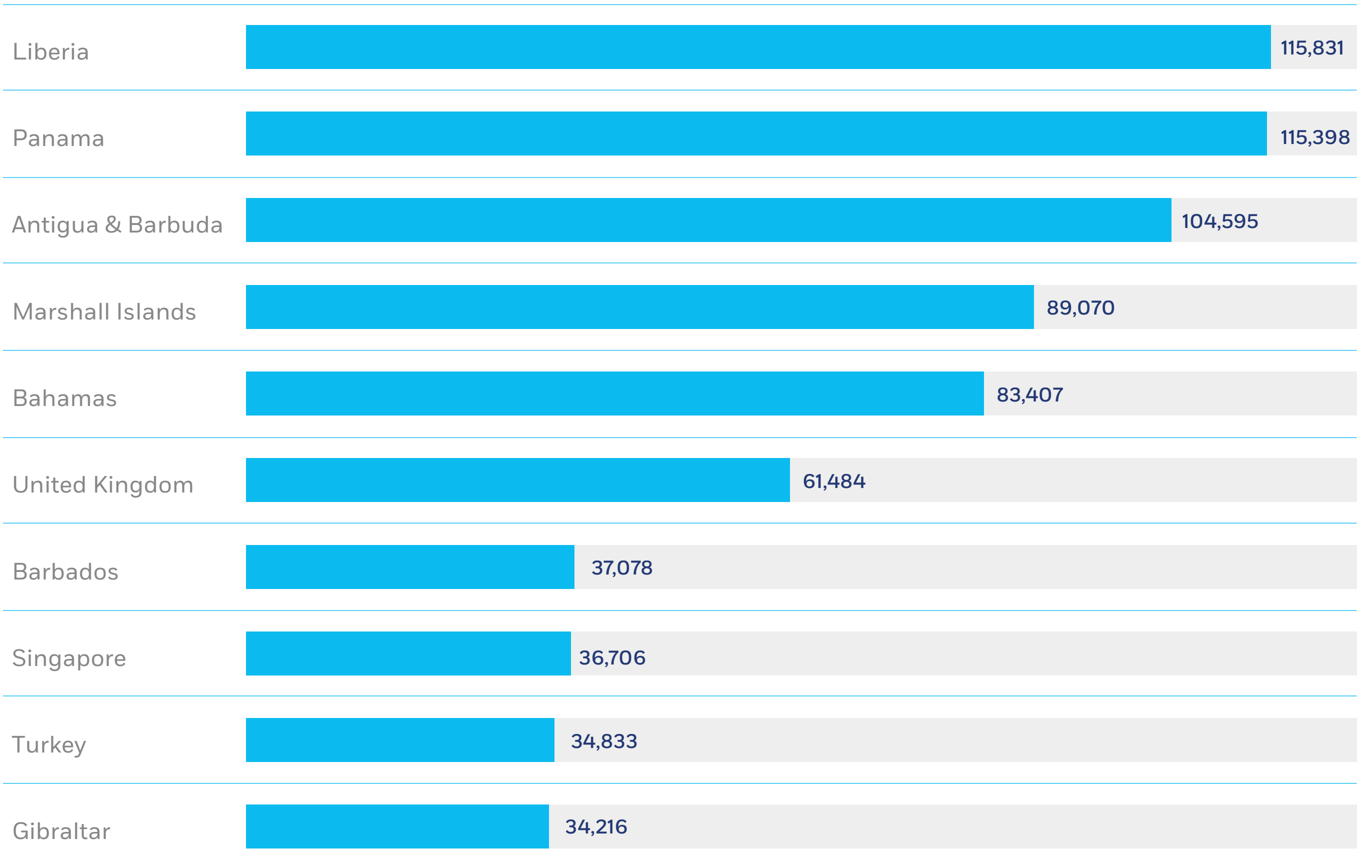


Source: EMSA services (SafeSeaNet).

As shown, fewer than 25 % of all ships visiting EU ports in 2023 did not have an EU Member State flag. To ensure the safety of these ships, and that they are not substandard (i.e. below the international safety standards), the EU has an efficient second line of defence, PSC, which will be analysed in Section 3.4. Since 2020 there has been an increase in the number of calls by ships flying an EU Member State flag in EU ports, a trend that seemingly started even before the COVID-19 pandemic.

The top 10 non-EU flags of ships calling at EU ports over the 2019–2023 period are listed in Figure 58. These represent 72 % of the non-EU ship calls recorded over that period [71].

Figure 58: Top 10 non-EU flags of ships calling at EU ports, based on number of calls between 2019 and 2023.

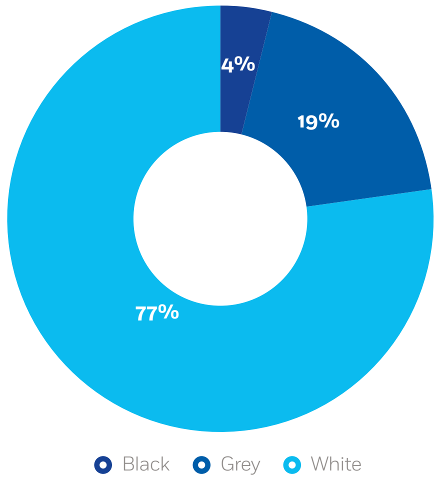


Source: EMSA services (SafeSeaNet).

It is worth noting that while until 2023 all the above-listed flags were included in the white list of the Paris MoU, i.e. the list of those with a better safety performance, since then the Panama flag has moved to the grey list. The grey and black lists include flags with poorer safety performance, but which are allowed to call at EU ports. The following figures present the percentage of calls from ships flying grey- or black listed flags between 2019-2023.

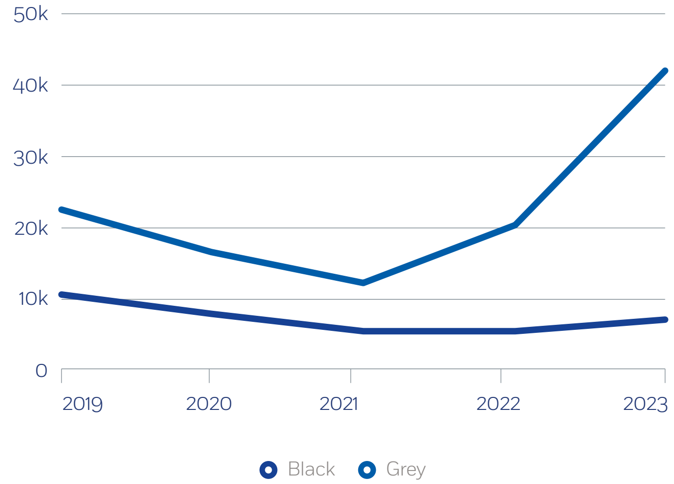
71 In the last edition of Emsafe the respective Figure 23 showed only the number of calls by ships of the top 10 non-EU flags in 2020.

Figure 59: Distribution of the non-EU flags of the ships calling at EU ports in 2023 according to the most recent Paris MoU WGB list.



Source: EMSA services (SafeSeaNet).

Figure 60: Evolution of port calls in the EU by ships with non-EU grey- and blacklisted flags according to the Paris MoU WGB list.



Source: EMSA services (SafeSeaNet).

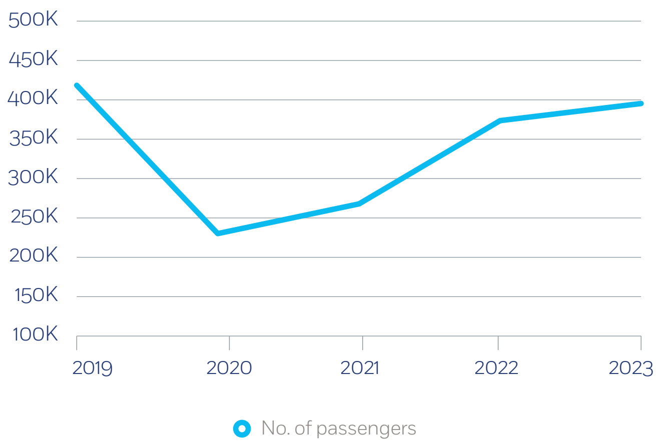
As can be observed, the percentage of ships with grey flags has greatly increased since the last analysis in 2020 (from 5 % to 19 %), while the percentage of those with black flags, based on the Paris MoU WGB list, remains relatively low. This can mostly be attributed to the fact that the non-EU flag that calls in EU ports second most often – Panama – has been on the grey list since 2023. This means that Paris MoU members are now stricter in their inspections of the relevant part of the fleet calling at EU ports to ensure that these ships are brought up to the desired safety and environmental standards.

3.3.5 Number of passengers transported to/from EU ports

Figure 61 presents the number of passengers transported to/from EU ports. After a steep decrease in 2020 linked with the COVID-19 pandemic, traffic is rapidly recovering to its pre-pandemic levels.

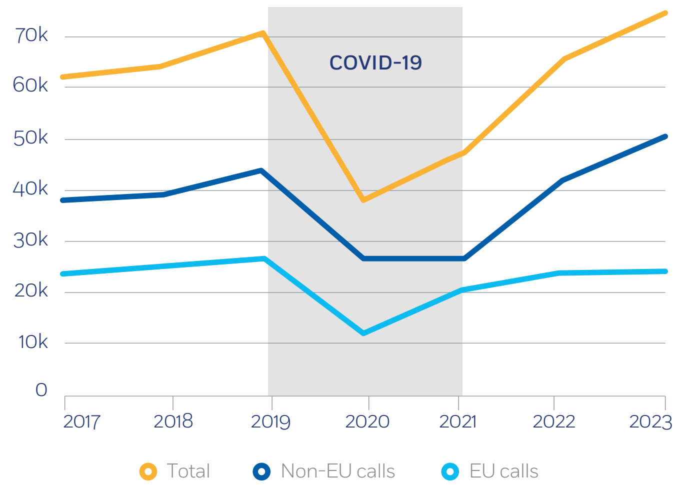
European seas and ports are among the most important destinations in the global cruise sector, with more than 30 % of worldwide port calls made in EU ports in 2023 (Figure 62). In 2023, more than 60 % of the cruise ship calls in the EU were from ships flying the flags of EU Member States.

Figure 61: Number of passengers embarked and disembarked in EU ports – in thousand passengers per year from 2019 to 2023.



Source: EMSA based on European Commission: Eurostat (2025b).

Figure 62: Cruise ship port calls in the EU – 2017–2023.



Source: EMSA services (SafeSeaNet).

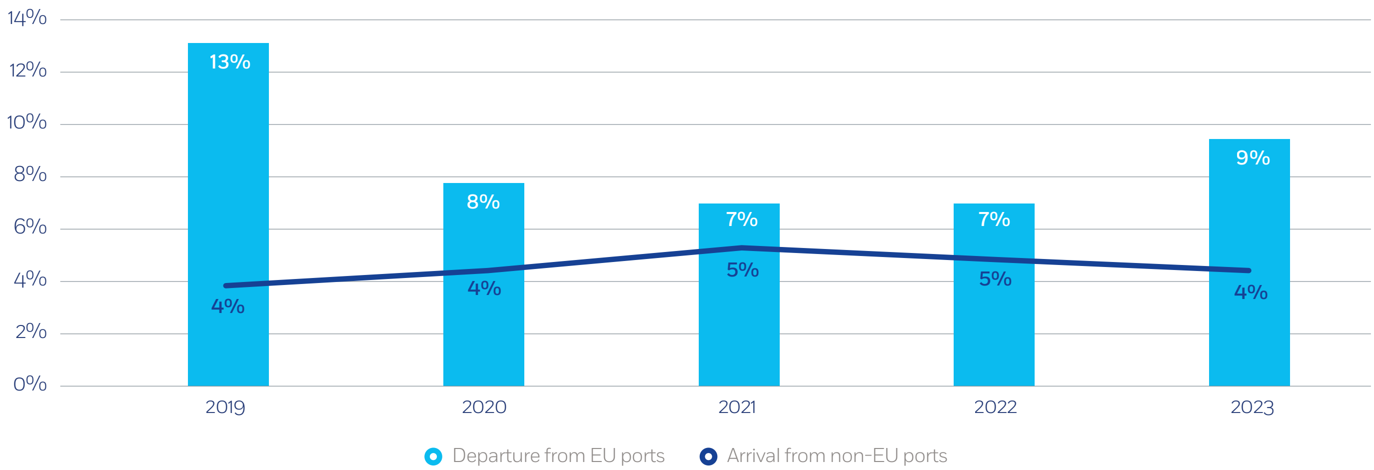
3.3.6 Transportation of dangerous and polluting goods by sea

Part of the cargo transported by sea falls under the generic category of dangerous and polluting goods, and is commonly referred to as hazmat (hazardous materials). Vessels carrying hazmat are required to inform the competent authority – at the latest at the moment of departure from the loading port – about the specifics of the cargo, its amount and its location on board so that, in the event of an accident, response services can have a better picture of the problem ahead, the risk assessment in ports, etc.

In accordance with the VTMIS Directive, the ship master, agent or operator of a ship carrying hazmat must report it upon departure from an EU port, or, if arriving from a port located outside the EU, the hazmat must be declared upon departure or as soon as the port of destination is known.

Figure 63 presents the evolution of the percentage of ship calls reporting hazmat in SafeSeaNet when departing from EU ports or arriving from outside the EU. The decrease in the amount of hazmat declared upon departure in 2020 may be related to the effect the COVID-19 pandemic had on the transportation of goods by sea. After 2021, the percentage continued to be low compared to pre-COVID-19 values, which is explained by the increase in the number of ship calls (without hazmat), as seen in Section 3.3.1, but in absolute values the number of ship calls reporting hazmat has increased.

Figure 63: Percentage and evolution of ship calls with declared hazmat upon departure from EU ports and arrival from non-EU ports in 2023.



Source: EMSA services (SafeSeaNet).

The reception of hazmat in EU ports from ships arriving from non-EU ports entails a higher risk because the conditions under which the cargo was shipped and packed may not always meet EU standards. For this reason, it is important to understand which non-EU countries normally ship to EU ports and which vessel flags are used to carry those goods.

Table 35 shows the non-EU flags that called the most at EU ports in 2023, arriving from outside the EU and carrying hazmat, and Table 36 the countries from which these vessels departed.

In the previous version of this report, Table 21 ranked Russia as the country from which the second most non-EU-flagged vessels carrying hazmat departed before calling in at EU ports. This is no longer the case, as the EU has closed its ports to Russia's entire merchant fleet and prohibited the maritime transport of Russian crude oil and petroleum products to third countries.

However, there was a relative increase of close to 70 % in the number of calls by ships departing from the United Kingdom, while the numbers from the other listed countries remained almost the same. A comparison with pre-pandemic years shows that that traffic between the United Kingdom and EU Member States was particularly affected by the transport restrictions imposed during COVID-19. In addition, there was an increase in the United Kingdom's share of EU imports of natural gas, replacing blocked Russian imports after 2021.

Table 35: Top five flags of ships carrying hazmat from outside the EU in 2023.

Vessel flag	Number of ship calls
Liberia	4 526
Marshall Islands	2 997
Panama	2 265
Singapore	1 399
Bahamas	1 081

Source: EMSA services (SafeSeaNet).

Table 36: Countries of departure of most ships carrying hazmat from outside the EU in 2023.

Previous country	Number of ship calls
United Kingdom	16 580
Türkiye	3 445
Egypt	2 892
United States	2 764
Morocco	1 808

Source: EMSA services (SafeSeaNet).

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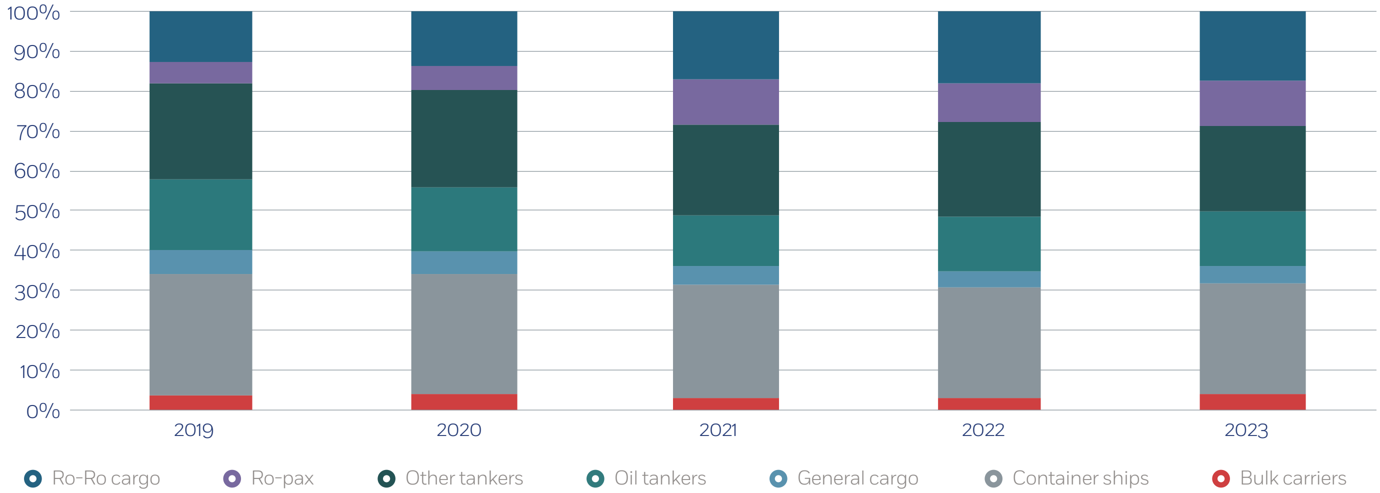
Figure 64 shows the calls of vessels arriving from outside the EU carrying hazmat in terms of ship-type distribution.

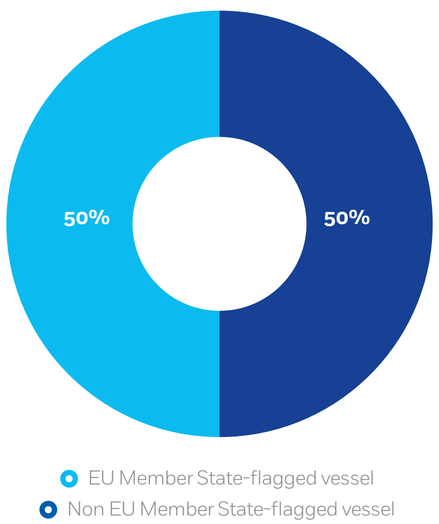
Figure 64: Distribution and evolution of calls by ship type of vessels arriving from outside the EU carrying hazmat.



Source: EMSA services (SafeSeaNet).

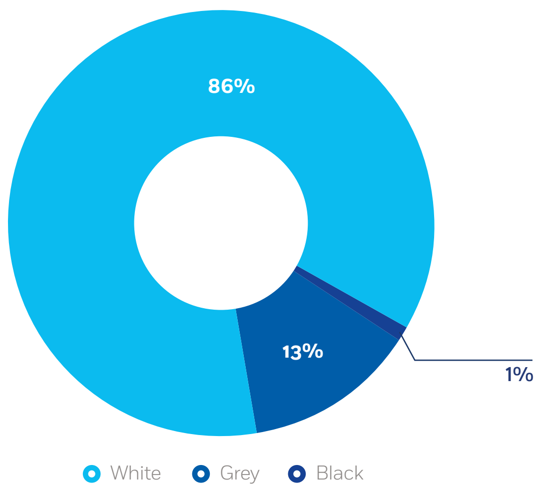
Figure 65 and Figure 66 present the distribution of non-EU-flagged ships **carrying hazmat** and coming from non-EU ports in 2023, and the distribution of those flags according to the Paris MoU WGB list. Compared to 2020, there has been a significant increase (from 3 % to 15 %) in the percentage of grey-flagged ships declaring hazmat calling at EU ports. As explained in Section 3.3.4, this is most likely due to the shift of Panama's flag – the non-EU flag calling second most often in EU ports – to the grey list in 2023.

Figure 65: Distribution of flag for calls from outside the EU carrying hazmat in 2023.



Source: EMSA services (SafeSeaNet).

Figure 66: Distribution of flags according to the Paris MoU WGB list for non-EU countries – vessels carrying hazmat and arriving from locations outside the EU in 2023.

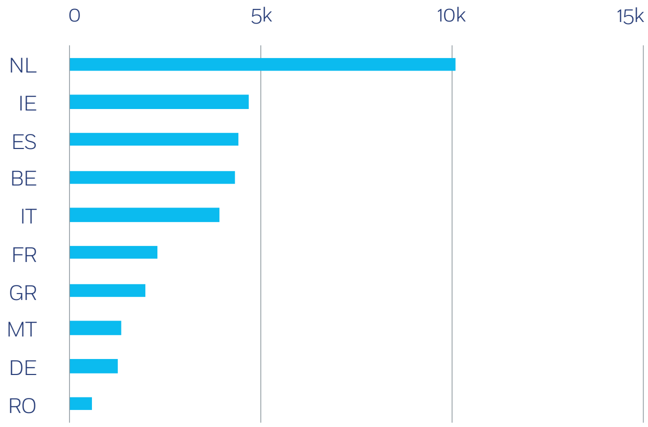


Source: EMSA services (SafeSeaNet).

Figure 67 and Figure 68 show the EU Member States that receive the most calls by ships with hazmat from outside the EU and the Member States that have the most calls by vessels flying grey and black flags as per the Paris MoU list, respectively.

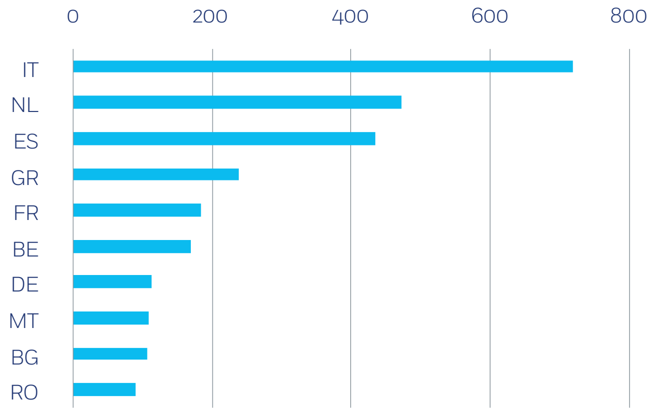
In 2023, **the number of substandard ships carrying hazmat and arriving at EU ports is substantially larger** than, in most cases more than double, those numbers in 2020.

Figure 67: Number of ships calling at EU Member States in 2023, carrying hazmat and arriving from outside the EU.



Source: EMSA services (SafeSeaNet).

Figure 68: Number of grey and black-flagged vessels calling at EU Member States in 2023, carrying hazmat and arriving from outside the EU.



Source: EMSA services (SafeSeaNet).

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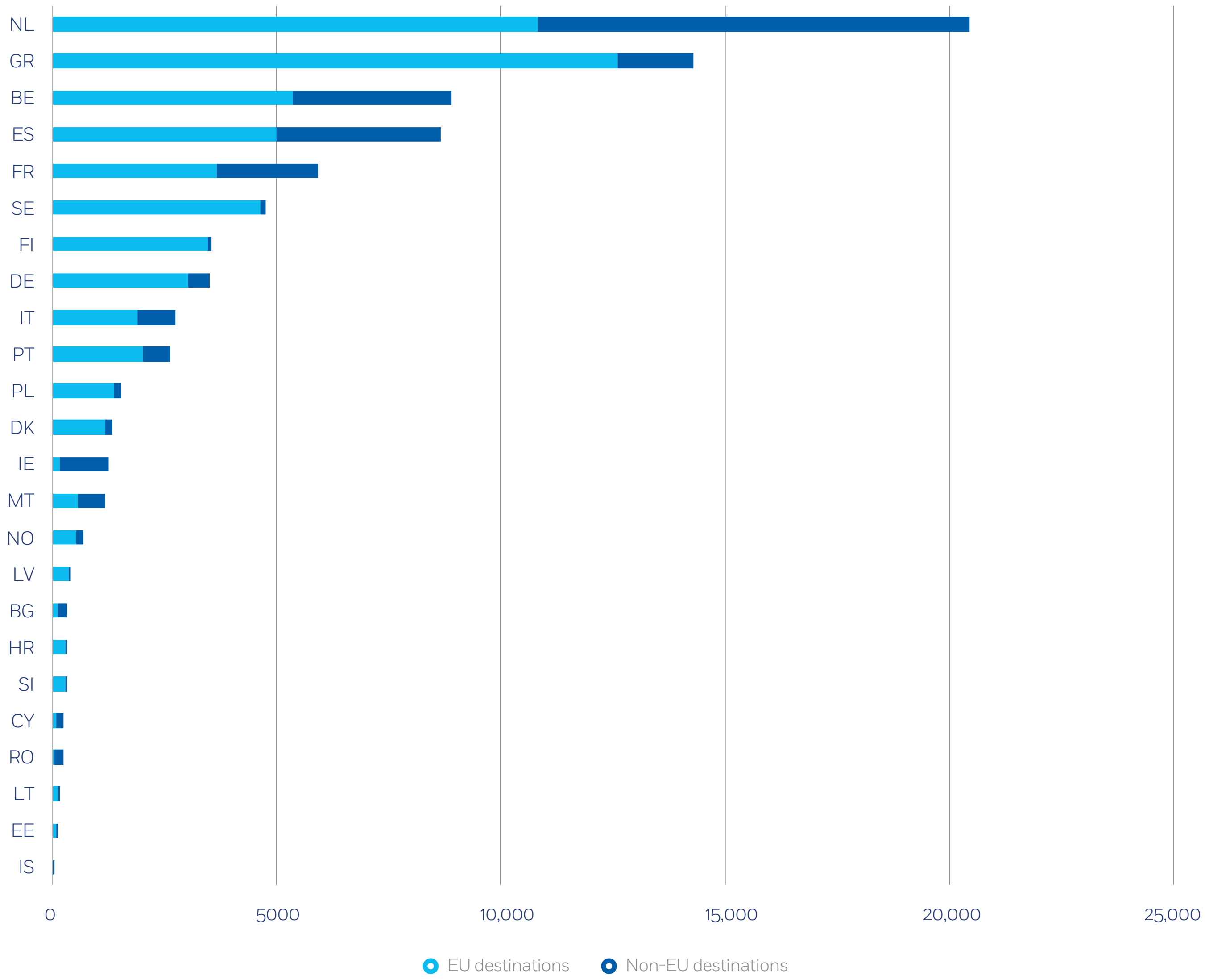
Figure 69 shows the next destination of ships containing hazmat departing EU ports in 2023.

Figure 69: Number and distribution by Member State of the declared destination records of hazmat departing from the EU in 2023.



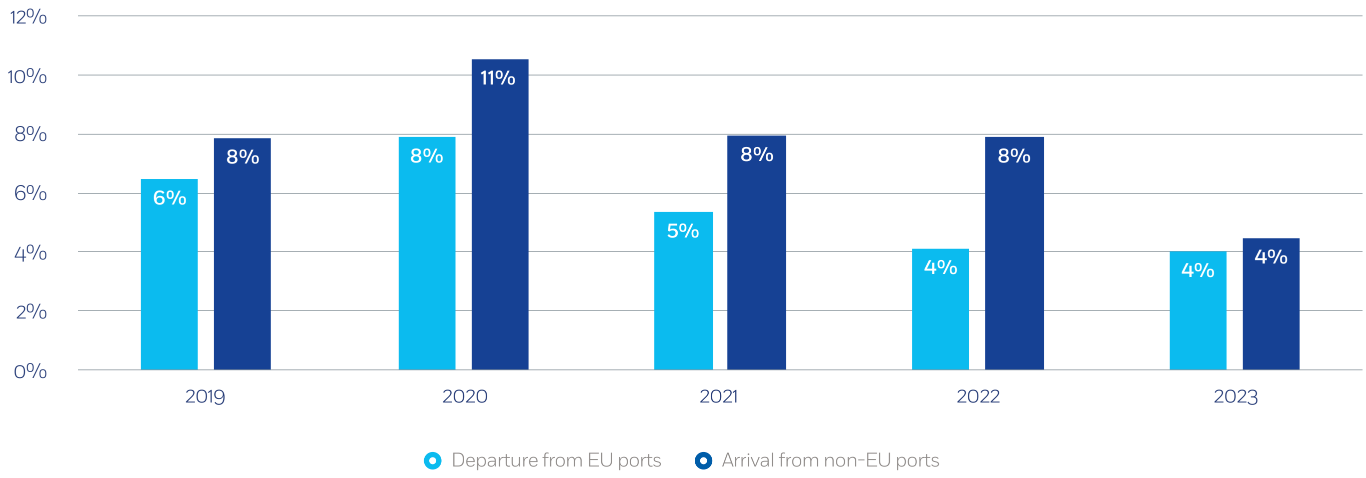
Source: EMSA services (SafeSeaNet).

The misdeclaration of dangerous and polluting goods poses a severe risk to crew, cargo and reception ports because potentially dangerous cargoes may go unnoticed. For this reason, national administrations place a special focus on verifying whether hazmat is properly declared, and declared at the right moment. EMSA, in close collaboration with national administrations and the industry, performs regular audits in SafeSeaNet by cross-checking data from different sources.

In addition, EMSA also makes available a Central Hazmat Database, in agreement with the IMO, offering a single location for all relevant actors from national authorities and the industry to consult the substances classified under the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk, the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk, the International Maritime Solid Bulk Cargoes Code, the International Maritime Dangerous Goods Code and Annex 1 to MARPOL.

Figure 70 shows the figures for **undeclared hazmat**, which have generally **improved over time** but still have the potential for improvement. The percentage of undeclared hazmat has decreased by close to 50 % since 2019 when looking at arrivals from non-EU ports.

Figure 70: Percentage of missing hazmat declarations upon arrival from ports outside the EU and departure from EU ports.



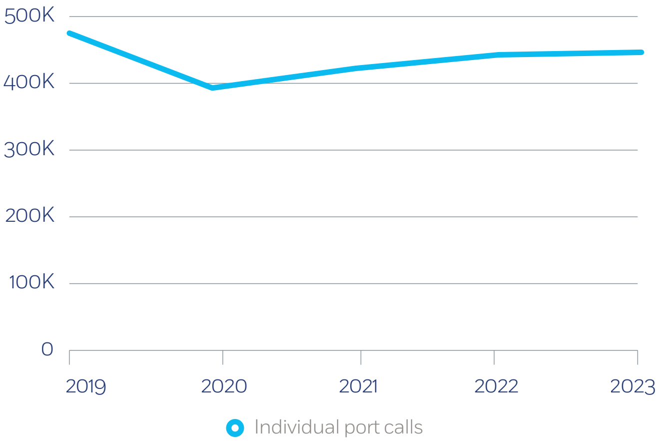
Source: EMSA services (SafeSeaNet).

3.4 EU port state control statistics

The ships subject to PSC in a given state are those ships calling at its ports that fly the flag of a different state and that fall under the scope of the international conventions in force accepted by that state. In general, this encompasses all ships except fishing vessels, warships, naval auxiliaries, wooden ships of a primitive build, government ships used for non-commercial purposes and pleasure yachts not engaged in trade.

The activity of PSC therefore depends on the number of calls made by eligible ships. After a decrease attributed to the effect of the COVID-19 pandemic on European shipping traffic in 2020, the number of port calls and individual eligible ships calling within the Paris MoU region increased gradually in 2021 and 2022 and stabilised in 2023 (see Figure 71).

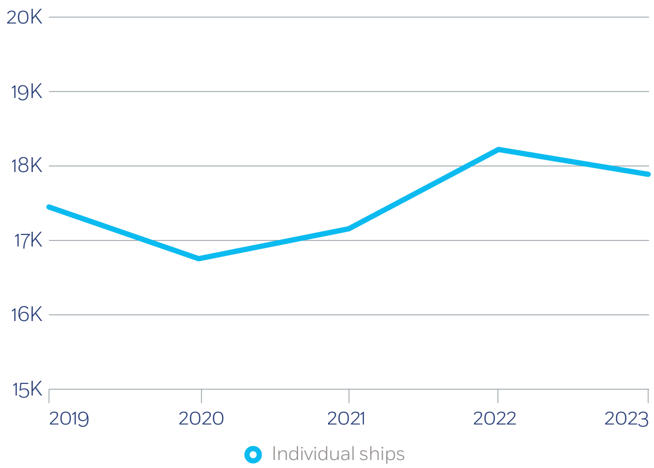
Figure 71: Number of port calls at EU ports by ships eligible for PSC – evolution in the 2019–2023 period.



NB: Port states excluded: Canada, Montenegro, Russia, United Kingdom. Ships at anchorage are also excluded.

Source: Thetis (EMSA, 2023b).

Figure 72: Number of individual ships eligible for PSC calling at EU ports – evolution in the 2019–2023 period.



NB: Port states excluded: Canada, Montenegro, Russia, United Kingdom. Ships at anchorage are also excluded.

Source: Thetis (EMSA, 2023b).

Between 2019 and 2023, more than 70 % of the ships eligible for PSC calling at EU ports were inspected under the Paris MoU. During the second quarter of 2020, many national health authorities restricted PSC inspections, leading to a sharp reduction in the overall number of inspections carried out. **After restrictions were lifted, most Member States restarted their inspection efforts, even going beyond their original targets.** The number of PSC inspections carried out every year in the EU under the Paris MoU has remained above 14 000 since the recovery from the COVID-19 period (Figure 73). The number of individual ships inspected in 2023 by PSCOs in the EU increased by 4 % in comparison with 2019.

Each ship is attributed a ship risk profile in Thetis that depends on the type of ship, its age, the performance of the flag and the RO, and historical parameters such as the number of deficiencies found during previous inspections, the detention rate, etc. The risk profile determines when the ship is to be inspected, the inspection frequency and the types of inspection to be carried out. The inspection frequency for high-risk ships is once every 5–6 months, for standard risk ships it is once every 10–12 months and for low-risk ships it is once every 24–36 months. Additional inspections may be also triggered by overriding or unexpected factors than can jeopardise the safety of the ship. This means that some ships may be due for inspection more than once a year. Thus, the total number of inspections is naturally higher than the number of individual ships inspected.

Regarding the order of inspections, precedence is given to ships that have already passed their window for inspection and ships with an overriding factor. Examples of ships with

Figure 73: Number of individual ships inspected and total PSC inspections carried out by EU Member States in the 2019–2023 period.

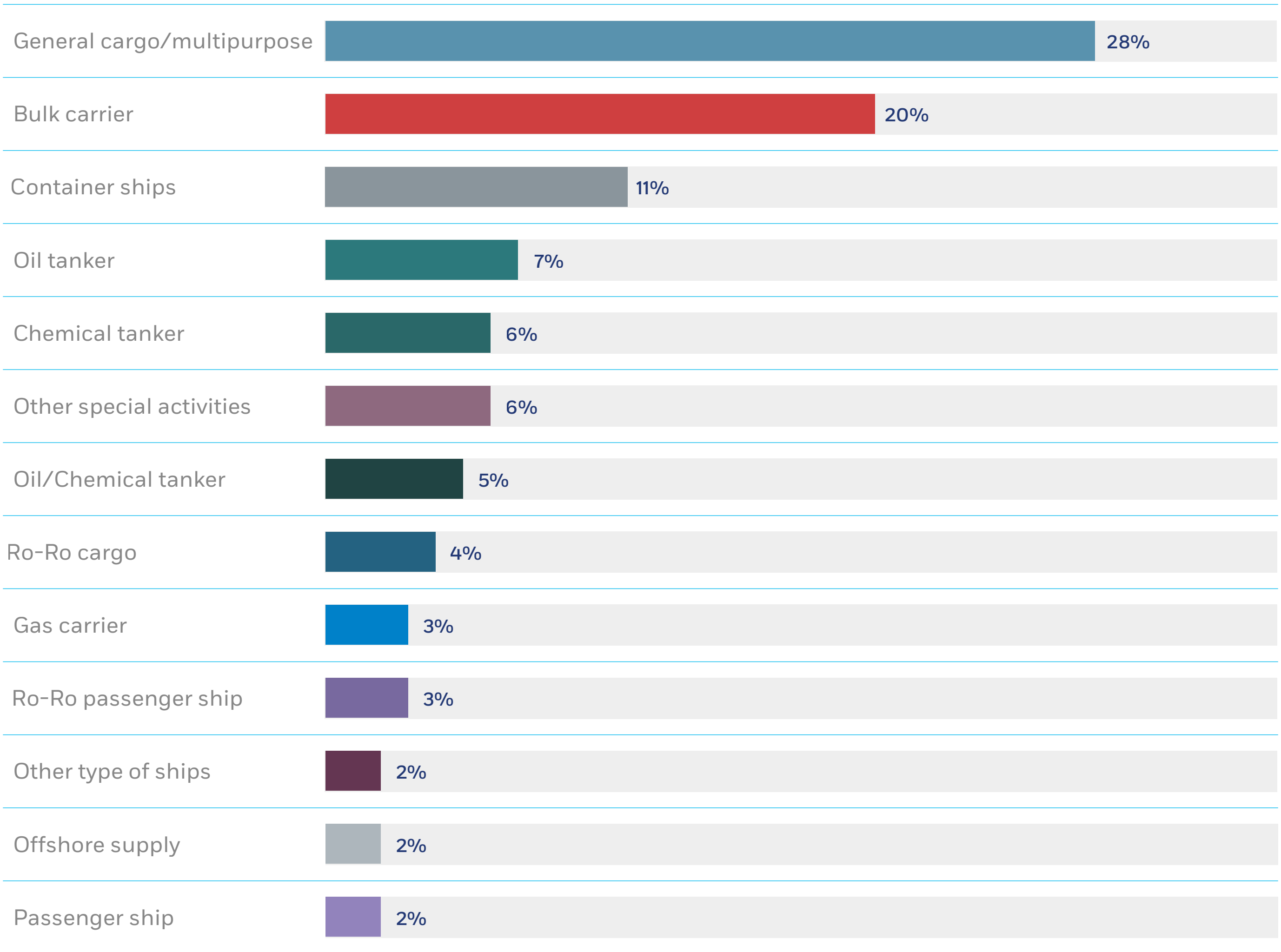
NB: Port states excluded: Canada, Montenegro, Russia, United Kingdom. Ships at anchorage are also excluded.

Source: Thetis (EMSA, 2023b).

overriding factors are ships involved in a collision, grounding or stranding on their way to port; ships that have been manoeuvred in an unsafe manner; ships accused of having discharged harmful substances into the sea; ships reported by another Member State; ships that have been suspended or withdrawn from their class for safety reasons after the last PSC inspection; and ships that cannot be found in the database. In accordance with the PSC Directive, all such ships must be inspected by PSC.

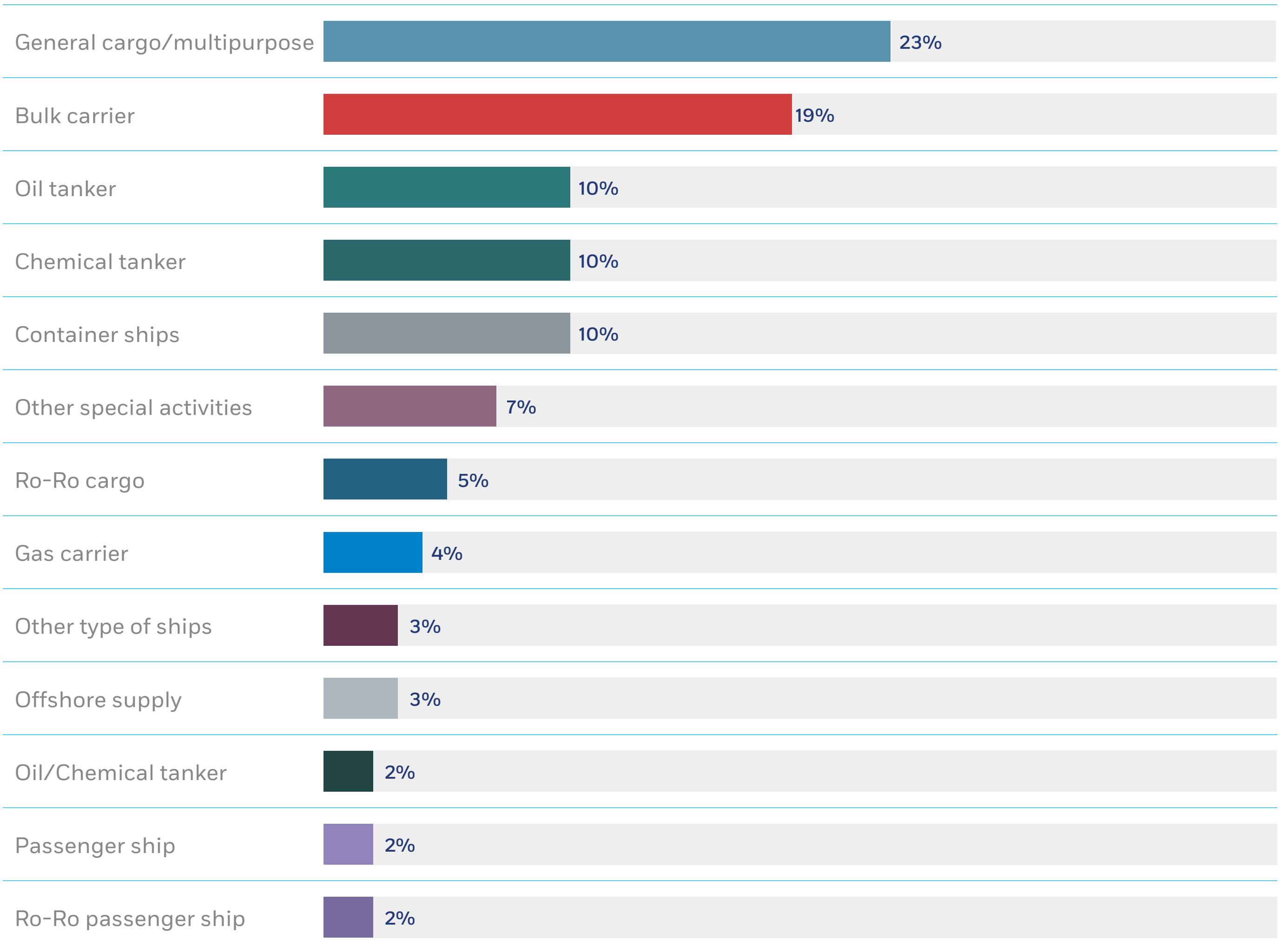
The type of ship is also a factor in the calculation of the ship risk profile, with chemical tankers, gas carriers, oil tankers, bulk carriers and passenger ships all considered to have a higher level of risk. Between 2019 and 2023, 48 % of all port calls and inspections correspond to ships of these types. However, general cargo / multipurpose ships, although not in the list of ship types of higher risk, constituted 28 % of PSC inspections, even though they represent 23 % of port calls. An explanation for this higher inspection rate could be other risk factors, such as their flag or the fact that they are certified by an organisation not recognised by the EU. In general, the share of inspections is lower than the share of port calls only in the case of oil tankers.

Figure 74: Distribution of PSC inspections by ship type in the 2019–2023 period.



Source: Thetis (EMSA, 2023b).

Figure 75: Distribution of the number of PSC eligible calls in the EU by ship type in the 2019–2023 period.



Source: Thetis (EMSA, 2023b).

PSC involves various types of inspection, namely initial inspections, more detailed inspections and expanded inspections. In an initial inspection of a ship, the documentation required to be kept on board according to maritime legislation and the international conventions is checked, along with the rectification of any deficiencies previously found and the overall condition of the ship. A more detailed inspection can be carried out when the inspector decides that the condition of the ship, its equipment or its crew does not substantially meet the relevant international requirements, or if the ship's flag state has not ratified the international convention applicable to a PSC inspection.

Expanded inspections can be carried out on board ships with a high-risk profile if not inspected in the previous six months and on board passenger ships, oil tankers, gas, chemical tankers or bulk carriers older than 12 years of age if not inspected in the previous 12 months. In addition, all the aforementioned categories of ships can be subject to an expanded inspection at any time in the case of overriding or unexpected factors, as can ships subject to reinspection following a ban ([72]). This type of inspection makes it possible to evaluate the effectiveness of the safety systems and procedures and their implementation by the crew.

72 When the ship is refused access to ports in the Paris MoU region.

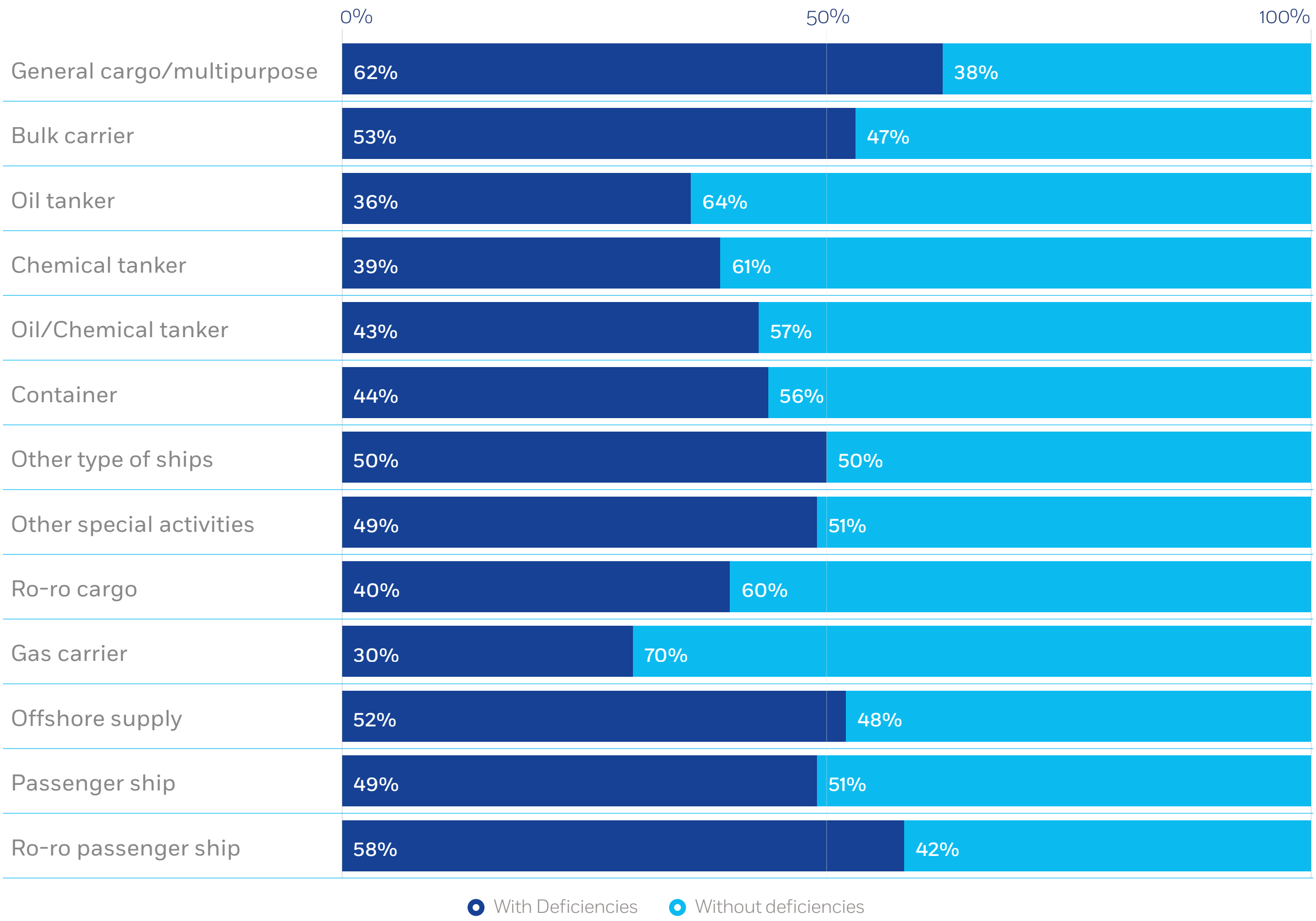
Table 37: Distribution of type of inspection by ship type – PSC inspections from 2019 to 2023.

	Initial inspection	More detailed inspection	Expanded inspection
General cargo/multipurpose	37%	58%	5%
Bulk carrier	35%	29%	36%
Oil tanker	35%	19%	46%
Chemical tanker	27%	22%	51%
Oil/Chemical tanker	28%	21%	51%
Container	56%	44%	0%
Other type of ships	58%	42%	0%
Other special activities	51%	45%	4%
Ro-Ro cargo	56%	43%	0%
Gas carrier	42%	21%	37%
Offshore supply	52%	48%	0%
Passenger ship	12%	23%	65%
Ro-Ro passenger ship	1%	16%	83%

Source: Thetis (EMSA, 2023b).

Figure 76 presents data on the percentage of inspections with and without deficiencies by ship type. As can be seen, general cargo/multipurpose ships are the ship type in which the percentage of inspections with deficiencies is highest (62 %). **In general, between 2019 and 2023, there was an increase in the number of inspections during which deficiencies were found.** This is true for all ship types except gas carriers.

Figure 76: Percentage of individual inspections with and without deficiencies found by ship type in the 2019–2023 period.



Source: Thetis (EMSA, 2023b).

During an inspection, one or more deficiencies may be identified and included in the PSC inspection report. Each deficiency has a code corresponding to a shortcoming in a requirement laid out in international conventions. The distribution of deficiencies found for each of the main conventions, in Table 38, shows that, on average, and independent of the ship type, **at least one out of every two deficiencies issued during PSC inspections is safety related**, although this percentage rises to 71 % in the case of ro-ro passenger ships – an increase of 2 percentage points since the previous Emsafe report. In general, for all ship types, 20–25 % are deficiencies involving the human element (STCW and MLC).

The distribution of deficiencies by specific SOLAS chapters, in Table 39, shows that those relating to fire safety are most frequently reported, independently of the type of ship inspected. Defects relating to Chapter II-1 (construction, structure, stability, machinery and electrical installations), Chapter III (life-saving appliances) and Chapter V (safety of navigation) make up the remaining deficiencies identified and are more or less equally distributed. It is worth noting that the percentage of fire safety deficiencies in the ro-pax category is the same as that found in the special inspection regime addressed in Section 3.5 (40 %).

Table 38: Distribution of deficiencies found by main convention and ship type in the 2019–2023 period.

Ship type	SOLAS	MARPOL	MLC	STCW	Load lines	ISM	COLREG
General cargo/multipurpose	55%	8%	20%	4%	6%	6%	1%
Bulk carrier	52%	8%	23%	3%	7%	6%	1%
Oil tanker	55%	10%	20%	3%	6%	5%	1%
Chemical tanker	54%	10%	20%	3%	6%	6%	1%
Oil/Chemical tanker	55%	9%	20%	3%	5%	6%	1%
Container ships	55%	7%	22%	3%	6%	6%	1%
Other type of ships	54%	12%	18%	7%	5%	2%	1%
Other special activities	50%	13%	20%	7%	7%	3%	1%
Ro-Ro cargo	57%	8%	21%	3%	4%	6%	1%
Gas carrier	56%	10%	20%	4%	4%	5%	1%
Offshore supply	57%	14%	17%	4%	3%	4%	1%
Passenger ship	61%	9%	17%	4%	3%	4%	1%
Ro-Ro passenger ship	71%	5%	14%	2%	3%	4%	0%

Source: Thetis (EMSA, 2023b).

Table 39: Distribution of deficiencies found by SOLAS chapter and ship type.

Ship type	Chapter II-1	Chapter II-2	Chapter III	Chapter IV	Chapter V	Other
General cargo/multipurpose	22%	27%	19%	4%	21%	5%
Bulk carrier	27%	26%	18%	3%	14%	3%
Oil tanker	26%	26%	16%	2%	13%	3%
Chemical tanker	26%	26%	19%	3%	11%	3%
Oil/Chemical tanker	26%	36%	19%	2%	13%	3%
Container ships	36%	18%	14%	3%	14%	3%
Other type of ships	18%	19%	16%	5%	34%	3%
Other special activities	19%	28%	17%	7%	28%	3%
Ro-Ro cargo	28%	26%	14%	2%	15%	3%
Gas carrier	26%	20%	19%	3%	14%	3%
Offshore supply	20%	24%	20%	4%	22%	6%
Passenger ship	24%	26%	17%	4%	17%	3%
Ro-Ro passenger ship	26%	25%	21%	2%	8%	3%

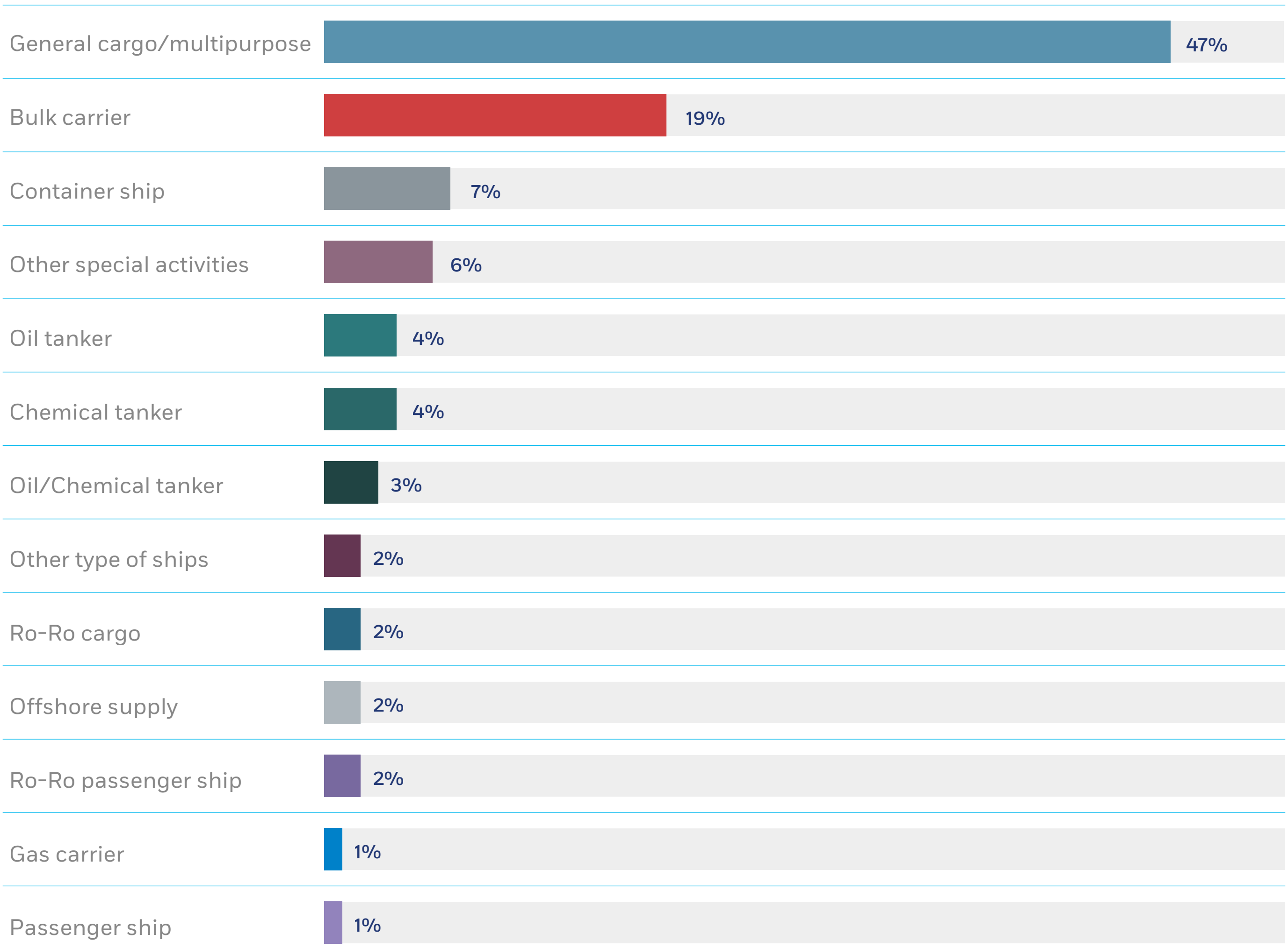
Source: Thetis (EMSA, 2023b).

Some deficiencies found during inspections could be so hazardous to safety, health or the environment as to constitute grounds for the detention of the ship. In such circumstances, the detention order is not lifted until the hazard is removed, or until the ship is authorised to proceed to sea under certain conditions. **The number of detentions increased significantly after the COVID-19 pandemic**, reaching a peak of 617 in 2022. Although a decrease was observed in 2023, **the number of detentions in EU Member States was 30 % higher in 2023 than it was before the COVID-19 crisis** in 2019. As shown, the ship type with the highest percentage of detentions is general cargo/multipurpose ships, with 47 %. This figure is disproportional to the percentage of inspections carried out in these ships (28 %). Accordingly, these ships apparently present a lower safety level in general than the other ship types.

Figure 77: Number of detentions per year – evolution between 2019 and 2023.

Source: Thetis (EMSA, 2023b).

Figure 78: Distribution of the number of detentions by ship type.

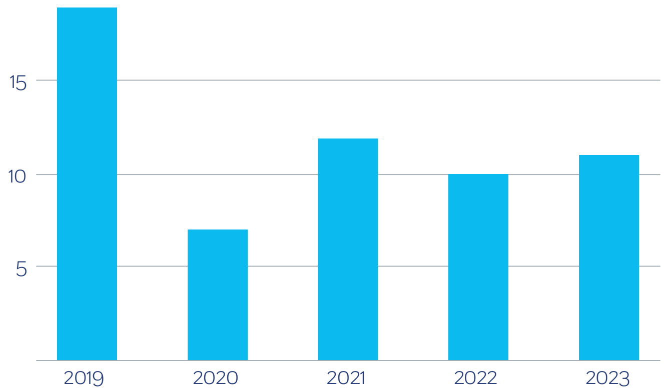


Source: Thetis (EMSA, 2023b).

There are various reasons a ship can be refused access to ports (banned) in the Paris MoU region: the ship has been subject to multiple detentions; the ship proceeds to sea without complying with the conditions determined by the authority in the port of inspection; or the ship does not call at the agreed repair yard following a detention. Figure 79 shows the number of ships for which authorities of EU Member States issued a refusal of access over the 2019–2023 period.

It is worth noting that if a ship is refused access and subsequently changes name, is sold to another company or is reflagged to another register, the refusal of access remains in place.

Figure 79: Number of refusals of access issued by EU Member States in the 2019–2023 period.



NB: Differences from the information provided in the last edition of Emsafe for the overlapping years 2019 and 2020 are attributed to late reporting of refusals of access.

Source: Thetis (EMSA, 2023b).

3.5 Special inspection regime for ro-pax and high-speed craft on regular voyages

3.5.1 Introduction

Following several high-profile accidents, including the one involving the ro-pax *Estonia* in 1994, which led to more than 800 deaths, the EU decided to implement a specific inspection regime for ro-pax and HSC on regular voyages between EU ports, or between an EU port and a port in a non-EU country, irrespective of the flag. This regime, established in 1999 through Directive 1999/35/EC ([73]), requires more regular inspections of these two types of ships in view of their intense activity, their quick turnaround time and the large number of people being carried.

In 1999, the EU consisted of 15 Member States, and a significant number of ro-ro passenger ships and passenger HSC travelled regularly between EU and non-EU countries. Given that the EU today has 27 Member States, most of these same voyages are now between EU ports. It was therefore necessary to update the inspection regime to reflect the changes in EU membership, while taking into account the progress made in the implementation of the PSC regime set up by Directive 2009/16/EC and the relevant experience gained. Consequently, and within the regulatory fitness and performance programme of passenger ship safety legislation carried out by the Commission, the EU adopted Directive (EU) 2017/2110 ([74]).

A key safety element of these ships relates to the watertightness of the openings (ramps) for vehicle embarkation. The watertightness and proper closing of these openings must be ensured while at sea to avoid the rapid flooding of the vehicle deck.

73 Council Directive 1999/35/EC of 29 April 1999 on a system of mandatory surveys for the safe operation of regular ro-ro ferry and high-speed passenger craft services (OJ L 138, 1.6.1999, p. 1, ELI: http://data.europa.eu/eli/dir/1999/35/oj).

74 Directive (EU) 2017/2110 of the European Parliament and of the Council of 15 November 2017 on a system of inspections for the safe operation of ro-ro passenger ships and high-speed passenger craft in regular service and amending Directive 2009/16/EC and repealing Council Directive 1999/35/EC (OJ L 315, 30.11.2017, p. 61, ELI: http://data.europa.eu/eli/dir/2017/2110/oj).

Another important aspect relates to the potential shifting of vehicles, including large trucks, in poor weather conditions. The shifting of vehicles can negatively influence the stability of the ship and increase the risk of fire, given that, depending on the size of the ship, the vehicles on this deck can together have several tonnes of fuel in their tanks. Therefore, it is essential to ensure that all cargo-securing devices are in adequate operational condition.

Some of these ships also have internal hoistable ramps, which must be both watertight and in adequate operational condition to avoid mechanical failures that could cause the ramp to come loose.

Therefore, for this type of ship, it is essential that all the safety elements on the ship intended to decrease the abovementioned risks be in adequate and continuous operating condition, which becomes even more challenging due to the tight schedules and intense activity of ro-pax and HSC. Cars must be unloaded, and passengers must disembark, to be replaced by others for the next journey, often several times a day. The wear and tear of equipment that has a substantial bearing on the overall safety of the ship, such as the embarkation ramps, internal hoistable ramps and vehicle-securing devices, is significant.

The related Commission staff working document accompanying the regulatory fitness and performance package indicated that, in 2015 and in relation to the domestic fleet, while vessels with ro-ro capacity (ferries and HSC) represented 49 % of the fleet, they accounted for 80 % of accidents ([75]). During the document's consultation period, national experts confirmed that a special inspection regime for these vessels was necessary.

The results of the specific surveys are reported in the EU's database (as part of Thetis) managed by EMSA.

One of the key elements of this system is to ensure that each ship is inspected twice per year. The scope of this regime includes two groups of ships: the first group refers to those that operate domestically and are flagged in the same country of operation; the second group covers those ships that operate from an EU Member State to a non-EU country and are flagged in that EU Member State, for example a Spanish-flagged ship operating between Algeciras (Spain) and Tangier (Morocco).

In October 2018, EMSA published guidance on Directive (EU) 2017/2110 to support the Member States in the implementation of the directive ([76]). The aim of EMSA's guidance is to assist Member States in their efforts to fulfil the requirements of Directive (EU) 2017/2110 and Directive 2009/16/EC, in relation to the inspection of ro-ro passenger ships and passenger HSC in regular service. It is a reference document that provides both technical information and procedural guidance, thereby contributing to harmonised implementation and enforcement of the provisions of the directive.

3.5.2 Regulatory framework

Table 40: Legislation on special regime of ro-pax and HSC on regular voyages.

	Level	Instrument	What it regulates
Legislation	EU	**Directive (EU) 2017/2110**	A system of inspections for the safe operation of ro-ro passenger ships and passenger HSC in regular service.

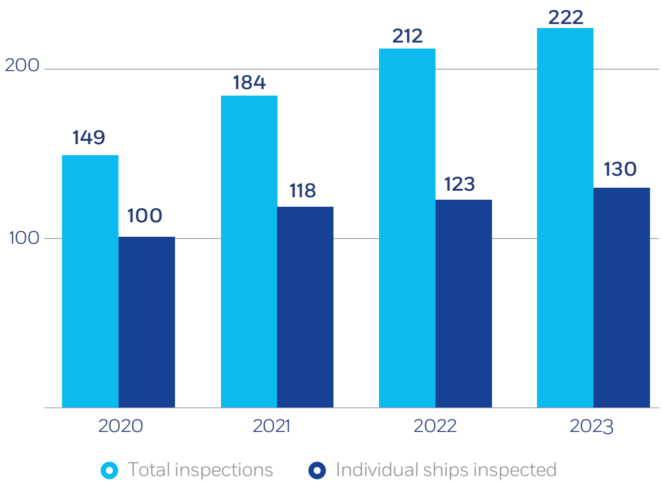
75 Commission staff working document – Accompanying the document 'Report from the Commission to the European Parliament and Council – REFIT – Adjusting course: EU passenger ship safety legislation fitness check', SWD(2015) 197 final of 16 October 2015, https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=SWD:2015:197:FIN.

76 https://www.emsa.europa.eu/publications/inventories/download/6517/4353/23.html.

3.5.3 Relevant data and analysis

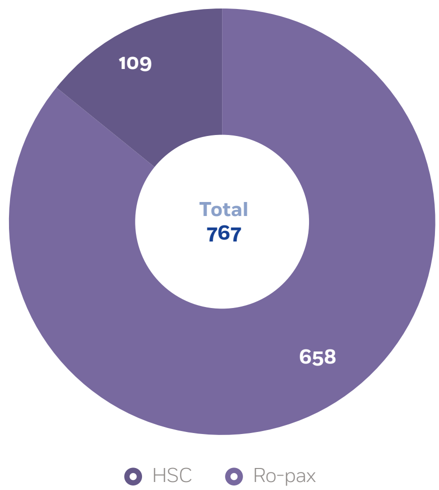
Considering the significant change in the scope of this directive since its entry into force on 21 December 2019, the first significant data available are those from 2020, which was also the year of the COVID-19 pandemic. The data from 2019 would not be comparable in the context of this analysis. The number of inspections and the number of ships inspected in the 2020–2023 period are included in Figure 80, and show an increase in the inspection efforts.

Figure 80: Ro-pax flag-state inspections carried out by EU Member States in the 2020–2023 period relating to Directive (EU) 2017/2110.



Source: Thetis (EMSA, 2023b).

Figure 81: Number of inspections carried out by EU Member States in the 2020–2023 period relating to Directive (EU) 2017/2110, by ship type.



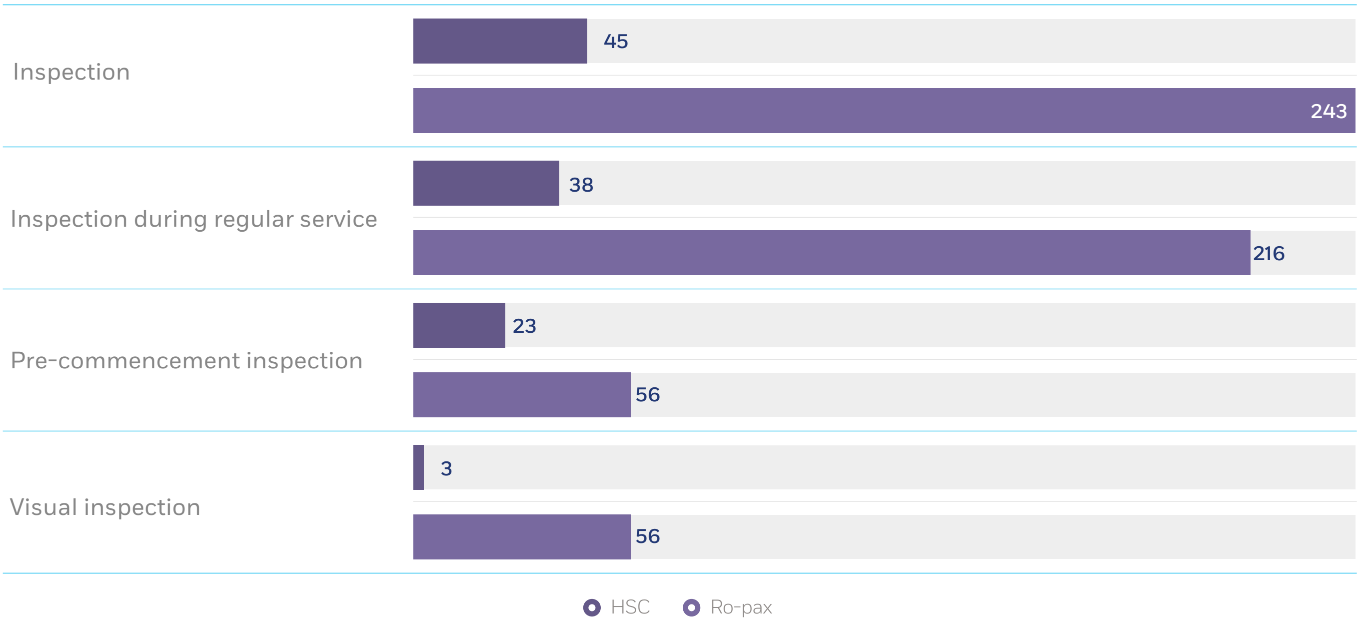
Source: Thetis (EMSA, 2023b).

The inspection regime is composed of the following different types of inspections.

- **A pre-commencement inspection,** which must be carried out before a ro-ro passenger ship or HSC starts to operate on a regular service.
- **Regular inspections,** which are subclassified into two types of inspection. Each of these inspections should be carried out once every 12 months and there should be, in general, an interval between them of four months. They are as follows.
  - **Inspection at port.** This should ensure that the safety requirements are fulfilled, including those relating to construction, subdivision and stability, machinery and electrical installations, loading and stability, fire protection, the maximum number of passengers, life-saving appliances, the carriage of dangerous goods, radio communications and navigation. Emphasis is also given to the familiarisation of crew members with, and their effectiveness in, safety procedures, emergency procedures, maintenance, working practices, passenger safety, bridge procedures, and cargo and vehicle operations.
  - **Inspection during a regular service.** This is carried out during a voyage and is aimed at ensuring the safety of the vessel during its operation.
- **A visual inspection** can be carried out if, due to unforeseen circumstances, there is an urgent need for the rapid introduction of a replacement ro-ro passenger ship or passenger HSC to ensure continuity of service.

Figure 82 shows the number of inspections carried out between 2020 and 2023 by type.

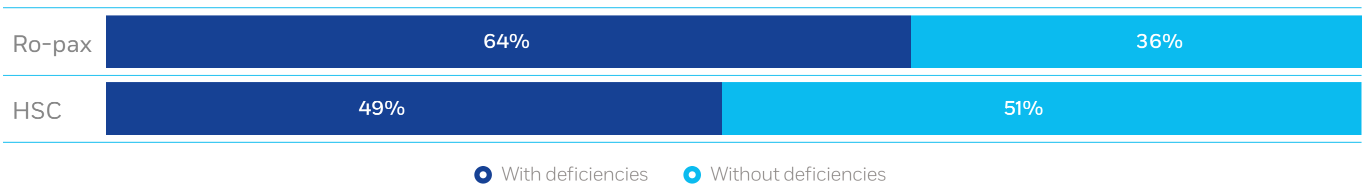
Figure 82: Number of inspections carried out by EU Member States in the 2020–2023 period relating to Directive (EU) 2017/2110, by type of inspection and ship type.



Source: Thetis (EMSA, 2023b).

In terms of deficiencies found, Figure 83 and Figure 84 summarise the results of the inspections.

Figure 83: Inspection results – percentage of inspections where deficiencies were identified.

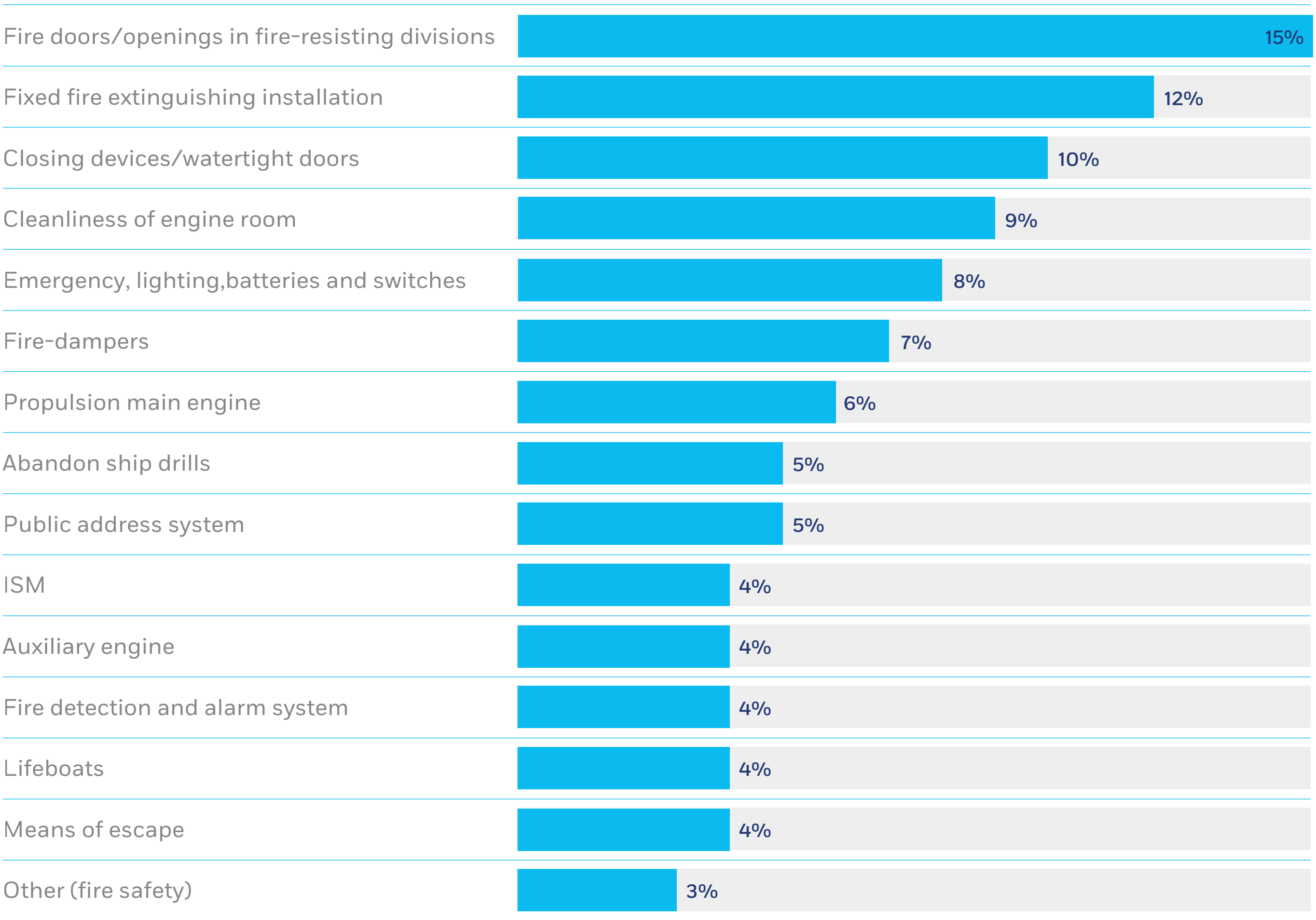


Source: Thetis (EMSA, 2023b).

The ships that come under the scope of Directive (EU) 2017/2110 are subject to more frequent and detailed inspections than other ship types, which greatly increases the probability of finding deficiencies.

Deficiencies relating to fire safety in general represent around 38% of the deficiencies reported during inspections. Fire safety is an area that receives particular attention during inspections, including fire drills and testing of fire prevention, detection and firefighting systems. Keeping fire safety elements in good working condition is essential in order to avoid catastrophic events in these ships. As indicated in previous sections, the average age of these ships, their design characteristics, retrofitting concerns and the gaps found during previous studies mean that fire safety is a key aspect in these ships, to which industry and authorities must pay constant attention.

Figure 84: Top 15 deficiencies identified in inspections of ro-pax and HSC in the 2020–2023 period.



Source: Thetis (EMSA, 2023b).

3.6 Training and qualification of port state control officers

In the EU – Paris Memorandum of Understanding

The III Code also provides for port states to ensure that the inspections are carried out only by authorised and qualified PSCOs in accordance with the relevant procedures adopted by the IMO ([77]), the latest of which is Resolution A.1185(33) ([78]).

Qualified PSCOs should fulfil the qualification and training requirements specified in this resolution (Sections 1.8 'Professional profile of PSCOs' and 1.9 'Qualification and training requirements of PSCOs').

77 Paragraph 61 of the III Code.

78 IMO Resolution A.1185(33) adopted on 6 December 2023, Procedures for port state control, 2023, https://wwwcdn.imo.org/localresources/en/OurWork/IIIS/Documents/A%20 33-Res.1185%20-%20PROCEDURES%20FOR%20PORT%20 STATE%20CONTROL,%202023%20(Secretariat)%20(1).pdf.

Unlike flag-state inspectors, the professional profile of PSCOs is covered by EU law, namely Article 22 of Directive 2009/16/EC. PSCOs in the EU follow the PDS defined in the Paris MoU training policy ([79]), which consists of two different components ([80]): the national training programme and the EMSA / Paris MoU training programme.

Between 2019 and 2023, the agency hosted 24 EMSA / Paris MoU seminars and trained more than 800 PSCOs. It also provided distance learning programmes to cover the PSCO training programme.

However, in relation to the national PSC training programmes, EMSA's visits revealed that there are substantial differences among EU Member States and there is significant room for improvement as far as harmonisation is concerned ([81]). Such differences are also evident in the training hours per year for newly hired and existing PSCOs under the national training programmes.

In order to support the national capacities of EU Member States, EMSA has developed a common core curriculum for PSCOs, which will be launched in 2025.

The curriculum is designed to develop the necessary individual competencies for carrying out duties associated with the inspection of ships to verify compliance with the relevant international instruments and EU maritime legislation, and adheres to Paris MoU procedures. It aims to provide PSCOs with the opportunity to develop the knowledge, skills and attitudes required to carry out inspections professionally, efficiently and effectively and to the required standards, including those derived from the Paris MoU procedures.

The curriculum is included in the revised Paris MoU training policy approved in May 2024.

Black Sea Memorandum of Understanding and Mediterranean Sea Memorandum of Understanding

Similarly to the practices adopted by the Paris MoU, a PDS is also available for PSCOs of the Black Sea MoU and the Med MoU. Given the support provided by EMSA in the training and qualification of the PSCOs in the past decade as part of the SAFEMED and Black and Caspian Sea projects, communication on the inclusion of the common core curriculum for PSCOs had already started in early 2023.

The Med MoU included the curriculum in its training policy in October 2023, while communication with the Secretariat of the Black Sea MoU was ongoing at the time this report was written.

Figure 85: Annual training hours of newly hired and existing PSCOs under the national training programmes.

Source: EMSA services based on questionnaire to Member States.

79 The Paris MoU training policy is the harmonised Community scheme for the training and assessment of competencies of PSC inspectors by Member States as mandated by Article 22(7) of Directive 2009/16/EC.

80 Paris MoU 2020, Port State Control Committee Instruction 53/2020/03P.

81 2017–2022 cycle of visits.

Coastal state 04

Coastal states play a crucial role within this framework by overseeing and regulating maritime activities within their waters to prevent accidents and environmental damage.

4.1 Traffic monitoring, communication and information systems

4.1.1 SafeSeaNet network

4.1.1.1 Introduction

A ship must be both safely crewed and safely constructed, but it operates in a dynamic environment where it continuously interacts with other vessels and ports. For this reason, traffic monitoring, reporting and exchanges of information are fundamental to ensuring proper maritime safety, especially regarding the transportation of dangerous and polluting goods by sea.

One of the key safety elements to be reported is the transportation of dangerous and polluting goods, so that coastal states can take appropriate prevention measures and can also be prepared to respond in case of accident. The IMO, via its codes and conventions, regulates the substances that are considered dangerous and polluting goods when transported by sea.

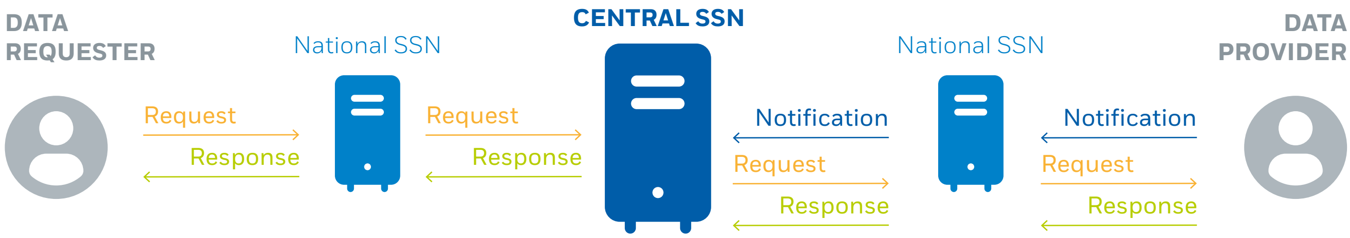
Under the VTMIS Directive (see Section 4.1.1.2), SafeSeaNet was set up as a network for maritime data exchange, linking maritime authorities from across Europe. It enables EU Member States, Iceland and Norway to provide and receive information on ships, ship movements and hazardous cargoes. In addition, information on bunkers carried on board a ship is also available via SafeSeaNet to Member States that require that information to be reported in their national single window (NSW).

SafeSeaNet remains under constant development and improvement to support new and revised EU legislation. Member States are now able to exchange information on people on board passenger ships operating to and from ports of Member States for SAR purposes in the event of an emergency or an accident in accordance with the PAX Directive, as amended. Also, linked with the new Directive (EU) 2019/883 on port reception facilities ([82]), SafeSeaNet exchanges information from the revised advanced waste notifications and waste delivery receipts in support of the new port reception facility inspection system (Thetis-EU).

82 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 (OJ L 151, 7.6.2019, p. 116, ELI: http://data.europa.eu/eli/dir/2019/883/oj).

The scope of the information exchanged is diverse, ranging from times of arrival at / departure from EU ports to details of dangerous and polluting goods carried by the vessels and their location on board, along with information on safety and pollution-related incidents.

Figure 86: SafeSeaNet system network for data exchange.



Source: EMSA services.

From a technical point of view, SafeSeaNet started as an index system within a ‘hub and spoke’ network (including authentication, validation, data transformation and logging). Currently, it is a hybrid system in which the information is partially stored centrally and the detailed part is stored at the national level, with SafeSeaNet functioning as an index. Users in Member States can provide or request data using national systems or EMSA’s Maritime Application Portal.

Another type of information exchanged through SafeSeaNet is the ship position reports in near real time using automatic identification system (AIS) or mandatory ship reporting system (MRS) messages provided by ship masters to coastal stations.

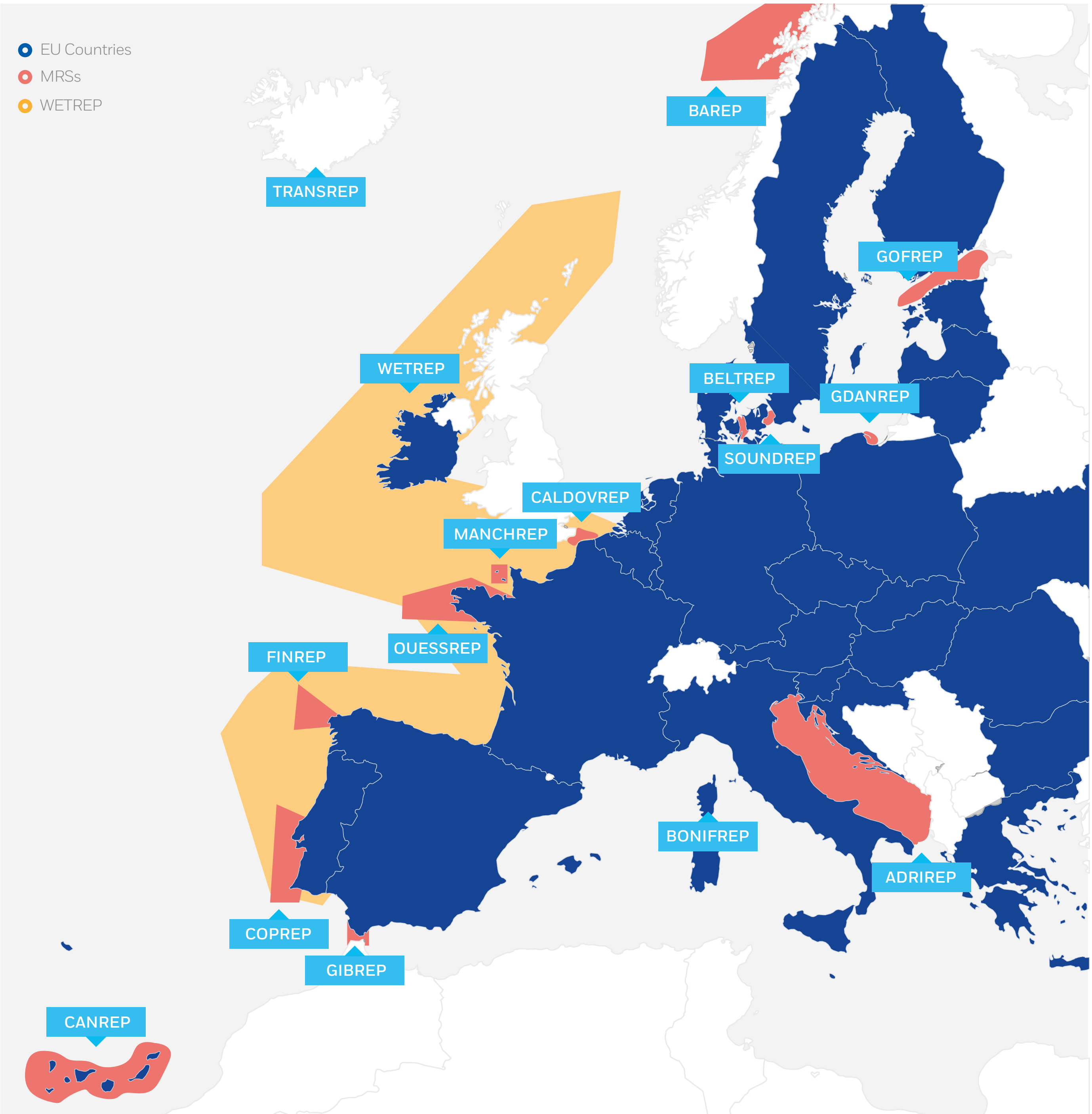
AIS was originally developed as an anti-collision instrument, used to transmit vessel position and identification. By collecting AIS information through a chain of coastal stations covering the entire EU coastline, and combining these position reports with more recent sources such as Satellite-AIS, long-range identification and tracking (LRIT) and vessel monitoring system reports, EU authorities can have a better picture of the maritime situation.

MRS areas are established by governments and approved by the IMO, establishing reporting requirements for certain types of vessels transiting through those areas, for safety reasons and for the protection of environmentally sensitive areas. For example, after the *Prestige* spill off the coast of Spain, the Western European Tanker Reporting System MRS was established, requiring all tankers above 600 dwt carrying heavy grade oils to report their entry into the area. This information is then shared via SafeSeaNet with interested parties at the national level.

In the last few years, EMSA and volunteer Member States have developed a technical solution for facilitating ship-to-shore reporting. By making consolidated ship data available to coastal stations, this solution facilitates the fulfilment of the reporting obligations of ships sailing in EU waters to those coastal stations. It also allows the electronic fulfilment of MRS reports by ships, replacing voice communication and allowing the reuse of information between reporting systems. Considering that the project has gained visibility, and considering the growing expectations of the maritime community, the Commission, together with Member States, agreed to establish the SafeSeaNet Working Group on Facilitation of Ship-to-Shore Reporting. The plan is to review the reporting procedures currently in place for ship reporting systems in the EU with the objective of reducing administrative burdens, better reusing data and harmonising reporting processes, and to test the suitability of electronic ship-to-shore reporting.

Work is ongoing to move this concept into operation. For example, at the request of the Maritime Safety Permanent Transnational Network (the framework for the continuation of the joint efforts initially taken by the EUREKA Consortium), and following the approval of the EMSA Administrative Board, EMSA continues to provide technical assistance for modernising the IMO-adopted ship reporting system in the Adriatic Sea (ADRIREP). This includes integrating the ADRIREP CST systems with EMSA’s Integrated Report Distribution (IRD) SafeSeaNet service, along with work on operational procedures and the preparation of amendments to the IMO resolution establishing ADRIREP. The project in the Adriatic has shown how state-of-the art technology for ship to-shore reporting can be introduced.--to-shore reporting. It is a good example for others to follow in implementing modern ship reporting systems that are fully in line with the overall objective of the EU maritime safety policy.

Figure 87: Mandatory ship reporting areas in Europe.



NB: Pre-Brexit map of EU Member States.

Source: EMSA services.

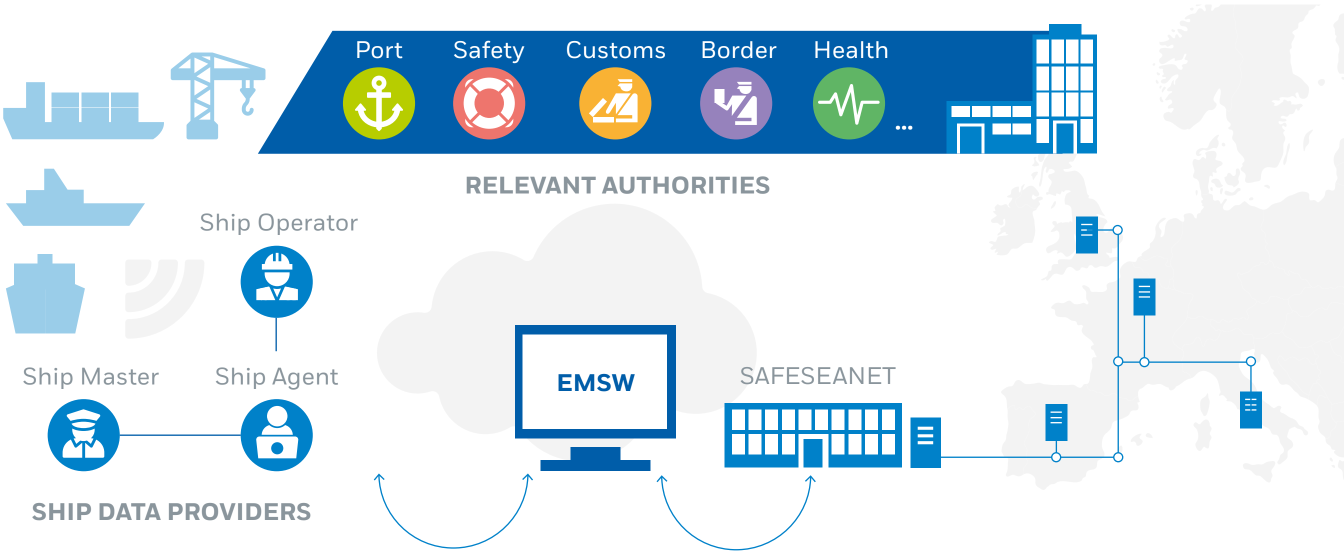
The European maritime single window

Another important characteristic of the shipping industry is the constant search for efficiency and simplification. International and EU legislation impose several reporting obligations on ships. To centralise and facilitate this reporting, NSWs were created. Member States first set up NSWs through which shipping companies could submit information electronically and make this information available as necessary to multiple national authorities in an automated manner, thus reducing the burden on industry. However, as each NSW was developed differently, the purpose of reducing the administrative burden was not achieved.

To tackle this problem, the EU recently adopted the European Maritime Single Window Environment (EMSWe) Regulation(Regulation (EU) 2019/1239 [83]) to harmonise and simplify the reporting formalities required of the shipping industry.

From 15 August 2025, with the new EMSWe Regulation fully in force, the EU-wide system will simplify and further harmonise the information procedures behind the various reporting obligations imposed on shipping companies through national, EU and international law. A common set of information will be shared with ships arriving at, staying in and departing from EU ports. This will be communicated electronically to the various national administrations, and the information will be transferred as necessary between Member States, making use of existing systems such as SafeSeaNet, common databases (ship, UN Code for Trade and Transport Locations [84]), hazmat), etc.

Figure 88: The European maritime single window.



Source: EMSA services.

83 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 (OJ L 198, 25.7.2019, p. 64, ELI: http://data.europa.eu/eli/reg/2019/1239/oj).

84 The UN Code for Trade and Transport Locations, commonly known as UN/LOCODE, is a geographic representation of over 100 000 locations across all countries and territories that is used to unequivocally identify a location. It is used by the shipping industry and applied by major international organisations.

4.1.1.2 Regulatory framework

From the perspective of EU vessel traffic monitoring, the maritime community is supported by three key EU legal instruments: the VTMIS Directive (Directive 2002/59/EC); the Reporting Formalities Directive (Directive 2010/65/EU ([85]), which will be repealed in 2025); and the EMSWe Regulation. This legislation regulates the information that needs to be reported and exchanged, simplifies the procedures, promotes the reuse of data and harmonises data submissions.

Table 41: Legislation on traffic monitoring and information systems.

	Level	Instrument	What it regulates
Legislation	International	Convention on Facilitation of International Maritime Traffic	Facilitates maritime traffic by simplifying and reducing to a minimum the formalities, documentary requirements and procedures on the arrival, stay and departure of ships engaged in international voyages.
		SOLAS	Especially Chapter V: LRIT, notification systems, traffic monitoring, routing systems, etc.
	EU	VTMIS Directive (Directive 2002/59/EC)	Establishes a vessel traffic monitoring and information system (VTMIS) with a view to enhancing the safety and efficiency of maritime traffic; improving the response of authorities to incidents, accidents or potentially dangerous situations at sea, including SAR operations; and contributing to the better prevention and detection of pollution by ships.
		Reporting Formalities Directive (Directive 2010/65/EU)	Simplifies and harmonises the administrative procedures applied to maritime transport by making the electronic transmission of information standard and by rationalising reporting formalities for ships arriving at and departing from ports situated in Member States.
		European Maritime Single Window Environment (EMSWe) Regulation (Regulation (EU) 2019/1239), repealing Directive 2010/65/EU from 15 August 2025	Introduces an interoperable environment with harmonised interfaces, to simplify reporting obligations for ships arriving at, staying in and departing from EU ports. Also aims to improve the European maritime transport sector's competitiveness and efficiency by reducing the administrative burden. It does so by introducing a simplified digital information system to harmonise the existing national systems and reduce the need for paperwork.

85 Directive 2010/65/EU of the European Parliament and of the Council of 20 October 2010 on reporting formalities for ships arriving in and/or departing from ports of the Member States and repealing Directive 2002/6/EC (OJ L 283, 29.10.2010, p. 1, ELI: http://data.europa.eu/eli/dir/2010/65/oj).

4.1.1.3 Data quality and correctness

The systems implemented by Member States to record ship arrivals, departures and stays are mostly automated, but the human element is still present, since the notifications are sent by ship masters, agents or operators. There is a continuous effort by national administrations, in collaboration with EMSA, to ensure the correctness of the information received in SafeSeaNet.

This effort can be observed from the evolution in the number of missed ship calls recorded in SafeSeaNet, which decreased substantially over the 10-year period between 2013 and 2023, as shown in Figure 89, reaching fewer than 0.5 % of all ship calls in 2023. This value has remained under 1 % since 2019.

Figure 89: Evolution in missed ship calls reported over the 10-year period from 2013 to 2023, as a percentage of total ship calls.

Source: EMSA services (SafeSeaNet) [86].

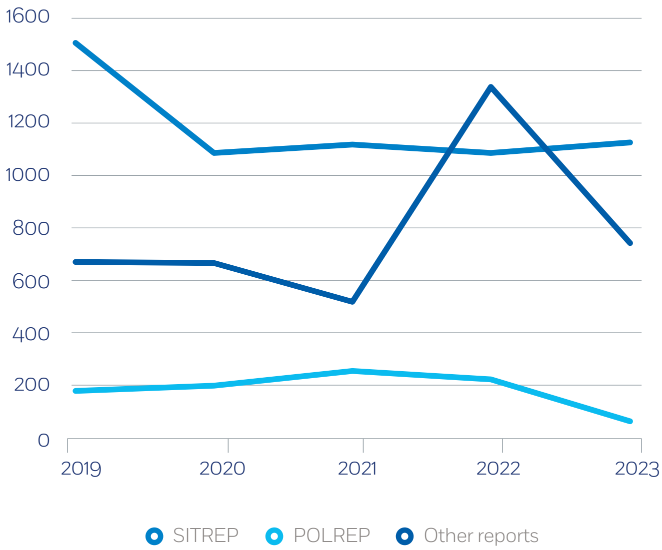
86 Cross-checked with external sources.

4.1.1.4 Accidents and incidents

Incident report notifications are sent to SafeSeaNet to inform about incidents relating to ship safety and seaworthiness (SITREP), pollution events (POLREP), waste, lost and found containers, etc. These reports may be shared with other Member States in the vicinity or along the route of the vessel.

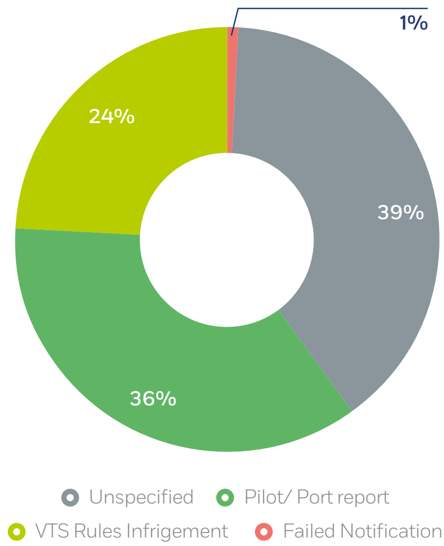
Figure 90 shows the evolution over time in reports of incidents affecting the safety of navigation and pollution, with the remaining incident reports in a single 'Other reports' category. For 2023, Figure 91 also presents a breakdown of the other types of incident reports.

Figure 90: Number of incident reports to SafeSeaNet and evolution between 2019 and 2023.



Source: EMSA services (SafeSeaNet).

Figure 91: Distribution of other types of incident reports to SafeSeaNet apart from SITREP and POLREP.



Source: EMSA services (SafeSeaNet).

4.1.2 VDES: the next generation of maritime communications

The Very High Frequency Data Exchange System (VDES) is a new technology that is seen by many as the next generation of maritime communications, building on AIS. VDES is bringing about a new era for maritime communications and is set to improve the safety of navigation. It should also enhance maritime safety and security and the protection of the marine environment. As a new technological advancement, VDES provides significant opportunities for exchanging digital data to the benefit of diverse users within the maritime transport domain. It is an innovative technology using terrestrial and satellite-based solutions that can significantly accelerate digitalisation in the maritime domain, and will be highly important for cost-effective shipping, greater sustainability and a greener transition.

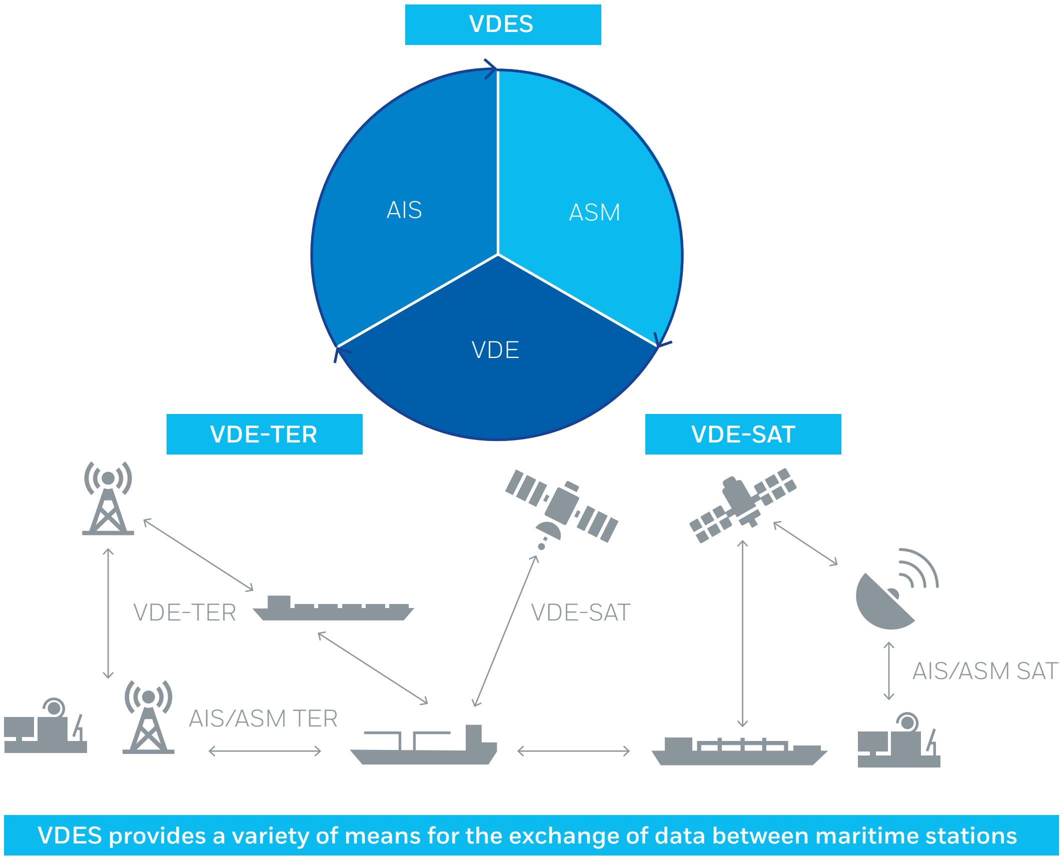
4.1.2.1 VDES system capabilities

VDES builds on the capabilities of AIS and incorporates space-based detection of AIS and application-specific messages (ASMs). It also provides the means for exchanging digital data at higher rates on a global level through its terrestrial and satellite components. VDES was mainly developed to address the increasing demand for maritime very high frequency (VHF) data communications and the overloading of AIS 1 and AIS 2, and also because AIS has become widely used for maritime safety, maritime situational awareness and port security (IALA, 2022).

VDES was developed to make use of the latest technological developments in maritime radio technology by using advanced modulation methods and by optimising spectrum efficiency using terrestrial and satellite communication. This has resulted in VDES being 32 times faster than AIS in terms of data rates. As can been seen in Figure 92, VDES consists of a multicomponent system made up of AIS, ASMs and VHF data exchange (VDE) in the VHF maritime mobile band (156.025–162.025 MHz), with VDE containing both terrestrial (VHF Data Exchange-Terrestrial – VDE-TER) and satellite (VHF Data Exchange-Satellite – VDE-SAT) components

(Rec. ITU-R M.2092-1 ([87])). VDES provides various means for the exchange of data between maritime stations, including ship-to-ship, ship-to-shore, shore-to-ship, ship-to-satellite and satellite-to-ship. As a system, the VDES should be able to operate in various modes, such as autonomous, assigned and polled modes.

Figure 92: VDES – a new era for maritime communications.



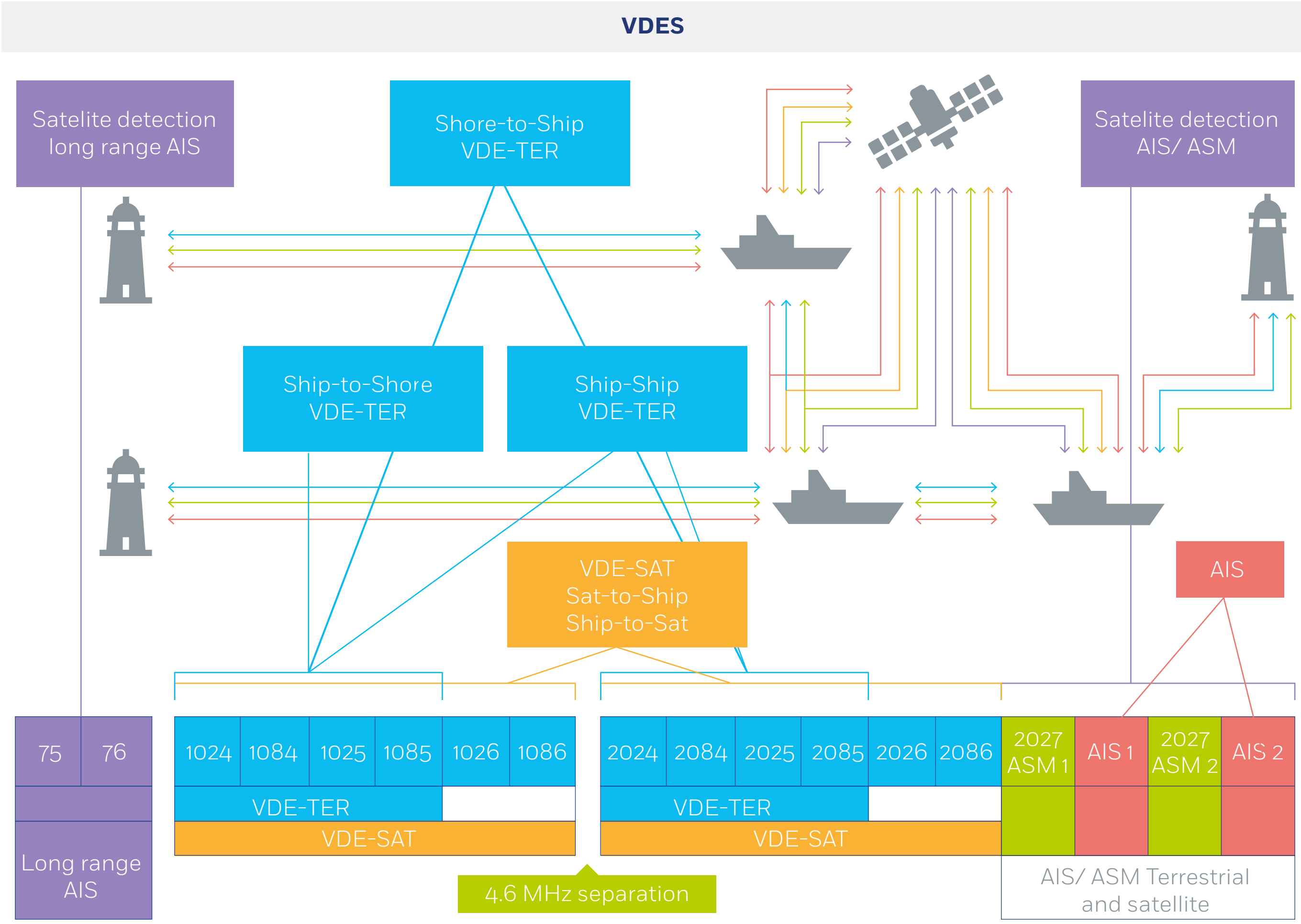
Source: EMSA services.

The full system showing the VDES functions and related frequencies is shown in Figure 93. The usage channels must be in accordance with Appendix 18 of the International Telecommunication Union (ITU) Radio Regulations. New channels have been allocated to enable VDES to have wider bandwidth, allowing it to include existing AIS applications and ASM and additional capabilities in support of VDE while giving its highest priority to AIS positioning reporting (transmission and reception) as required by Rec. ITU-R M.2092-1. AIS 1 and AIS 2 (AIS channels) and the long-range AIS using channels 75 and 76 must be used in accordance with Rec. ITU-R M.1371 ([88]), while the VDE channels for the upper and lower legs (VDE-TER and VDE-SAT uplink and downlink communications) and the ASM channels must be used in accordance with Rec. ITU-R M.2092-1.

87 Recommendation ITU-R M.2092-1, Technical characteristics for a VHF data exchange system in the VHF maritime mobile band, 2022, https://www.itu.int/dms_pubrec/itu-r/rec/m/R-REC-M.2092-1-202202-I!!PDF-E.pdf.

88 Recommendation ITU-R M.1371-5, Technical characteristics for an automatic identification system using time division multiple access in the VHF maritime mobile frequency band, 2014, https://www.itu.int/dms_pubrec/itu-r/rec/m/R-REC-M.1371-5-201402-I!!PDF-E.pdf.

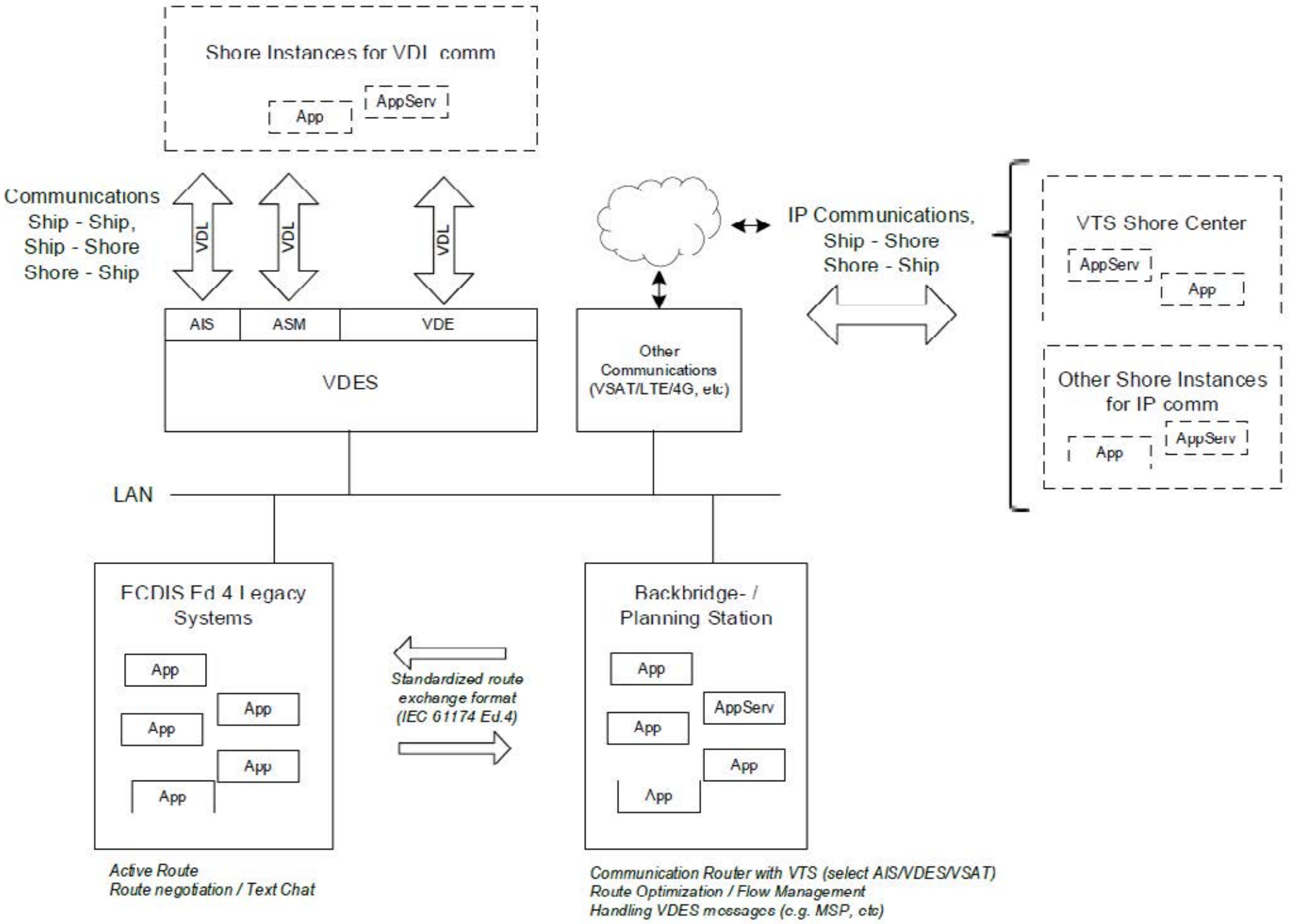
Figure 93 Full system showing the VDES functions and related frequencies.



Source: Rec. ITU-R M.2092-1.

The VDES operation concept as depicted by the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) is shown in Figure 94.

Figure 94: VDES concept.



Source: IALA (2022).

4.1.2.2 Regulatory framework

Within the context of the IMO regulatory framework, the work on introducing VDES into the 1974 SOLAS Convention started after MSC 103, in May 2021, agreed to include in its post-biennial agenda an output on 'Development of amendments to SOLAS Chapters IV and V and performance standards and guidelines to introduce VHF Data Exchange System (VDES)'. Following the discussions that took place at the 10th session of the Sub-Committee on Navigation, Communications and Search and Rescue (NCSR 10), it was agreed to establish a Correspondence Group on VDES. The group carried out a technical, regulatory and operational analysis of VDES and its communication component; developed draft performance standards required for the introduction of VDES into the SOLAS Convention; and prepared several options as draft amendments to SOLAS Chapters V and IV. The report of the Correspondence Group on VDES was submitted to NCSR 11, and during the sub-committee proceedings it was agreed that, while further consideration is required to introduce VDES into SOLAS Chapter IV, priority should be given to the development of amendments to Chapter V Regulation 19.2.4 to introduce VDES by considering the advantages and disadvantages of the options under consideration. The sub-committee also agreed to extend the target completion year of the associated output to 2025 and to re-establish the Correspondence Group on VDES to continue progressing intersessionally on the remaining work [89].

From the analysis the IMO Correspondence Group on VDES undertook it was established that the AIS component of VDES is technically identical to AIS and is a core component of VDES, therefore it can serve as a substitute in SOLAS Chapter V. The other components of VDES were considered to function as radiocommunication means and can therefore be regulated under Chapter IV. It was also concluded that VDES can cater for several communication needs and matters relating to cybersecurity, and the presentation and operation of VDES in respect of e-navigation and other applications should be

89 IMO NCSR 11/WP.1.

taken into consideration (90). Adequate training for seafarers and shoreside operations was found to be needed. In terms of the ITU regulations, while the terrestrial component of VDES (VDE-TER) and the ASMs were allocated channels on a primary basis, the channels for the satellite component (VDE-SAT) were allocated on a secondary basis. The report also pointed out that although the channels for VDES have already been allocated in the ITU Radio Regulations, under Article 5 and Appendix 18, the channels have not as yet been designated for use within the Global Maritime Distress and Safety System under Appendix 15, i.e. for the dissemination of maritime safety information (91). The consideration of such channel allocations designated for Global Maritime Distress and Safety System use would require an agenda item at the World Radiocommunication Conference in 2027 or subsequent conferences held under the auspices of the ITU.

Following the decision of NCSR 11 to re-establish the Correspondence Group on VDES, the group gave further consideration to the following matters: the draft amendments to SOLAS Chapter V; the development of the draft performance standards of shipborne VDES; and the development of the draft guidelines for the operational use of shipborne VDES. The group also identified the mandatory and non-mandatory instruments to be amended as a result of the amendments to SOLAS and developed the respective draft amendments (92). The report of the Correspondence Group on VDES was submitted to NCSR 12 for further consideration.

From an ITU regulatory point of view, the technical characteristics of VDES are contained in Rec. ITU-R M.2092-1, which provides the technical characteristics of VDES. This recommendation specifies how the functions of VHF data exchange, which contains the terrestrial and satellite components, ASMs and AIS, are integrated into and operating in the frequency bands indicated in Appendix 18 to the ITU Radio Regulations.

4.1.2.3 Potential use cases and further development

IALA has been instrumental in the development of the VDES concept. It published a guideline in 2022, 'G1117 – VHF Data Exchange System (VDES) overview', which provides detailed information on VDES, including the system concept and overview, the concept of operations, the role within e-navigation and its potential uses, such as for the authentication of AIS messages (93). Among the services for which VDES could be used, the guideline identifies the following:

In support of e-navigation maritime services:

- SAR communications,
- maritime safety information,
- ship reporting,
- VTSs,
- charts and publications,
- route exchange,
- logistics.

Other potential new services for which VDES could be used:

- loss of GNSS (positioning, navigation and timing),
- message forwarding,
- aids to navigation,
- vessel monitoring systems,
- autonomous collision avoidance manoeuvres,
- maritime domain awareness,
- disaster response.

IALA recently published a new guideline, 'G1181 – VDES VHF data link (VDL) integrity monitoring', which identifies sources of VDES VHF data link vulnerability and proposes methods for how the effects of invalid VHF data link transmissions could be detected and mitigated (94).

The International Electrotechnical Commission (IEC) has also been conducting work on VDES together with the ITU and IALA, and is presently working on a standard to outline the requirements and methods of testing for a shipborne mobile station (95).

4.1.2.4 EMSA's VHF Data Exchange-Satellite capability project

Driven by innovation and cutting-edge technology, EMSA and the European Space Agency (ESA) have, for the last several years, been looking into the new opportunities VDES offers in an age in which the digitalisation of shipping is becoming more important than ever. A significant milestone was reached in 2023, when EMSA actively participated with the ESA and the Norwegian Coastal Administration, together with Space Norway and Kongsberg Seatex, in a VDE-SAT Application and Services Platform (VASP) demonstration project to show the benefits of using the satellite component (VDE-SAT) of VDES when exchanging ship-to-shore and shore-to-ship digital data using a Norwegian satellite with a VDES payload.

90 IMO NCSR 11/9.
91 IMO NCSR 11/9.
92 IMO NCSR 12/9.
93 https://www.iala.int/product/g1117/?download=true.
94 https://www.iala-aism.org/product/g1181-vdes-vdl-integrity-monitoring/.
95 IMO NCSR 11/18/3.

Figure 95: VASP project.

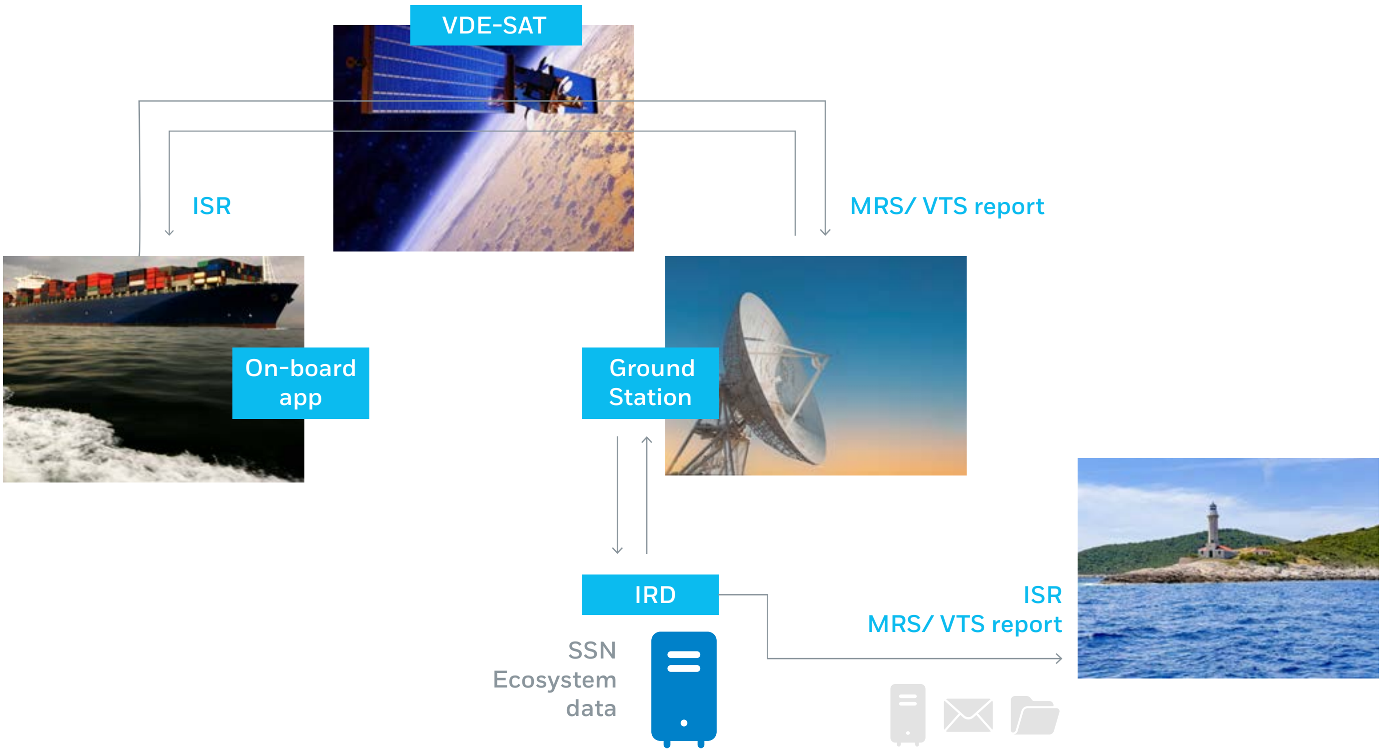
Source: Space Norway.

Figure 96: NorSat-2 LEO satellite.

Source: Space Flight Laboratory.

The VASP project carried out tests to demonstrate how the exchange of digital information between ships and EU Member State coastal stations using Norway's NorSat-2 LEO satellite and specific shipboard equipment can take place by exchanging MRS and VTS reporting messages. Figure 97 shows an outline of the EMSA system set-up employed to enable the communication flow between the ship, the VDE-SAT, the ground station and EMSA.

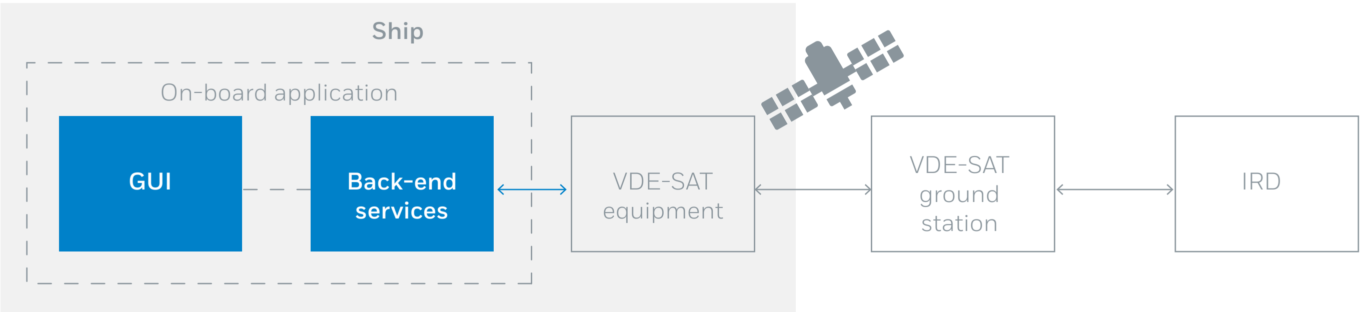
Figure 97: VASP EMSA system set-up.



Source: EMSA.

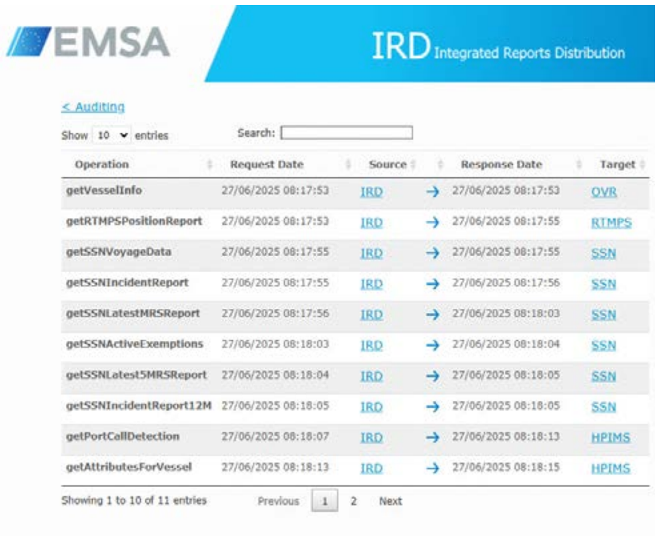
As can be seen from Figure 98, the demonstration project required EMSA to connect EMSA's IRD system with the Norwegian ground station, the development of an on-board application connected to the ship's VDE-SAT equipment and the installation of protype VDES equipment at EMSA's premises. Communication was established through satellite connections, integrated ship report requests and the submission of MRS/VTS reports. Authority responses could be transferred via VDE-SAT during a single pass of a satellite. The VASP project also demonstrated the SAR coordination service and the ice chart distribution service.

Figure 98: VASP communication flow to and from EMSA.



Source: EMSA.

Figure 99: EMSA IRD report.


EMSA
IRD Integrated Reports Distribution

< Auditing

Show 10 entries Search:

Operation	Request Date	Source		Response Date	Target
getVesselInfo	27/06/2025 08:17:53	IRD	→	27/06/2025 08:17:53	OVR
getRTMPSPositionReport	27/06/2025 08:17:53	IRD	→	27/06/2025 08:17:55	RTMPS
getSSNVoyageData	27/06/2025 08:17:55	IRD	→	27/06/2025 08:17:55	SSN
getSSNIncidentReport	27/06/2025 08:17:55	IRD	→	27/06/2025 08:17:56	SSN
getSSNLatestMRSReport	27/06/2025 08:17:56	IRD	→	27/06/2025 08:18:03	SSN
getSSNActiveExemptions	27/06/2025 08:18:03	IRD	→	27/06/2025 08:18:04	SSN
getSSNLatest5MRSReport	27/06/2025 08:18:04	IRD	→	27/06/2025 08:18:05	SSN
getSSNIncidentReport12M	27/06/2025 08:18:05	IRD	→	27/06/2025 08:18:05	SSN
getPortCallDetection	27/06/2025 08:18:07	IRD	→	27/06/2025 08:18:13	HPIMS
getAttributesForVessel	27/06/2025 08:18:13	IRD	→	27/06/2025 08:18:15	HPIMS

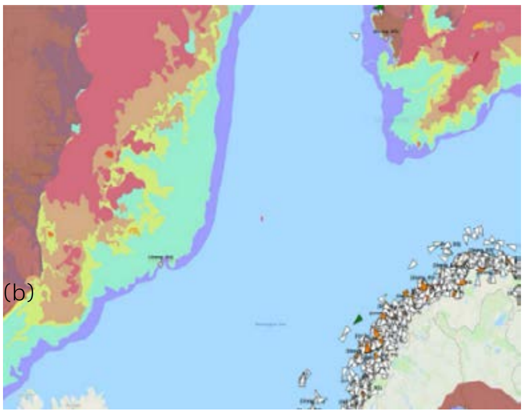
Showing 1 to 10 of 11 entries Previous 1 2 Next

Source: EMSA services.

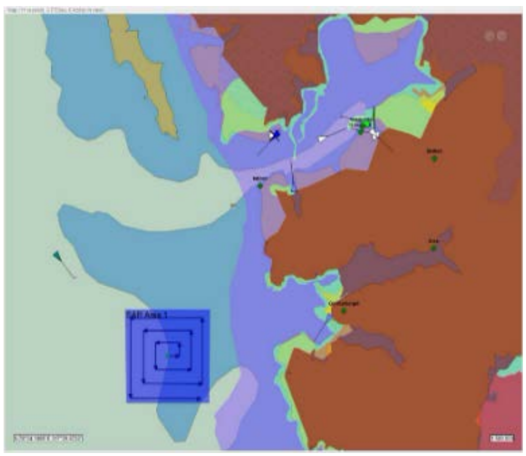
From EMSA's perspective, the project successfully demonstrated that MRS and VTS information can be exchanged between a vessel and a coastal station by using VDE-SAT communication and that VDES provides significant opportunities for exchanging data to the benefit of diverse users within the maritime domain.

Figure 100 (a) and (b): VASP ice chart distribution and SAR coordination service as displayed on the vessel in the Kongsberg AIS Central Monitor application.

(a)



(b)



Source: Kongsberg Discovery, Seatex.

4.1.2.5 The first joint EMSA–European Space Agency Workshop on VDES

On 6 December 2023, the first joint EMSA–ESA Workshop on VDES was held at EMSA's premises in Lisbon. Representatives from Member States and from the maritime and space industries participated actively during the workshop. The VDES workshop contributed to a better understanding of the potential use of VDES as an innovative technology using terrestrial and satellite-based solutions, which can significantly accelerate digitalisation in the maritime domain. Participants had the opportunity to see how the benefits offered by VDES could be harnessed to their full advantage to increase maritime safety, improve environmental performance and enable more cost-effective shipping for greater sustainability and a greener transition. A substantial number of companies from the space industry presented an update on their future VDES satellite deployments, multiple demonstration/validation campaigns of VDES test beds, the development of VDES transceivers, improved antenna solutions and technologies for supporting higher data rates. Participants had the opportunity to see what VDES services the space industry is aiming to offer. They also had the opportunity to discuss what should be further developed by sharing their experience and perspectives on VDES developments and by identifying use cases for VDES. The list below summarises potential VDES use cases as suggested by the participants:

- seamless communication services and data exchange between vessels and shore-based authorities;
- a digital maritime messaging service to provide transparent seamless information transfer across different communication links;
- meteorological and oceanographic data collection and warnings / ice chart distribution service;
- SAR operation coordination, such as the exchange of search patterns and position reports;
- MRS data exchange;
- the exchange of route and port information and VTS services;
- the exchange of maritime safety information, such as for polar regions;
- AIS rebroadcasting for enhanced situational awareness;
- navigational augmentation and VDES R-Mode for position accuracy prediction in support of e-navigation and improved navigation safety;
- VDES R-mode can serve as an independent resilient terrestrial positioning, navigation and timing system to provide a backup to global navigation satellite systems;
- multi-maritime connectivity for digital reporting and navigation, such as MASS operations;
- position reporting by ships on a global level by complementing AIS and LRIT with additional information for enhancing navigational safety;
- remote equipment diagnostics and equipment monitoring.

VDES is bringing about a new era for maritime communications and provides significant opportunities for exchanging data to the benefit of diverse users within the maritime transport domain.

EMSA aims to remain at the forefront in contributing towards a better understanding of the potential use of VDES as an innovative technology to suit Member States' and users' needs. The agency will be looking into the new opportunities VDES offers in an age in which the digitalisation of shipping is becoming more important than ever.

4.1.3 Other information systems – Electronic Quality Shipping Information System

Equasis was created 25 years ago as a tool aimed at reducing substandard shipping by providing, in a free and transparent way, safety-related information on ships and shipping companies. Equasis includes information on merchant ships above 100 GT, yachts, fishing vessels and related companies.

With more than 30 000 monthly users in 2023, Equasis remains accessible to the public worldwide, free of charge. It is a valuable source of ship-specific information on management, class, insurance, PSC inspections, detentions and types of deficiency, geographical information and more. A profile of Equasis users and its use within the maritime community is provided in Figure 101.

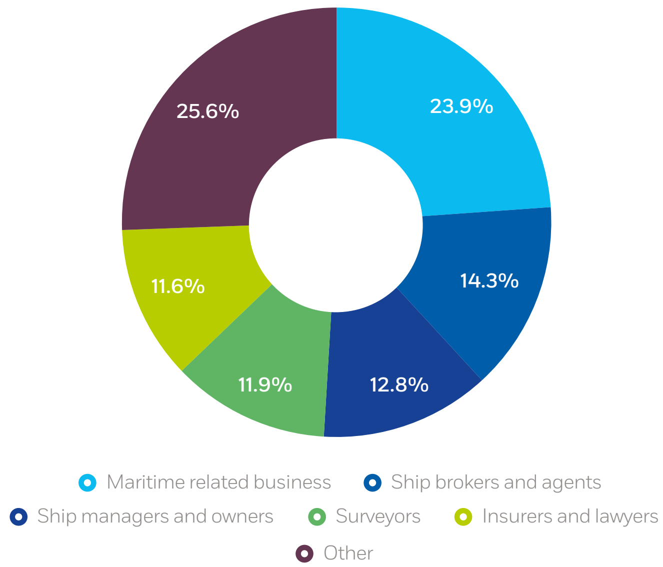
The information system works based on voluntary data-sharing agreements with industry providers and public organisations. Currently, a group of 60 data providers work with Equasis and share data periodically. The complete list of providers can be found on the Equasis website ([96]). Data providers form part of the Equasis Editorial Board, together with user representatives and observers.

The cost of running Equasis is shared equally between the members of its Supervisory Committee, which currently includes the maritime administrations of Brazil, Canada, France, Japan, Norway, South Korea, Spain, the United Kingdom, the United States and EMSA (on behalf of the Commission).

EMSA has hosted the Management Unit of the project since 2009, acting as the secretariat of the Supervisory Committee and of the Editorial Board. The Management Unit implements the decisions by the organisation and manages the agreements with internal and external parties and service providers (data providers, users, consultants and providers of IT service, staff, etc.) on behalf of Equasis. IT aspects are dealt with by the Technical Unit, hosted by the French maritime authorities (Directorate General for Maritime Affairs, Fisheries, and Aquaculture / Sub-Directorate for Digital Transformation).

The distribution of Equasis users by country and volume of website visits is illustrated in Figure 102. It clearly shows that the project is found useful within the maritime community based in Europe, Asia and North America.

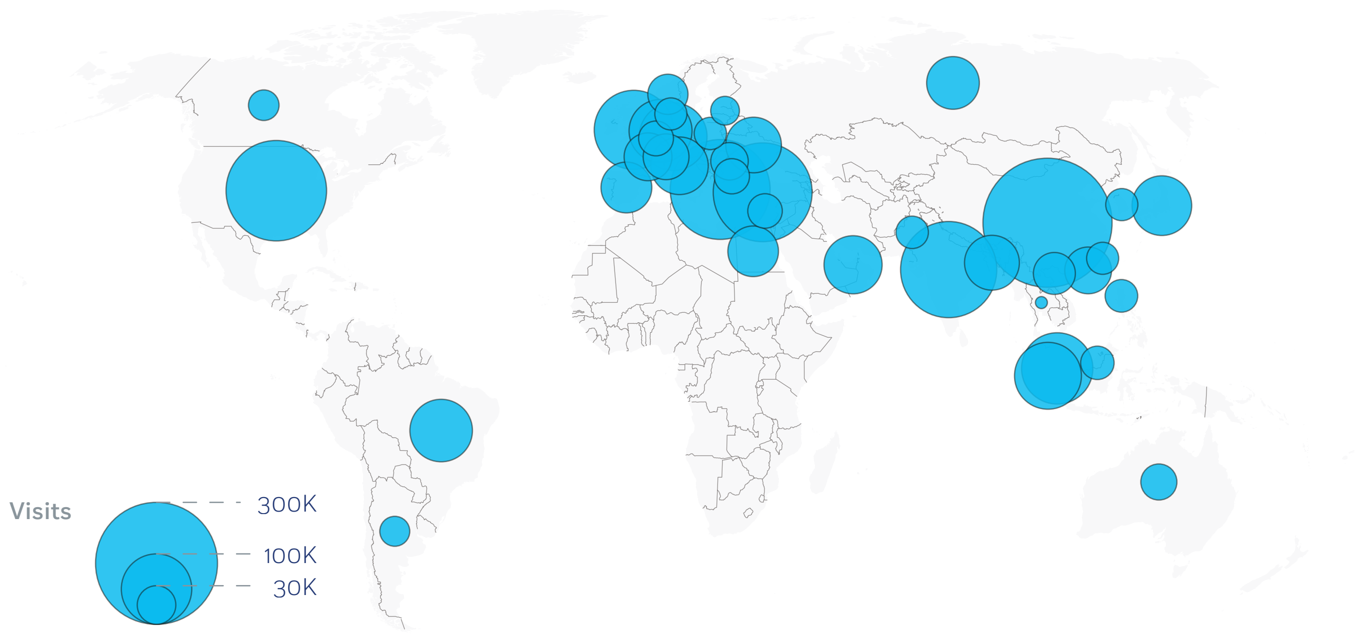
Figure 101: Equasis users' profiles by business group in 2023.



The "other" category includes public authorities, press & media, NGOs, seafarers, researchers at universities or maritime colleges, and members of the public.

Source: Equasis.

Figure 102: Equasis users' locations around the world in 2023.



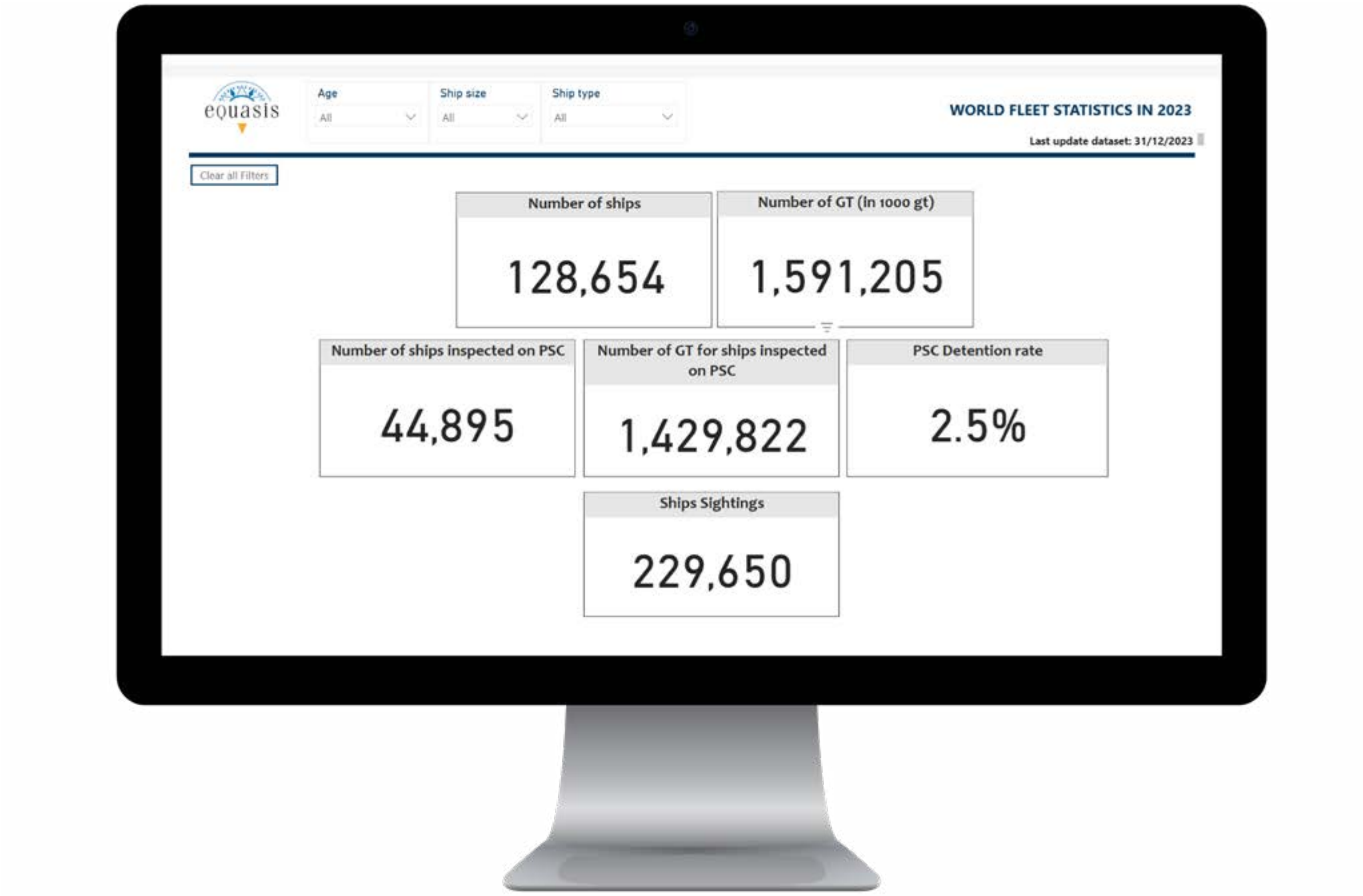
Source: Equasis.

96 https://www.equasis.org/EquasisWeb/public/About?fs=DataUpdatePublic&P_ABOUT=Providers.html.

One of the main products of Equasis is the world fleet report publication, made publicly available since 2005, which provides a yearly picture of the fleet based on the data provided to Equasis, its characteristics and its safety performance.

In 2024, the report was modernised and statistics on Equasis data are now dynamically available to the public through dashboards on the website.

Figure 103: New format of the Equasis world fleet report.



Source: Equasis.

4.2 Places of refuge

4.2.1 Introduction

When an accident happens at sea that potentially involves pollution, fire, chemical products or similar issues, it can be difficult to find a safe place to shelter the ship unless a system has already been agreed. As a direct result of maritime accidents in European waters, such as those of the tankers *Erika* and *Prestige,* EU Member States and all parties to UNCLOS had to create a system to help ships in need of assistance.

The solution found was the development of the concept of places of refuge to handle ships in distress and to provide them with an appropriate location for emergency use.

In accordance with Directive 2002/59/EC (consolidated version), '"ship in need of assistance" means, without prejudice to the provisions of the SAR Convention concerning the rescue of persons, a ship in a situation that could give rise to its loss or an environmental or navigational hazard'.

A place of refuge is one 'where a ship in need of assistance can take action to enable it to stabilize its condition and reduce the risks to navigation, and to protect human life and the environment' ([97]). Suitable places of refuge may include ports, inlets, lee shores, coves, fjords, bays or any place of shelter near the coast.

Accordingly, national authorities must draw up contingency plans to manage emergencies at sea, including a list of places of refuge that could be used should the need arise. However, the situation may become more complex if the accident happens in international waters close to the coast of more than one state. In these cases, it is essential to have pre-established communication links between the competent authorities and ports of the Member States involved, to facilitate cooperation.

When a ship has suffered an incident at sea, sometimes the best way to prevent further damage or pollution from its progressive deterioration is to lighten its cargo and bunkers and to repair the damage. Such an operation is best carried out in a place of refuge, as it is rarely possible to deal satisfactorily and effectively with a marine casualty in open sea conditions.

For maritime incidents outside the jurisdiction of Member States, cooperation and coordination are essential in determining which state is in the best condition to provide a place of refuge.

Because of the many variable factors involved in an incident (e.g. the condition of the sea, the weather, the condition of the vessel, required and available facilities and equipment) and the variety of risks involved when bringing a ship in need of assistance into a place of refuge, a decision to grant access to a place of refuge can only be taken on a case-by-case basis.

While Directive 2002/59/EC provides for the legal framework, a more detailed approach is needed to handle an incident efficiently. The EU's related operational guidelines and the regular table-top exercises (see Section 4.2.3), are intended to cover this need by providing practical guidance to the competent authorities of Member States and the other main parties involved in managing a request for a place of refuge from a ship in need of assistance.

Historical examples of incidents show that challenges are posed when an incident occurs on the high seas or outside the jurisdiction of any one Member State.

97 IMO Resolution A.1184(33) adopted on 6 December 2023, Guidelines on places of refuge for ships in need of assistance, https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/AssemblyDocuments/A.1184(33).pdf.

4.2.2 Regulatory framework

Table 42: Legislation on places of refuge.

	Level	Instrument	What it regulates
Legislation	International	IMO Resolution A.1184(33)	Guidelines on places of refuge for ships in need of assistance.
		SAR Convention	Rescue of persons in distress at sea.
	EU	Places of refuge – EU operational guidelines	Guidance for competent authorities and the main parties involved in managing a request for a place of refuge from a ship in need of assistance.
		Directive 2002/59/EC	Requirements for Member States to draw up and make available the plans to accommodate ships in distress, in the waters under their jurisdiction.
	National	National plans addressing the issue of places of refuge as required by Directive 2002/59.	

4.2.3 EU operational guidelines on places of refuge

The issue of accommodating ships in need of assistance has grown in importance since the incident involving the *MSC Flaminia* in 2012, which led to the setting up of the Cooperation Group on Places of Refuge under Article 20(3) of Directive 2002/59/EC. The document 'Places of refuge – EU operational guidelines' ([98]), as developed by the group with the support of industry stakeholders, introduced a new spirit of enhanced cooperation and coordination among Member States and with the industry.

The purpose of the operational guidelines for ships requiring assistance is to provide Member States, ship masters, companies and salvors with a comprehensive framework for an effective response. This framework is designed to ensure that the efforts of all parties involved are complementary and coordinated. They also provide a robust operational process leading to well-advised but quicker decision-making, building on effective, speedy and accurate sharing of information as key enabling factors. It is a bottom-up process, aiming to foster wider involvement and drawing attention to a broader scenario extending beyond the EU's borders, whereby, in order to fulfil the obligations deriving from the legal provisions, concerted plans for decision-making can be envisaged. The operational guidelines support Member States in a constructive way, implementing the rules and assisting competent authorities as the main operational bodies in the decision-making process. The need for international coordination and decision-making is crucial in situations in which more than one state may be involved, particularly for incidents occurring beyond national jurisdiction.

The EU's operational guidelines have been tested in scenarios resembling, as far as possible, a real situation, with all parties involved through table-top exercises. EMSA organises exercises to support the practical implementation of the places-of-refuge policy in the EU Member States. They are based on hypothetical case studies, developed to be as realistic as possible, and the representatives of the Member States, the Commission, EMSA and the maritime industry (i.e., salvage, class, and insurance) are invited to participate. In fact, as a conclusion from the first exercise of this kind, the need emerged for an instrument that would guide Member States in dealing with places-of-refuge situations, which led to the drafting of the operational guidelines referred to above. The exercises that followed served to update these guidelines. The operational guidelines cover coordination and procedural aspects in

98 https://transport.ec.europa.eu/document/download/7851864c-6fa2-4526-87f4-e89be0d8c2b1_en?filename=por-operational-guidelines.pdf

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handling a request for a place of refuge when it involves a Member State in waters under its jurisdiction; situations in which the involvement of neighbouring Member States is required; and cases in which the incident occurs outside the jurisdiction of any one Member State.

Regarding coordination, the principle is that each state involved starts to examine its ability to provide a place of refuge and that, in the interest of resolving the situation, there is direct contact between the competent authorities involved to decide which is best place to take the coordinating role. The guidelines provide detailed information on the roles and responsibilities of key players in a request for a place of refuge.

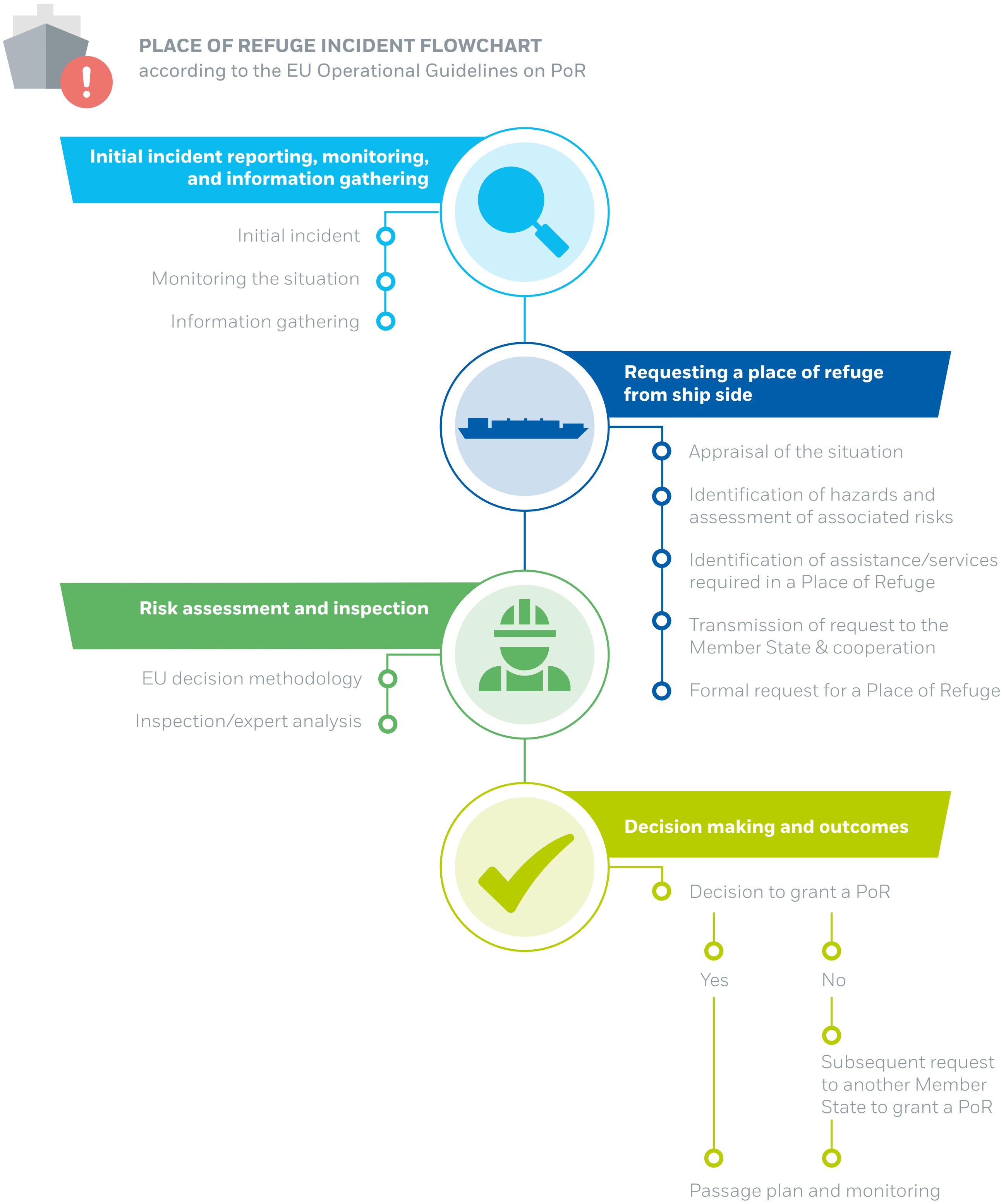
In 2022, the fifth EU–EEA Member States Table-top Exercise on Places of Refuge [99] took place at EMSA, led by Denmark and attended by 61 participants from Member States, neighbouring states, the industry and stakeholders. The exercise resulted in several key recommendations to improve the decision-making process, handling and outcomes of place-of-refuge requests, which rely greatly on cooperation and information sharing:

- place-of-refuge plans should be available in multiple languages, as language was found to be a barrier preventing neighbouring states from being aware of their neighbours' plans;
- the competent authority should be sufficiently robust to handle the information exchange, and in particular the transfer of information from external sources into the format of EU systems;
- fighting the misdeclaration of hazmat should still be considered a priority, as it can have serious implications for the entire decision-making process.

99 https://emsa.europa.eu/we-do/safety/places-of-refuge/item/5042-eu-eea-member-states-table-top-exercise-places-of-refuge-july-2022.html.

Figure 104 represents the phases of a place-of-refuge incident as per the EU's operational guidelines.

Figure 104: Flowchart of a place-of-refuge incident according to the EU's operational guidelines on places of refuge.



Source: EMSA services.

4.2.4 Remote technical support

IT systems and communication tools can be of real utility in cases of ships in distress. For example, it was reported that during the *Prestige* disaster, the decision to fill two tanks on the port side of the vessel in an attempt to return it to an upright position caused the stresses on the structure to surpass the structural strength of the ship as it was designed. This would have been important information for the crew and salvage team to have before taking the decision they did.

Nowadays, many classification societies offer continuous, around-the-clock emergency information services for ships in distress, as the decision-making during the first few hours of an accident is vital for a good outcome. The information provided includes post-damage stability and strength calculations. This information can be very useful for the ship and authorities within the places-of-refuge framework to take the right decisions.

4.2.5 Pollution

The potential pollution and damage that can arise from accommodating a vessel in a place of refuge is a sensitive issue. In such cases, the usual national and international liability and compensation rules apply (i.e. the Convention on Limitation of Liability for Maritime Claims, the International Convention on Civil Liability for Oil Pollution Damage, the International Convention on Civil Liability for Bunker Oil Pollution Damage, the Nairobi International Convention on the Removal of Wrecks and potentially the International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea). Moreover, any ship flying a flag of an EU Member State, or proceeding to an EU port regardless of the flag, is required to hold civil liability insurance as per Directive 2009/20/EC on the insurance of shipowners for maritime claims ([100]). A Member State accommodating a vessel in a place of refuge may ask for proof of valid insurance. However, even when the vessel in question cannot present such proof, the state must continue with the analysis of the place-of-refuge request and identify the best course of action for the protection of human life and the environment. Lack of proof of adequate insurance cover cannot constitute a sufficient reason to refuse such a request.

4.2.6 Health crisis

During the initial phase of the COVID-19 pandemic, several cruise ships were refused access to port, thereby creating serious situations in which thousands of people were stranded at sea and denied urgent medical assistance. This global humanitarian crisis resulted from the very rapid changes implemented in the health policies and border restrictions of certain countries.

The places-of-refuge concept, as currently defined, does not appear to apply in this case. The definition of a ship in need of assistance refers to a ship in a situation, apart from one requiring the rescue of persons on board, that could give rise to the loss of the vessel or to an environmental or navigational hazard.

Furthermore, Directive 2002/59/EC does not address health crises on board ships; it appears that a pandemic outbreak of the kind witnessed during the COVID-19 crisis was not contemplated in any of the situations described in the relevant legal instruments.

Both cruise operators and port authorities are now better prepared to respond to such situations, should they occur again. However, at the legislative level, there has been no change to the current framework.

Neither Directive 2002/59/EC nor the EU operational guidelines addresses health-related safety issues directly. Therefore, any intention to use them for this purpose in the future will entail either a modification of these instruments or a relevant broad interpretation of the current legal texts. It could also entail more tailor-made drafting of the guidelines to address specific health-related safety issues.

100 Directive 2009/20/EC of the European Parliament and of the Council of 23 April 2009 on the insurance of shipowners for maritime claims (OJ L 131, 28.5.2009, p. 128, ELI: http://data.europa.eu/eli/dir/2009/20/oj).

4.3 Search and rescue

4.3.1 Introduction

SAR is one of the most critical topics within the field of maritime safety. UNCLOS already included the obligation to render assistance to ships in distress and the establishment of a SAR service at the state level. This was complemented in 1979, when the SAR Convention was adopted at a conference in Hamburg with the aim of developing an international SAR system for people in distress at sea.

The convention describes preparatory measures that should be taken, including the establishment of rescue coordination centres (RCCs). It also outlines operating procedures to be followed in the event of emergencies or alerts and during SAR operations.

To implement the SAR Convention, the world's oceans have been divided into 13 SAR areas, in each of which the countries concerned have delimited SAR regions (SRRs) for which they are responsible.

Material investments required by the convention, such as the installation of shore-based facilities, have been obstacles to widespread ratification, along with liability issues. Therefore, a revised annex to the convention, entering into force in January 2000, was adopted in 1998 to clarify the responsibilities of governments and to promote a regional approach and coordination between maritime and aeronautical SAR operations. The number of states party to the convention has reached 113, representing 80 % of the world fleet. Each state party undertakes to make available to the IMO and other states the information relating to their SAR facilities, including the contact details of their MRCCs and medical services. This information is available through GISIS, which is a free public-use information system developed by the IMO.

4.3.2 Regulatory framework

Table 43: Legislation on SAR.

	Level	Instrument	What it regulates
Legislation	International	UNCLOS Article 98	Duty to render assistance. Establishment, operation and maintenance of SAR services in every coastal state.
		International Convention on Salvage	Duty to render assistance.
		SAR Convention	Preparatory measures and operating procedures to be followed in the event of emergencies or alerts and during SAR operations. Definition of SAR areas.
		SOLAS Chapter V Regulations 7 and 33	SAR services to be provided by the state, including distress and coordination arrangements in their area of responsibility. Masters' obligations and procedures in distress situations.
		STCW Convention and Code	Minimum requirements for certification of officers, including the competences of responding to distress signals at sea and coordinating SAR operations.
	EU	Directive 2002/59/EC	Establishment of a Community vessel traffic monitoring and information system helping to ensure the immediate reporting by the master of a ship sailing within their SAR region.
		Council Directive 98/41/EC	Provision of the number of people on board passenger ships and their personal information, facilitating the management of SAR operations.
		Regulation (EU) No 656/2014	Rules for surveillance of the external sea borders in the context of operational cooperation.
		Commission Implementing Regulation (EU) 2021/581	Communication obligations between the European Border and Coast Guard Agency, the national competent authorities for border control and the RCCs.
	National	**Each party must draw up and keep up to date a plan explaining the national organisation for SAR, including the authorities engaged in SAR, the strategy, resources and description of operational oversight.**	

4.3.2.1 Overview of search and rescue in the EU

In accordance with the SAR Convention, each state party must draw up and keep up to date a plan explaining the national organisation framework for SAR. It must include the public or private authorities engaged in SAR, the strategy adopted, resources and a description of the operational oversight provided. Depending on the regulatory architecture of each state, the plan may be spread across several laws, decrees or orders.

Therefore, SAR competence resides at the national level. Furthermore, the convention allows for the conclusion of bilateral or multilateral agreements by the coastal states or parties concerned to cooperate on and coordinate SAR services in specific areas. The aim of these agreements is to clarify the areas of SAR responsibility and to establish cooperation arrangements and complementary protocols among the relevant national competent authorities.

There is no obligation to notify the IMO of these agreements. Some examples of agreements in various EU regions are as follows:

- **Baltic Sea:** Estonia, Finland, Russia and Sweden;
- **North Sea and English Channel:** Belgium, France and the United Kingdom;
- **Atlantic Ocean:** France and Spain;
- **Mediterranean Sea:** France, Italy and Spain;
- **Black Sea:** Bulgaria, Georgia, Romania, Russia, Türkiye and Ukraine;
- **Adriatic Sea:** Croatia, Italy and Slovenia.

Within each state, MRCCs or RCCs have been created to coordinate SAR operations in their respective areas of responsibility within the SRR when a distress call is received. If the incident is reported to an MRCC/RCC, but is not in its own SRR, the centre will need to coordinate with another MRCC/RCC for the possible orderly transfer of responsibilities so that assistance can be given.

It is notable that SOLAS requires all ships to carry an up-to-date copy of Volume III of the *International Aeronautical and Maritime Search and Rescue Manual*. This manual aims to harmonise maritime SAR functions and operational models and promote international forms of cooperation. It provides guidelines for a common aviation and maritime approach to organising and providing SAR services.

4.3.2.2 Search and rescue cooperation plans – passenger ships

Passenger ships have a special status within the SAR framework. SOLAS includes a specific provision for passenger ships engaged in international voyages, which obliges them to have on board a plan for cooperation with appropriate SAR services in the event of an emergency. This document, known as the SAR cooperation plan (SARCP), is developed in collaboration by the ship operator, the management company and the SAR services based on IMO MSC.1/Circ.1079/Rev.1 [101]. The aim of this plan is to enhance the link between the ship, the company and the SAR authorities of the relevant state(s), and it includes the direct contact details of the three parties to avoid unnecessary delays. To assess the efficiency of the SARCP, regular exercises are organised.

There are two different operational situations regarding the SARCP.

- **Passenger ships operated on fixed routes, such as ferries.** The plan is kept by the relevant RCC. Companies must collaborate continuously with the relevant SAR services to complete the SARCP and keep it updated. SARCP evaluations are planned and organised in collaboration with the MRCC of the SRR.
- **Passenger ships not operated on fixed routes, such as cruise ships.** It is not necessary for each of the MRCCs through whose region the ship transits to hold a copy of the ship's SARCP. In this case, the convention established a centralised repository (a SAR data provider) where most of the plans are stored and available continuously. This repository is managed and hosted by the United Kingdom's Maritime Coastguard Agency (MCA). The MCA is responsible for receiving new or updated plans and must ensure immediate access to the SAR plan for companies and MRCCs with responsibilities in the areas of operation of the vessels concerned. An updated index with the list of ships using the SAR data provider is available on the website of the MCA.

The SARCP complements existing emergency response plans already established and implemented by companies and ships in the context of the ISM Code.

It is also worth mentioning that the SARCP is not mandatory for passenger ships engaged in domestic trade regardless of the number of passengers carried or the distance to the coast and to SAR means.

At the EU level, there is a legal instrument developed to facilitate the SAR activities of passenger ships: the PAX Directive. Its main objectives are to provide SAR authorities with data on the number of people on board passenger ships to facilitate their work, and to be able to access some information about passengers that can be provided to authorities, families, etc. The information to be recorded – basically the number of people on board a passenger ship (on short voyages) and their personal information (on longer voyages) – is essential for the management of SAR operations by an MRCC. In the past, the information was recorded by the operator before departing and stored by the company registrar, but was available to SAR authorities only upon request. Since 2023, this information has been recorded either in the NSW or in AIS so that it is directly available to the SAR authorities without intermediaries.

Another emerging issue in this field is SAR in remote areas. Although this issue is not limited to passenger ships, they are a focus of attention due to the large number of people they carry and the increase in the number of cruise ships visiting the polar zones (both the Arctic and the Antarctic). A massive SAR operation in any of these remote areas with limited maritime traffic and available SAR resources is a challenge for which the maritime community should be prepared.

101 https://wwwcdn.imo.org/localresources/en/OurWork/Safety/Documents/Documents%20relevant%20to%20SAR/MSC.1-Circ.1079-Rev.1%20Guidelines%20for%20preparing%20plans%20for%20co-operation%20between%20sar%20services%20and%20passenger%20ship.pdf

4.3.3 Search and rescue operations

SAR operations are organised efforts to save lives during maritime emergencies, such as ship collisions, capsizes, fires or groundings. The main goal is to respond quickly and effectively to ensure the safety of people at sea.

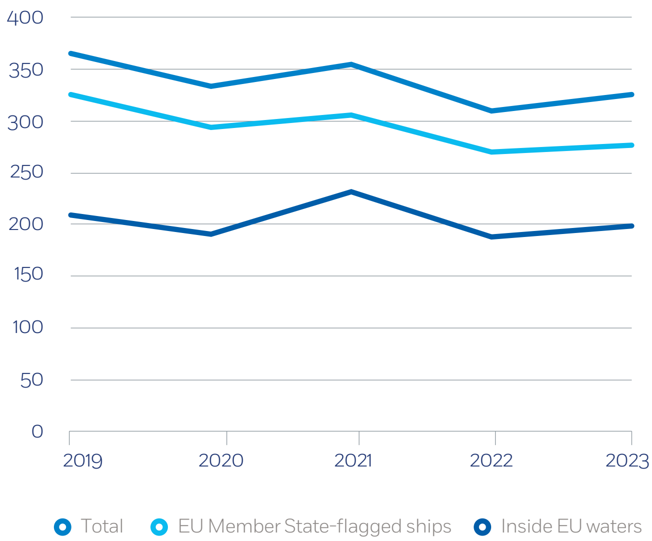
4.3.3.1 Data available on the European Marine Casualty Information Platform

The information on SAR operations in this section is as reported by the EU Member States in EMCIP and is linked to the occurrences reported on the platform. The scope of the accidents reported is defined in Directive 2009/18/EC and includes casualties involving ships flying the flag of one of the EU Member States, occurring within EU Member States' territorial sea or internal waters, as defined in UNCLOS, or involving substantial interest on the part of EU Member States.

The mandatory information to be reported in EMCIP is listed in Annex 2 to Directive 2009/18/EC and does not include information on SAR operations. **Reporting SAR operations is recommended by the PCF but is not compulsory.** As a result, while SAR operations are crucial for maritime safety, it is important to note that the following statistics may not capture all SAR operations, i.e. the actual numbers are likely higher than those reported.

The total number of reported SAR operations in the period from 2019 to 2023 is 1 686 – an average of 337 SAR interventions annually. Figure 105 shows the trend in the number of SAR operations from 2019 to 2023, differentiating between those involving EU Member State-flagged ships and those occurring inside EU waters.

Figure 105: SAR operations – total number of ships with SAR intervention and breakdown of occurrences within EU waters and involving at least one EU Member State-flagged ship.

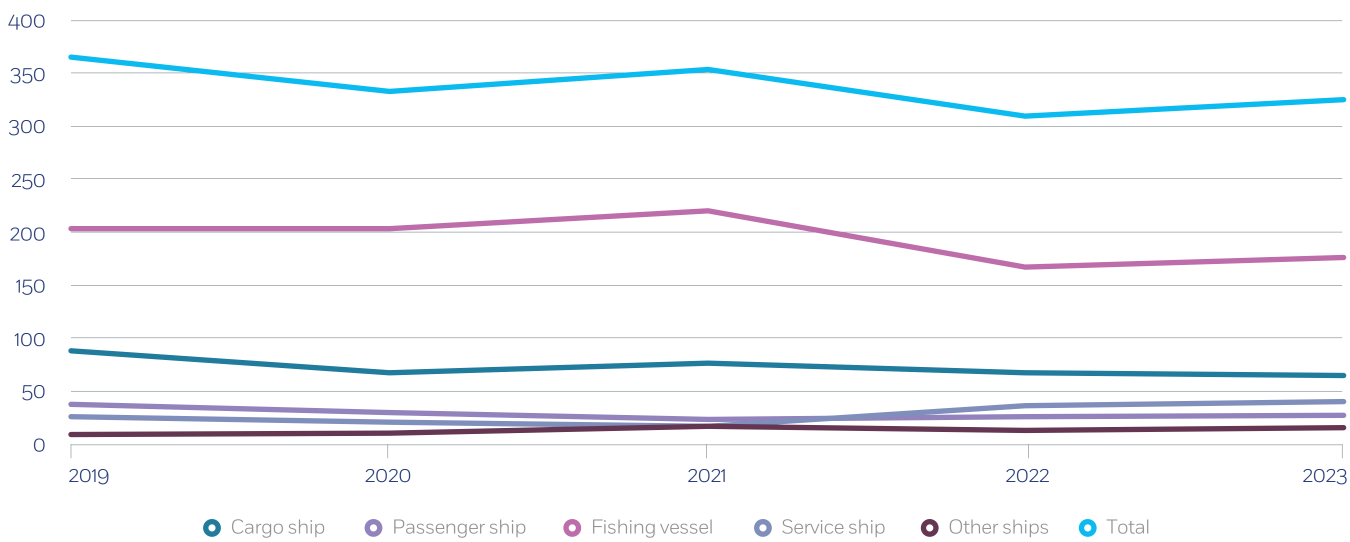


Source: EMCIP (EMSA, n.d.).

Out of the total number of SAR interventions reported in connection with occurrences inside EU waters between 2019 and 2023, 13 % involved non-EU-flagged vessels.

Figure 106 shows the evolution in the number of SAR operations over the 2019–2023 period, organised by ship type.

Figure 106: SAR operations – evolution in number of SAR operations, organised by ship type.



Source: EMCIP (EMSA, n.d.).

Fishing vessels accounted for the highest number of SAR operations, with 58 % of the total operations reported, followed by cargo ships with 22 %, passenger ships with 9 %, service ships with 8 % and other ships with 4 %.

Considering the number of fishing vessels involved in accidents, as reported in EMCIP, this means that during this period 36 % of fishing vessels in distress required a SAR intervention.

4.3.3.2 Use of remotely piloted aircraft systems in search and rescue activities

The use of remotely piloted aircraft systems (RPAS) during SAR events is available to SAR coordinating authorities. RPAS provide enhanced search functions through a multitude of specialised on-board sensors that can be used to detect ships, life rafts, objects on the sea's surface, people overboard, etc. These craft have the ability to stay on the scene to monitor the development of the SAR event and can cover a wider area than rescue ships due to their speed, enabling them to scan the sea's surface more efficiently.

RPAS are unmanned aircraft that are piloted remotely from a ground control station (GCS). For maritime functions, the GCS is located relatively close to the coastline or on board a vessel. Depending on the category of the RPAS, the range, endurance and capabilities of the payload can vary substantially. For a mid-size RPAS, from 40 to 200 kg, it is possible to achieve a range of 500 km from the coastline and 800 km along the coastline, with an endurance of 4 to 17 hours depending on the type of RPAS and the payload on board. If operated from a ship, a trade-off must be made between the performance of the RPAS and the size of the ship (i.e. the larger the RPAS, the larger the ship needs to be, so that the RPAS can be operated safely; smaller RPAS, in general, have a lower level of autonomy and performance).

RPAS equipped for maritime functions typically carry on board a selection of the following sensors suitable for SAR activities.

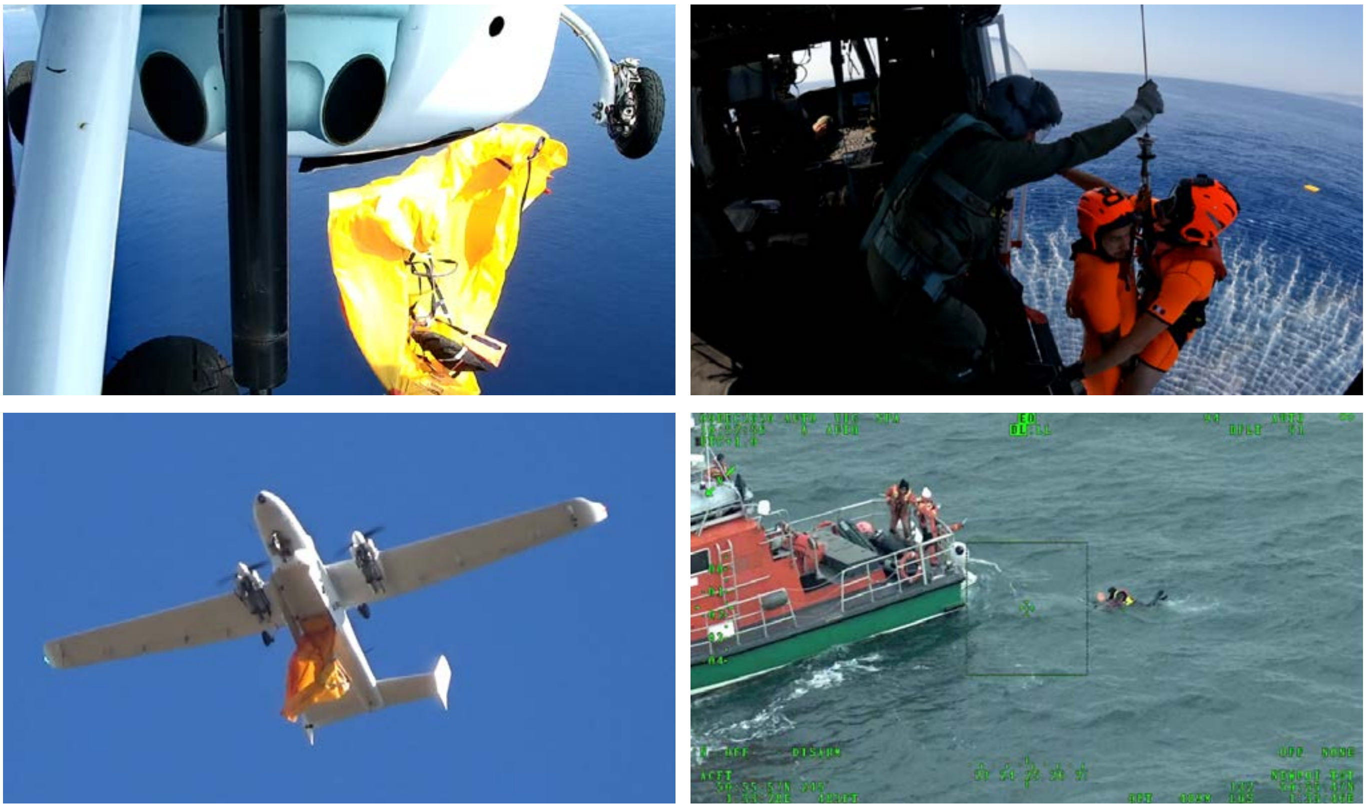
- **Gimbal/cameras.** Prime sensor equipped in all RPAS, presenting different resolutions, sensitivities and detection, recognition and identification functions to observe during daylight (electro-optical), and infrared to be used at night.
- **Maritime radar.** With maritime moving target indicator, and optionally with imagery modes for environmental monitoring.
- **AIS.** AIS signal detection.
- **Optical scanners.** Optical and infrared to automatically scan the sea surface for objects of interest.
- **Distress sensor (emergency position-indicating 406 MHz radiobeacon).** For the collection of distress signals.
- **Mobile frequency detection.** For the detection of activity at sea.
- **Radar detection.** For the detection of vessel radars.

Compared to manned aircraft, RPAS typically have a significantly higher endurance and can operate for longer periods. However, depending on the size of the RPAS, the speed can be lower than that of manned aircraft, and searching larger areas of interest could take longer. Also, contrary to manned aircraft, RPAS are not yet fully integrated in Member States' SAR operational procedures.

RPAS provide live video streaming of the situation at sea, given that the pilots and payload operators are stationed in the GCS instead of on board the aircraft. This feature can greatly increase coordination capabilities. In addition to the live-streaming of the situation, some RPAS can drop equipment such as life rafts or other rescue equipment, similar to manned aircraft.

Based on operational experience, it has been demonstrated that RPAS are capable of supporting SAR events. In some cases, the RPAS has been performing a different task at sea when it is diverted to support a SAR operation. On other occasions, however, the RPAS is on standby and is activated at short notice. In all cases, depending on the speed of the aircraft and the distance from the event, the arrival on scene will be coordinated with other assets supporting the activity. In this respect, it should be noted that RPAS often cannot share airspace with other air assets due to legislative issues, which further complicates the coordination tasks.

Image 3: Images of RPAS SAR operations and exercises.



Source: EMSA services.

4.3.3.3 Earth-observation services' support for search and rescue activities

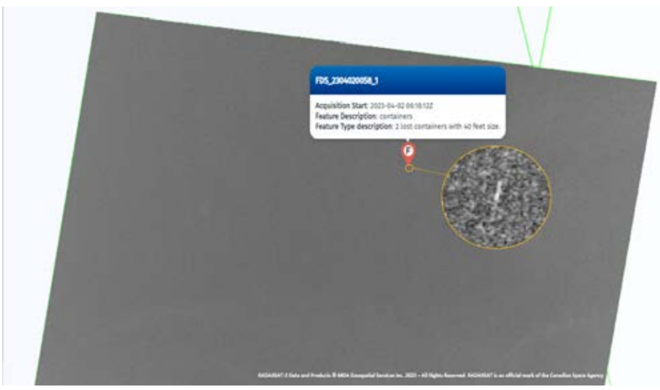
Maritime accidents can take place in remote locations where SAR and surveillance assets may take several days to reach the area concerned. Moreover, in the case of more severe accidents, the ship reporting systems can be compromised (e.g. be damaged or lose power), which makes locating the vessel particularly challenging. Earth-observation systems can support maritime safety authorities in these difficult situations, with a combination of high-resolution radar (immune to cloud cover, providing wide area monitoring and operating day and night) and very-high-resolution optical coverage (able to detect very small objects on the sea surface and to provide identification of the vessel and high-level characterisation of its conditions). The combination of these satellite assets, along with their global near-real-time availability, makes Earth-observation systems a relevant tool to support SAR activities, particularly in remote areas, optimising surveillance efforts and deploying on-scene assets.

Earth-observation products are already systematically requested by Member States in the event of maritime accidents, either within or outside of EU waters. Member States can request Earth-observation products at short notice via EMSA to monitor maritime accidents, to support SAR operations and to monitor a ship in a situation that could give rise to its loss or to an environmental or navigational hazard.

Two examples of activations of Earth-observation services via the EMSA contingency plan in 2023 are given below.

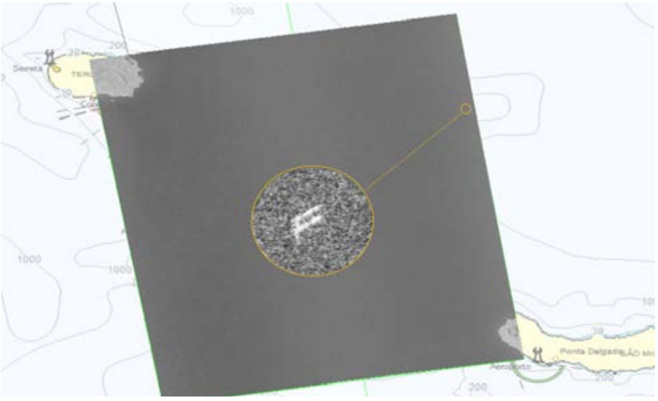
- **In March 2023**, a container vessel lost two containers near Gijon, Spain, at 11:45 UTC. MRCC Madrid requested that EMSA provide satellite imagery to detect the two containers adrift (Figure 107).
- **In July 2023**, MRCC Delgada (Portugal) requested satellite imagery to detect a drifting barge without AIS to produce a navigation warning (Figure 108).

Figure 107: Detection of drifting containers using EMSA's Earth-observation services.



Source: EMSA services.

Figure 108: Detection of a drifting barge in the Azores area (Portugal) using EMSA's satellite services.



Source: EMSA services.

One of the tools offered is the enhanced SAR-SURPIC (Search and Rescue Surface Picture), which provides the positions of all nearby ships during an emergency. It combines various data sources – T-AIS, LRIT, Sat-AIS, vessel monitoring systems – and provides a unique view of the vessels in the vicinity that may respond to a distress situation.

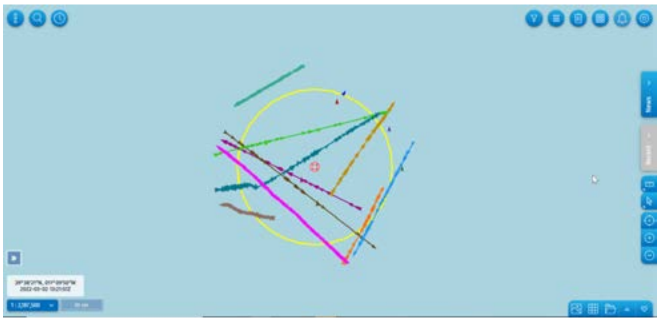
From September 2022 to September 2024, 460 enhanced SAR-SURPICs were created. These correspond to a **more than 40 % increase in the number of requests compared to the same period between 2019 and 2021**. The effect of COVID-19 must be considered; however, it may be relevant to understand what types of distress situation are associated with requests for this service. More than 50 % of the requests came from the authorities of Spain, followed by France (21 %) and Ireland (10 %).

4.3.3.4 Use of Integrated Maritime Services in support of search and rescue activities

In addition to the above, there are several information systems that can be useful for authorities dealing with SAR. One of them is the Integrated Maritime Services (IMS) system, available from EMSA, which was developed at the EU level with the cooperation of all EU Member States.

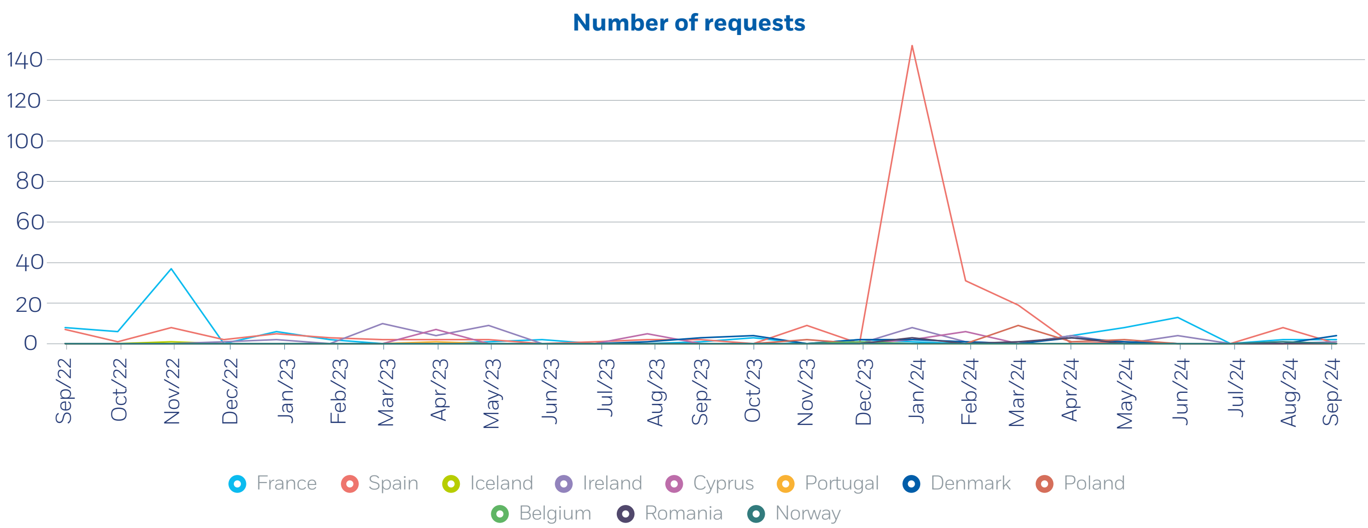
The integrated and comprehensive maritime traffic picture provided by IMS allows for the efficient monitoring of SAR activities, highlighting situations of distress and providing an overview of potential SAR means and of EU maritime authorities' contacts and locations.

Figure 109: Example of SAR-SURPIC output.



Source: EMSA services.

Figure 110: Number of SAR-SURPIC requests from September 2022 to September 2024.

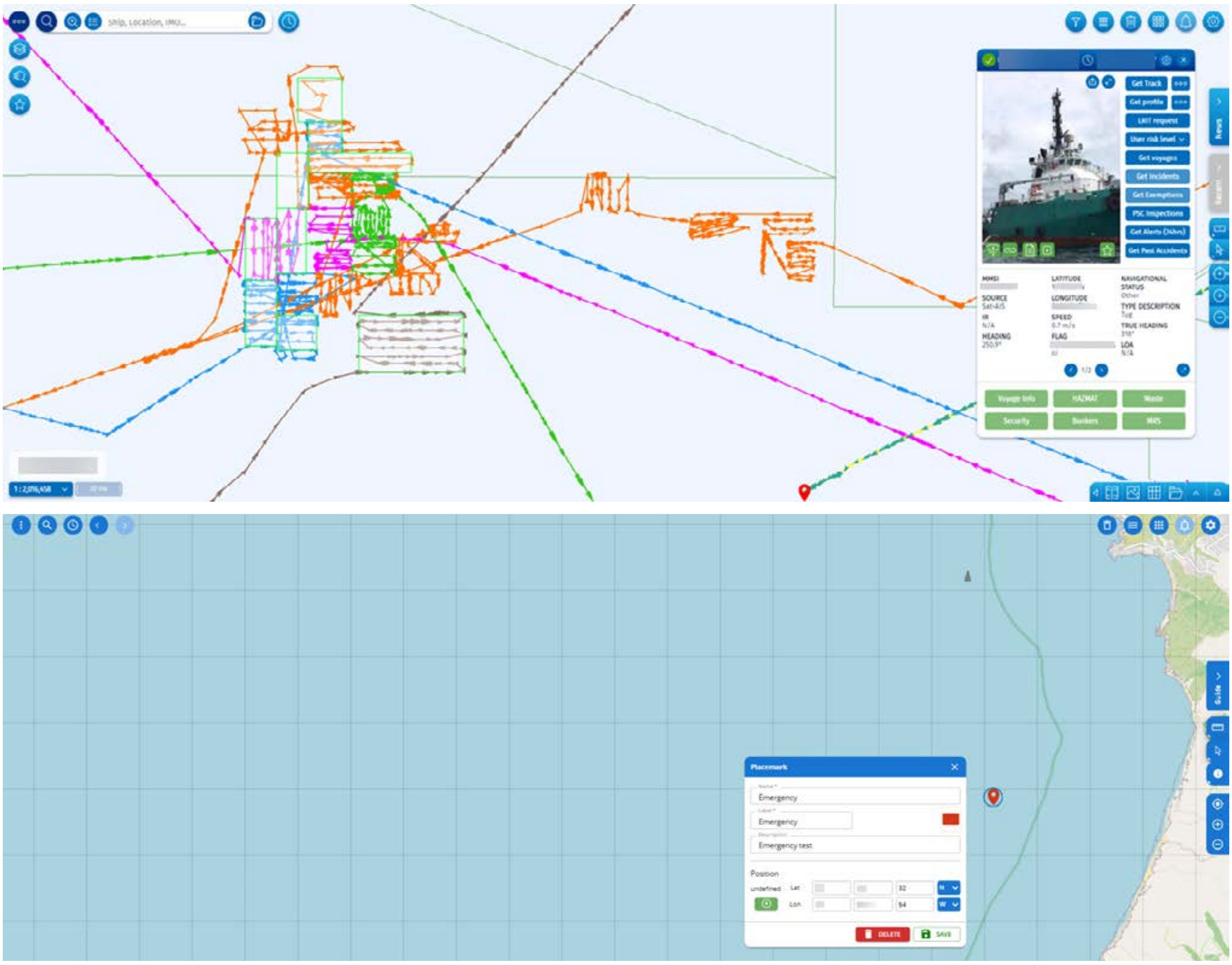


Source: EMSA services.

Another tool applicable to SAR is automated behaviour monitoring, which can alert authorities to potentially dangerous situations. Automated behaviour monitoring is linked to Earth-observation imagery, thereby enhancing its effectiveness.

The combination of data from different reporting/tracking systems makes it possible to mark the location of an accident/emergency, track the response vessels and SAR means, display the search patterns and provide the latest position of the ship in distress.

Figure 111 (a) and (b): IMS ship tracking.



Source: EMSA services.

A chat-box function is now available to IMS users via the EMSA application portal. The objective of this tool is to further enhance the maritime picture by allowing the real-time exchange of text messages between authorities with access to IMS, including SAR authorities (e.g. during joint operations or cross-border situations). EMSA has started to provide on-demand awareness sessions to interested authorities.

Exercises are a very important part of the SAR framework, enhancing cooperation and testing the level of preparedness. IMS can support these exercises with the functions indicated above, plus additional information such as the number of people on board, the presence of hazardous substances, the accident history of the ships in question, etc. In addition, when there are several Member States involved in an exercise, IMS can facilitate this cooperation by providing a single maritime situation picture.

In the future, IMS will expand the SAR toolbox in line with user requirements. Initiatives have been launched to prepare new functions to support SAR activities, such as the IMS drift demonstrator and the expert group on the display of Cospas-Sarsat alerts in IMS. The IMS drift demonstrator was developed between the end of 2023 and May 2024. It will serve as a lesson-learnt prototype to build the next phases of the IMS drift project. Regarding Cospas-Sarsat, a working group was launched during spring 2024 to draft the requirements on how alerts could be displayed in IMS for volunteer Member States.

Cross-cutting safety issues 05

5.1
The human element

5.1.1 Introduction

This section looks at the human element from a holistic perspective. It addresses the relevance of the work of seafarers (officers and ratings) in the world of shipping and puts it into context. As the shipping industry operates different types of vessels, on various routes, carrying high quantities of valuable cargo, some of it composed of dangerous goods, it is important that seafarers be well trained and educated, and able to work under pressure. In addition, when working on board large passenger vessels carrying thousands of passengers, seafarers' responsibilities regarding safety increase significantly. Many seafarers, after leaving their seagoing careers, continue to work in the industry ashore in areas where they can contribute to improving maritime safety, including in maritime administrations, education and training institutions, pilotage, surveying, ports or shipping companies. The human element also has a shore-based component that is considered here.

The level of crewing, as indicated previously, is defined by the flag state based on IMO guidelines. Accordingly, there is a lack of harmonisation, which in turn paves the way for competition to decrease manning levels to make a particular flag more attractive than its competitors.

It is also important to bear in mind that seafarers' living and working conditions are inherently linked not just to human rights but also to maritime safety. The requirements relating to safe management have a direct impact on the work on board performed by seafarers and on the way in which shipping companies are managed ashore, with consequences in terms of maritime safety and pollution prevention. This section explains why this topic is important for maritime safety and how it is regulated at the international, European and national levels. Furthermore, it includes an analysis of the available data on seafarers, highlighting the different education and training systems and the challenges and opportunities ahead, including the attractiveness of seagoing careers.

5.1.2 Key challenges

The development of technologies that have facilitated the exploitation of marine resources and the growth of maritime transport has resulted in increased employment in a wide range of maritime economic activities (fishing, aquaculture, maritime transport, port work, ship building and repair, and coastal tourism). In line with this increase, it is essential to ensure that there are sufficiently qualified seafarers capable of responding to the growing regulatory demands associated not only with seafarer training and certification but also with the necessary level of maritime safety that these activities require.

EMSA's 'Annual overview of marine casualties and incidents 2023' highlighted that in the period from 2014 to 2022, an average of 80 % of all maritime accidents were influenced by human action or behaviour (EMSA, 2023a). On the other hand, it should be noted that the number of accidents avoided by seafarers is not reflected in this overview, nor is it in any other available publication. This remains an area where research would be useful, especially for maritime educators and policymakers.

Besides the risks associated with their work, seafarers have many responsibilities on board ships and play a key role in ensuring the safety of ship operations in a global and multicultural environment.

Seafarers work without borders, and consequently seafaring professions must be continuously regulated at the international level so that seafarer education, training, professional qualification requirements, working conditions and safety can be ensured in accordance with international agreements. In this area, the legal basis comes originally from the IMO, sometimes in cooperation with the ILO. In their respective areas of responsibility, both organisations have developed a legal framework over the years that covers different aspects of the human element, including seafarer qualifications, the safe management of ships and the prevention of pollution, in order to avoid accidents that are likely to threaten human life, the ship or the marine environment (see Section 5.1.3).

As highlighted above, qualified seafarers are key to ensuring maritime safety and the prevention of pollution by reducing maritime accidents. However, it remains a challenge for the sector to keep attracting entrants into seafaring careers, particularly where more traditional maritime nations are concerned, including in EU Member States. There is a need not only to attract young people to seafaring careers, so as to prevent the risk of an ageing and decreasing workforce, but also to find maritime experts to work in shore-based maritime activities, such as pilotage, surveying, education and training. These are the challenges that lie ahead and that need to be tackled in the short term by the shipping industry, and they may require additional workforce and competencies.

Having good working and living conditions on board is of paramount importance for attracting the workforce. Although the ILO has the MLC 2006 within its scope, it is often difficult to ensure the implementation of this convention.

Of particular relevance to the working and living conditions at sea is social isolation. This is intrinsic to the reality of people working on a ship, especially on cargo ships where the number of crew is already reduced. Together with fatigue at sea (which has already been subject to many research studies), the difficulty in connecting to the internet, limited shore leave (emphasised by the COVID-19 pandemic) and the decrease in ships' cruising speeds (as a method of fuel saving that increases travel time), among other issues, these factors do not contribute to retaining people in a seafaring career.

Some problems may occur due to the growth of automation in the maritime sector, and particularly on board. Increased automation has allowed shipping companies to reduce crewing levels. The main goal is to achieve maximum efficiency, particularly in economic terms. Nevertheless, reducing manning levels may also have negative effects for the crew by leading to an increased workload in certain situations (e.g. when the turnarounds in ports are short and all crew have tasks that cannot be postponed, including cargo operations, accompanying surveyors, PSC inspectors and bunkering). This can result in a lack of sleep, and the resulting fatigue can lead to impaired performance and diminished alertness. Fatigue in crew members is a serious problem and plays a significant role in maritime accidents. Addressing fatigue risk management through the establishment of on-board techniques during the scheduling of shipboard work and resting periods is an essential part of safeguarding maritime safety.

5.1.2.1 COVID-19 – lessons learnt

A comprehensive overview of COVID-19's impact on the maritime sector, focusing specifically on safety in shipboard and ship-to-shore operations relevant to commercial shipping and fisheries was published by EMSA in 2023 [102]. The study includes, for example, proposed actions to fight emerging risks relating to the mental health and well-being of seafarers; the increased digitalisation of activities; the decreased attractiveness of the sector; the maintenance of professional skills and competencies; and the lack of harmonised regulations and protocols dealing with unexpected events.

Further analysis of the effect of the COVID-19 pandemic, such as that of the research project 'Effects of the COVID-19 pandemic on seafarers and shipping' by the World Maritime

102 https://emsa.europa.eu/publications/item/5184-potential-covid-19-related-maritime-safety-issues-and-emerging-risks.html.

University ([103]), has corroborated that the period led to short- and long-term impacts on the livelihood of seafarers and their morale relating to being at sea, and highlighted the still inadequate consideration of human factors and social welfare in the industry's practices and regulations.

5.1.2.2 New competencies

In the short to medium term, new competencies for personnel need to be developed and adopted, both ashore, for those working in remote operation centres (ROCs) that will have a role in the control of the operation of MASS, and at sea, for seafarers who have tasks assigned relating to the operation of ships using alternative fuels.

The development of MASS will likely imply the transfer of some, or in a few cases all, forms of human intervention to ROCs. Although the number of accidents at sea caused by seafarers on board ships can be reduced, such a transfer creates potential risks that have not yet been identified, given the lack of safety knowledge and experience. Different types of accidents can also occur, but in different roles, such as those dealing with remote supervision, confirmation, monitoring or control. It is important that attention be given to the qualification of the seafarers who will operate these vessels and to those who will control them from ROCs. EMSA recently published a study that provides valuable insights into the development of competence-based curricula for MASS ROC operators ([104]). By defining qualification objectives, differentiating between basic and advanced training and utilising competency tables, educators can create effective training programmes. The curriculum presented in the study serves as a starting point for further discussions and improvements as the field of MASS operations continues to evolve, and is expected to assist educators in the design of relevant education and training programmes. Research projects, such as the Norwegian-funded 'Human maritime autonomy enable (HUMANE)', finalised in 2021, have been tackling this topic ([105]).

The growing use of alternative fuels is also prompting developments for seafarers. The international community estimates that that up to 800 000 seafarers could require additional training by the mid 2030s to use the new fuels (International Transport Workers' Federation, 2024). In this regard, in 2024 EMSA also commissioned a study, Trainalter ([106]), based on the need to identify and describe specific competencies and training areas in terms of knowledge, understanding, skills and proficiency for seafarers to ensure the safe operation of ships using alternative fuels and energy systems for propulsion and auxiliary power generation. As a result of the study, competencies were outlined in a competency catalogue for reference, divided up by the type of fuel: LNG, biofuel, methanol, battery-powered hybrid electric propulsion, fuel cells, ammonia and hydrogen. The results are to be used to assist the EU Member States and the Commission to put forward proposals, whether for new competences to be included in the STCW Convention or for the development of guidelines necessary to be considered in the design of training and assessment programmes for seafarers. Proposals for regulatory purposes may also be drafted based on the results of the study.

103 https://www.wmu.se/project/effects-of-covid-19-pandemic-on-seafarers-and-shipping.

104 https://www.emsa.europa.eu/we-do/digitalisation/maritime-monitoring/items.html?cid=2&id=5089.

105 https://www.hvl.no/en/project/591640/.

106 https://emsa.europa.eu/visits-to-member-states/standards-for-seafarers/items.html?cid=128&id=5377.

These outcomes are particularly relevant in view of the ongoing comprehensive review of the STCW Convention, and its subsequent revision, when defining competencies for seafarers.

The paragraphs above highlight the importance that the adoption of updated competencies has for maritime safety, firstly due to the consequences that errors made by seafarers can have, and secondly due to the need to ensure that the education and training programmes are updated to include new technologies and that proper working conditions are available to those who choose a seafaring career.

5.1.3 Regulatory framework

The STCW Convention, which was adopted in 1978 and entered into force in 1984, is the most relevant instrument dealing with the education, training and certification of seafarers. It was subject to a major amendment in 1995 (including the adoption of the STCW Code). Other major amendments were adopted in 2010 in Manila, Philippines, and are thus known as the Manila amendments. The date of adoption of these amendments, 25 June, was later established by the IMO as the International Day of the Seafarer. Minor amendments have been adopted since then.

More recently, the EU Member States, together with some other IMO members and observers, put forward a proposal for a comprehensive review of the STCW Convention, since major revisions are anticipated every 10 years, and the previous comprehensive amendment took place well over 10 years ago (in Manila, in 2010, as mentioned above). The work on the review started in February 2023 during the ninth session of the IMO Sub-Committee on Human Element, Training and Watchkeeping, and was completed in February 2025. Various sessions of the sub-committee and intersessional working groups are now working on the revision. For the time being, the amendments are planned to be adopted in 2030, although this deadline may need to be revised due to the complexity of the revision process. The amendments will have to consider the current developments in shipping and need to be a tool to improve maritime safety in the coming years and decades through the education, training and certification of seafarers.

The MLC 2006 is another relevant instrument, adopted at the ILO level. It establishes minimum working and living standards for all seafarers employed on ships, irrespective of the flag. It is the most important instrument recognising the need for maritime labour regulation to protect seafarers when they sign employment agreements. As a result of the experience gained throughout the COVID-19 pandemic, new amendments were adopted by the ILO in 2022..

The ISM Code was adopted through an amendment to the SOLAS Convention, which resulted in the introduction of a new chapter to the convention. Its purpose is to provide an international standard for the safe management of ships and for pollution prevention. Its main objectives are to provide safe practices in ship operation and working environments; to establish safeguards against all identified risks; and to continuously improve the safety management skills of personnel ashore and on board ships. Regulation I/14 of the STCW Convention provides a clear link between the STCW Convention and the ISM Code. These three instruments are the foundation of the international regulations dealing with the human element. On this basis, instruments were developed and adopted at the EU level, as Table 44 shows.

Table 44: Legislation on the human element.

	Level	Instrument	What it regulates
Legislation	International	STCW 78, as amended	Education, training, assessment and certification of seafarers.
		MLC 2006, as amended	Seafarers' living and working conditions.
		ISM Code, as amended	Following the Herald of Free Enterprise accident, several IMO resolutions were adopted that resulted in an amendment to the SOLAS Convention, introducing a new Chapter IX, making it mandatory to establish an SMS in companies and on board.
	EU	Directive (EU) 2022/993	Transposes the STCW Convention (education, minimum level of training and certification of seafarers).
		Regulation (EC) No 336/2006	Implementation of the ISM Code within the EU.
		Council Directive 2009/13/EC	Implementing the Agreement concluded by the European Community Shipowners' Associations (ECSA) and the European Transport Workers' Federation (ETF) on the Maritime Labour Convention, 2006, and amending Directive 1999/63/EC.
		Directive 2013/54/EU	Concerning certain flag-state responsibilities for compliance with and the enforcement of the Maritime Labour Convention, 2006.

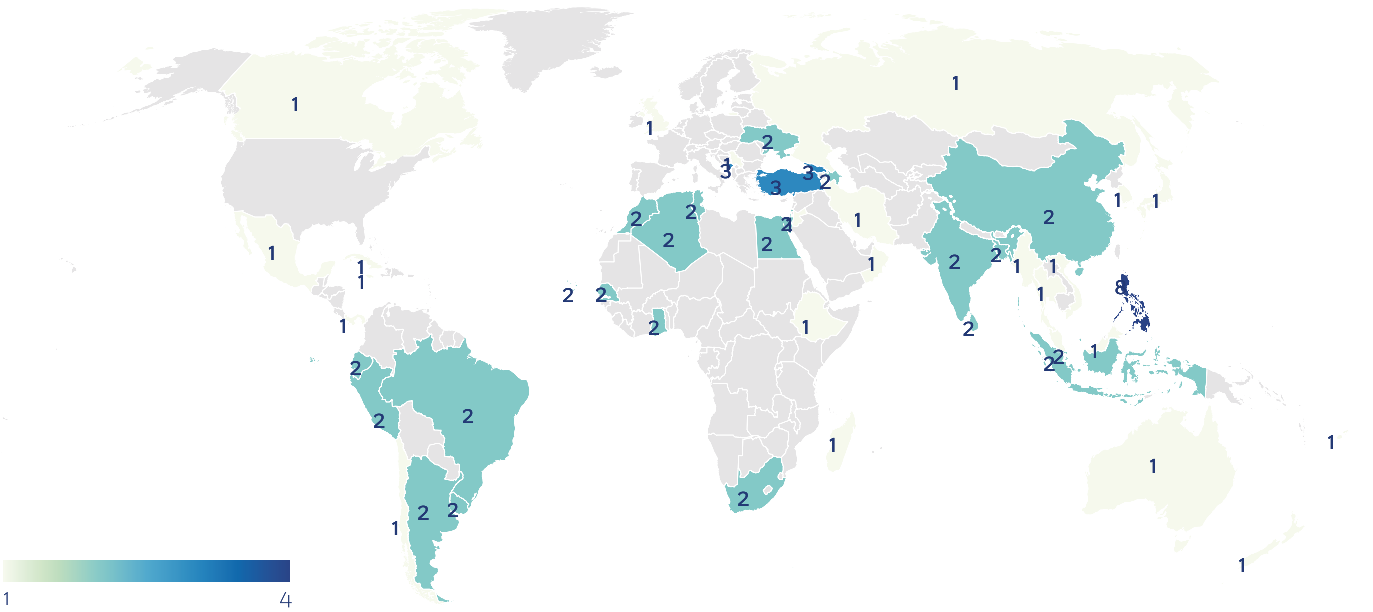
5.1.4 Education and training systems for seafarers

The education and training system for maritime careers is not uniform throughout the EU. Each Member State determines its own educational and training systems; some may have access to a maritime career during secondary education, others through higher education or polytechnic institutes. Therefore, the academic level reached at different stages constitutes a barrier to the mobility of seafarers within the EU, such as for students wishing to participate in the Erasmus programme.

It is also worth mentioning that EU Member State-flagged ships can have on board seafarers educated, trained and certified both inside and outside the EU. This is something that should be accounted for when determining the best methods to ensure that crew members on board EU-registered ships are appropriately educated and trained. The codified Directive (EU) 2022/993 includes a specific procedure based on which the assessment of compliance with the STCW Convention by non-EU countries is centralised in the Commission, so that their certificates of competency (CoCs) can be recognised by Member States and, accordingly, they can be allowed to work on board EU Member State-flagged ships. The Commission – assisted by EMSA, which carries out the necessary field inspections – assesses the systems implemented in non-EU countries on behalf of the EU Member States and in line with the STCW Convention. All assessments are expected to take place on a 10-yearly basis so that, in addition to the occasional evaluation of proposed new non-EU countries, each country that has already been recognised at the EU level will be assessed regularly. The inspections conducted by EMSA, geographically summarised in Figure 112, are the basis for the assessments.

To this end, more than 80 inspections of maritime administrations and education and training institutes have now been carried out in non-EU countries around the world to assess compliance with the STCW and, as a consequence of those inspections, 51 non-EU countries have been recognised, with one more in the process of recognition.

Figure 112: Geographical distribution of EMSA's inspections of maritime administrations and education and training institutes in non-EU countries since 2005.



Source: EMSA services.

In addition, the Commission, assisted by EMSA, has been given the task of verifying the levels of implementation of EU legislation relating to the education, training and certification of seafarers in EU Member States. The associated visits to Member States are carried out by EMSA based on a five-year cycle. This allows the mutual recognition of certificates among Member States.

5.1.5 Relevant data and analysis

5.1.5.1 Number of certified seafarers

It has always been difficult to get accurate data on seafarer numbers. Despite studies conducted by various organisations, notably the International Chamber of Shipping / Baltic and International Maritime Council, the problem has remained, making it difficult to know the exact number of seafarers available to crew both the world fleet and the EU Member States' fleet.

In 2007, EMSA started to develop a STCW Information System, which, apart from registering information about the maritime education, training and certification systems at the EU level, aims to provide reliable information on the availability of masters and officers to EU Member State-flagged ships. EU Member States can also send data on ratings on a voluntary basis.

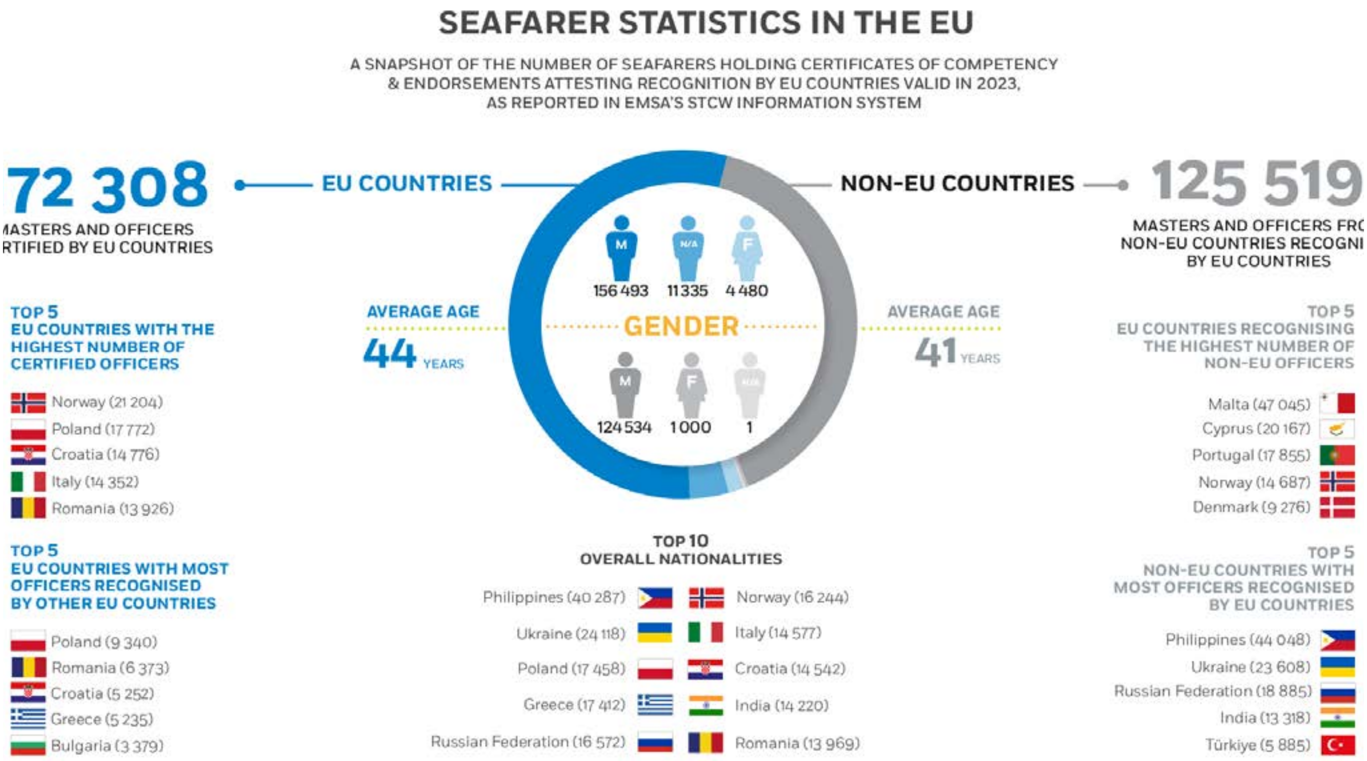
Since 2014, following the adoption of Directive 2012/35/EU ([107]), amending Directive 2008/106/EC on the minimum level of training of seafarers ([108]), Member States have been required to send data to EMSA on an annual basis on CoCs issued to masters and officers, along with endorsements attesting recognition (EaRs) issued to masters and officers from other countries. CoCs are necessary for masters and officers to work on board, and when these certificates are not issued by the flag state of the ship, EaRs of the original CoC must be issued. The data, received in anonymised form, are processed through the STCW Information System (STCW-IS) and an annual statistical review is published.

107 Directive 2012/35/EU of the European Parliament and of the Council of 21 November 2012 amending Directive 2008/106/EC on the minimum level of training of seafarers (OJ L 343, 14.12.2012, p. 78, ELI: http://data.europa.eu/eli/dir/2012/35/oj).

108 Directive 2008/106/EC of the European Parliament and of the Council of 19 November 2008 on the minimum level of training of seafarers (OJ L 323, 3.12.2008, p. 33, ELI: http://data.europa.eu/eli/dir/2008/106/oj).

The data included in the STCW-IS show that by the end of 2023, 172 308 masters and officers held valid CoCs issued by EU Member States (a 20 % decrease since 2019), while another 125 519 held original CoCs issued by non-EU countries (an increase of 4 % since 2019) with EaRs issued by EU Member States. Deducting the effects of Brexit, the reduction in the number of CoCs issued by EU Member States is still around 7 %. **Overall, the end of 2023 saw 297 827 masters and officers as potential crew to serve on board EU Member State-flagged vessels, a 12 % decrease with respect to 2019 based on the number of registered CoCs and EaRs.**

Figure 113: Seafarer statistics in the EU – 2023.



Source: EMSA, STCW-IS.

In 2023, the average age of seafarers eligible to work on EU Member State-flagged ships was 44 years for those certified in EU Member States and 41 for those certified in non-EU countries. In addition, only around 0.8 % of the available seafarers in 2023 certified in non-EU countries were women, while this percentage was slightly higher (2.78 %) for the group of seafarers who got their certification in the EU. It is worth mentioning that there is increased awareness within the industry of the need to increase the attractiveness of seafaring to young people and across genders. ECSA and the ETF agreed to work together on this topic through a joint project, 'Contributing to an attractive, smart and sustainable working environment in the shipping sector', which concluded in 2022. This study recommends that diversity, culture and gender training should be part of the basic training of seafarers.

The five EU Member States with the largest number of masters and officers holding CoCs issued by them in 2023 were, in descending order, Norway, Poland, Croatia, Italy and Romania. The five EU Member States with the most masters and officers holding EaRs issued by them, also in descending order, were Malta, Cyprus, Portugal, Norway and Denmark. Finally, the five non-EU countries that had the most masters and officers holding CoCs recognised by EU Member States were the Philippines, Ukraine, the Russian Federation, India and Türkiye.

Meanwhile, EMSA initiated a new project in 2021 to set up and host an EU Seafarers' Certification Platform. This platform will facilitate the issuance of electronic certificates to seafarers. It will complement or offer an alternative to the redesigning or enhancement of national register systems by the individual Member States, with all the associated costs, while promoting the establishment of e-certification at the EU level. The main stakeholders will be the EU maritime administrations, and the main users could include any organisation that may need to verify the authenticity and validity of STCW certificates issued at the EU level. These include maritime administrations, law enforcement authorities, PSC bodies and shipowners. The project, which has had contributions from the Member States, is expected to be finalised and made available in its entirety during the second half of 2026. The fact that it is being developed in parallel with the comprehensive review and subsequent revision of the STCW Convention facilitates its being updated to match this important IMO convention.

5.1.5.2 Human-element deficiencies in port state control

Between 2019 and 2023, 5 705 STCW deficiencies were identified during PSC inspections within the Paris MoU region, an increase of 17 % with respect to the 2016–2020 period. These deficiencies are related to Part A of the STCW Code, which contains mandatory provisions that detail the minimum standards required to give full and complete effect to the provisions of the STCW Convention.

As can be seen in Table 45, most of the deficiencies recorded between 2019 and 2023 were linked to the STCW Code, Part A, Chapter VIII, which sets out standards regarding watchkeeping, such as hours of rest. Next in line are deficiencies linked with Chapter I, with 1 915 deficiencies recorded. This chapter regulates standards regarding general provisions, for instance standards governing the use of simulators. In third place is Chapter II, with 246 deficiencies, which concerns standards relating to the master and deck department, such as the mandatory minimum requirements for the certification of ratings forming part of a navigational watch.

Concerning the chapters with fewer identified deficiencies, these relate to the engine department, in Chapter III, and to Chapter IV, which covers radiocommunication and radio operators. Chapters V and VI regulate standards regarding special training requirements for personnel on certain types of ships and emergency, occupational safety, security, medical care and survival functions, respectively. Chapter VIII covers standards regarding watchkeeping. Chapter VII covers standards regarding alternative certification, for which there is currently no specific deficiency code in PSC.

Table 45: STCW number of identified PSC deficiencies in the 2019–2023 period – Paris MoU.

STCW	Part A	Ch.I	Ch.II	Ch.III	Ch.IV	Ch.V	Ch.VI	Ch.VIII	
No. of deficiencies	186	1,915	246	176	19	35	134	2,994	5,705

Source: Thetis (EMSA, 2023b).

More than 50 % of STCW-related deficiencies in the reference period were found on board bulk carriers or general cargo ships.

Regarding MLC-related deficiencies, Table 46 summarises the main figures arising from PSC inspections.

Table 46: Number and frequency of deficiencies relating to working and living conditions found in the 2019–2023 period by PSC – Paris MoU.

Category of deficiencies	2019		2020		2021		2022		2023	
	No. def	No. insp./ def.	No. def	No. insp./ def.	No. def	No. insp./ def.	No. def	No. insp./ def.	No. def	No. insp./ def.
MLC Title 1	105	134	79	132	89	139	87	165	109	133
MLC Title 2	920	15	839	12	987	13	1,171	12	1,0191	14
MLC Title 3	1,427	10	1,033	10	1,463	7	2,213	6	2,289	6
MLC Title 4	2,197	4	1,821	4	2,443	4	3,498	4	2,656	4
Total	4,649	3	3,772	3	4,982	2	6,971	2	7,173	2

Source: Thetis (EMSA, 2023b).

Minimum requirements for seafarers to work on a ship (MLC Title 1) is the category with the fewest deficiencies registered throughout the years among the working and living conditions group. A minimum requirement set out in this section of the convention is that the minimum age for people allowed to work in any capacity on a ship to which the convention applies is 16 years. Medical fitness, training and qualifications, and recruitment systems are also covered by MLC Title 1.

Deficiencies in the conditions of employment (MLC Title 2) – including work and rest hours, wages and manning levels – are found every year, with an average frequency of around 1 in every 13 inspections. In addition, according to the table, deficiencies concerning the accommodation, recreational facilities, food and catering (MLC Title 3) were found on average once every eight inspections from 2019 to 2023.

Healthcare, safety protection and accident prevention for seafarers (MLC Title 4) has been the human-element-related category with the most deficiencies found during PSC inspections every year since 2019. **The implementation of Title 4 covers those elements that may pose risks to the health and safety of crew on board. This type of deficiency remains within the top three overall categories of deficiencies as ranked by the Paris MoU 2023 annual report (Paris MoU, n.d.a).** The growing number of inspections has led to more findings of MLC Title 4 deficiencies, with deficiencies found in a constant 25 % of cases (one in every four inspections).

More than 60 % of the MLC-related deficiencies in the reference period were found on board bulk carriers or general cargo ships, and around 13 % on board tankers.

Moreover, looking at the comparison between the number of deficiencies under STCW and MLC and the total number of inspections over the 2019–2023 period, **on average there was one deficiency relating to working and living conditions found in every second inspection**.

5.2
Current safety agenda

This topic can be quite broad, therefore the scope of this section is restricted to those ships engaged in international and domestic voyages for which there are implications for the EU. It does not claim to be an exhaustive list, so only the most relevant topics will be introduced.

5.2.1 Regulatory framework

The main legislation defining the current safety standards and their implementation at the international and EU levels is listed in Table 47.

Table 47: Legislation on ship safety standards.

	Level	Instrument	What it regulates
Legislation	International	SOLAS	Promoting the safety of life at sea by establishing common agreed uniform principles and rules on the construction, equipment and operation of merchant ships.
		COLREG	Safety of navigation in preventing collisions at sea.
		International Convention on Load Lines	Limiting the draught of the ship by establishing minimum freeboard as a buoyancy reserve.
		Cape Town Agreement (not in force)	Safety of fishing vessels by establishing minimum standards for the construction and outfitting of such vessels.
		FAO/ILO/IMO 2005	Voluntary guidelines for the design, construction and equipment of small fishing vessels.
		International Convention for Safe Containers, 1972	Ensuring safety in the handling, stacking and transporting of containers.
	EU	Directive 2009/45/EC	Safety rules and standards for passenger ships.
		Directive 2003/25/EC	Specific stability requirements for ro-ro passenger ships.
		Council Directive 98/41/EC	Registration of passengers.
		Regulation (EU) No 530/2012	Accelerated phasing-in of double-hull or equivalent design requirements for single-hull oil tankers.
		Directive 2001/96/EC	Requirements and procedures for the safe loading and unloading of bulk carriers.

	Level	Instrument	What it regulates
Legislation	EU	Council Directive 97/70/EC	Safety regime for fishing vessels of 24 metres in length and over.
		Council Directive 93/103/EC	Minimum safety and health requirements for work on board fishing vessels.
		Directive 2014/90/EU	Marine Equipment Directive (MED).
		Commission Implementing Regulation (EU) 2021/1158	Design, construction, performance requirements and testing standards for marine equipment.
		Commission Implementing Regulation (EU) 2018/608	Technical criteria for electronic tags for marine equipment.
		Commission Delegated Regulation (EU) 2018/414	The identification of specific items of marine equipment that can benefit from electronic tagging.

5.2.2 Passenger ships

At the international level, the main discussion topics involving passenger ships since 2019 have been the following.

- Amendments to the fire safety requirements of ro-ro passenger ships
  - These amendments are based on the EMSA Formal Safety Assessment Firesafe studies ([109]). The modifications will significantly increase the safety level of these ships. The additional elements built on the experience gathered in recent accidents such as those of the *Norman Atlantic* or the *Sorrento*.
  - One of the many lessons learnt from the *Norman Atlantic* accident was that there was a need to further define the distance between side openings in the ro-ro spaces and life-saving appliances. The current legislation only indicates the following.

Image 4 Fire on board the Sorrento.

Source: Sociedad de Salvamento y Seguridad Marítima.

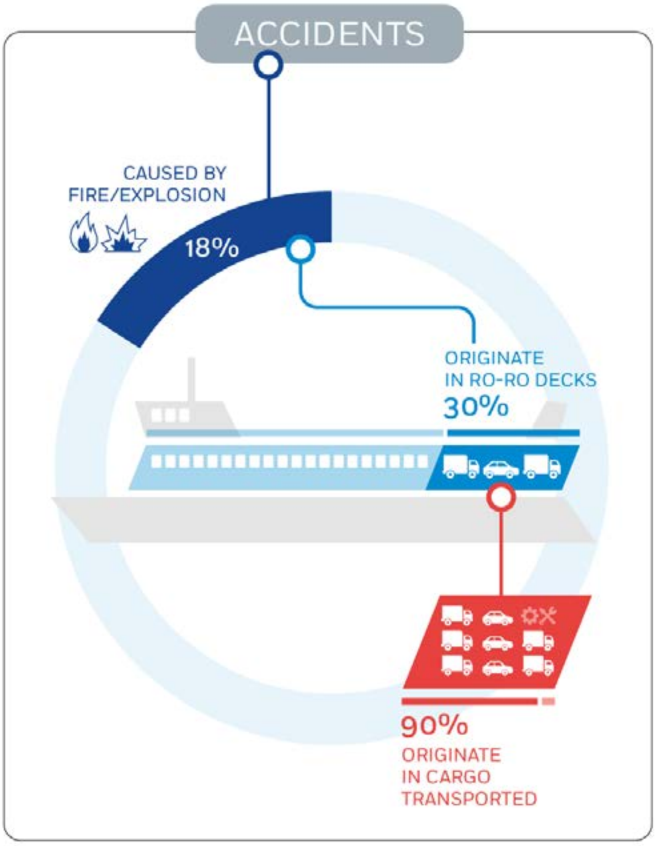
Permanent openings in the side plating, the ends or deckhead of the space shall be so situated that a fire in the cargo space does not endanger stowage areas and embarkation stations for survival craft and accommodation spaces, service spaces and control stations in superstructures and deckhouses above the cargo spaces.

109 https://www.emsa.europa.eu/firesafe.html.

The flames coming out of the permanent side openings burned the life-saving appliances, making evacuation difficult and only possible via aerial means. Firesafe, among other topics, proposed a minimum distance that was finally approved by the IMO to prevent this situation from happening again in new ships. This measure will be applicable from 2026.

- Other elements included in Firesafe and approved at the IMO include improvements in fire detection, through additional detectors and closed-circuit television systems, and additional firefighting elements in weather decks. As can be seen in Figure 114, the Firesafe studies concluded that the vast majority of fires (90 %) on ro-ro decks originate in the cargo transported, generally cars and trucks, the safety of which is difficult for ship operators to control.

Figure 114: Percentage of accidents caused by fire on board ro-ro decks and location of origin on board.



Source: EMSA services.

- Carriage of new energy vehicles

There are concerns that the carriage of new energy vehicles, particularly electric vehicles, in ro-ro spaces might worsen the consequences of fire on the vehicle decks of those ships. These concerns gained particular attention after the high-profile accidents on board the pure car and truck carriers *Morning Midas* in 2025, MV *Fremantle Highway* in 2023 and *Felicity Ace* in 2022, along with several recent accidents on land involving electric vehicle fires.

EMSA recently published high-level guidance to assist relevant authorities and stakeholders in ensuring that the carriage of alternative fuelled vehicles is conducted safely ([110]).

The guidance considers the need to develop a risk assessment on each ship on which the carriage of alternative fuelled vehicles may affect the safety of the persons on board, the ship and the environment. Specific hazards have been identified in relation to transported vehicles using liquid fuels, compressed gas and batteries.

Whereas requirements for vehicle carriers carrying motor vehicles with compressed hydrogen or natural gas in their tanks for their own propulsion are included in SOLAS Chapter II-2 Regulation 20-1, electric vehicles are not currently addressed in SOLAS.

Specific hazards that need to be considered during a lithium-ion battery fire include cells emitting toxic gases (such as hydrogen fluoride) and/or flammable gases, small jet flames from the progressive ignition of cells, the accumulation of explosive gases, reignition of the fire once the means used to extinguish it is removed and, in general, the longer fire duration compared to traditional liquid fuels.

In addition to the above, it is more challenging to detect and confirm a battery fire at an early stage of development compared to a fire in a vehicle powered by diesel or petrol due to the design of the vehicle and battery and to the specific detection technology used.

Furthermore, the risks of charging vehicles on board – due to the potential malfunction of the charging equipment, incompatibility with the ship's electrical arrangements and possible incorrect operation, for example excessive charging time – should be assessed.

The EU-funded LASH FIRE project, which concluded in 2023, tested and verified the ability of a drenching system to control fire in all types of vehicles ([111]). The project also highlighted solutions and challenges for the manual firefighting of electric vehicle fires and the importance of personal protection equipment against jet flames and hazardous atmospheres.

Ongoing research is tackling relevant issues such as the effectiveness of other fixed firefighting solutions, including those of inert gas systems and high-expansion foam systems against battery fires; as well as other means to

110 https://emsa.europa.eu/publications/reports/download/8189/4729/23.html.

111 https://lashfire.eu/.

mitigate the risk of fire, like the early detection of thermal runaway; the reduction of reignition risk, fire propagation and explosion risk; and training and operation procedures for the safe handling of these fires. In 2025, EMSA contracted a new study to support real-scale testing on these relevant issues.

Some ferry operators in Europe have chosen to take a precautionary approach by prohibiting the transport of electric vehicles. Insurers urge that the different risks associated with lithium-ion batteries, such as that of reignition for extended periods and the fact that thermal runaway makes fires hard to extinguish, need to be considered and mitigated as far as possible. The International Union of Marine Insurance (IUMI) has published a recommendations and best practice paper on the transport of electric vehicles on board pure car and truck carriers and ro-ro vessels ([112]).

Until 2029, the IMO Sub-Committee on Ship Systems and Equipment will be working on an agenda item for 'Evaluation of adequacy of fire protection, detection and extinction arrangements in vehicle, special category and ro-ro spaces in order to reduce the fire risk of ships carrying new energy vehicles'. It is expected that the relevant provisions under SOLAS for the protection of vehicle and ro-ro spaces in that regard will be revised and amended, as necessary.

- Safe return to port and evacuation

Great challenges have been recognised in the emergency evacuation and rescue of passenger ships due to their increasing size and rated capacity and to the expansion of their operating areas. In 2006, MSC 82 adopted amendments to the SOLAS Convention dedicated to large passenger ships (those with a length of 120 metres or above or having three or more main vertical zones) constructed on or after 1 July 2010, into which the 'safe return to port' regulations were incorporated. The regulations aim to improve the safety level of such ships by reducing the likelihood of evacuation after fire or flooding casualties within a certain threshold, i.e. the ship remains the 'best survival craft' and can return to port. For that purpose, different requirements on the redundancy of essential/critical systems and on safe areas for passengers were introduced. To promote the effective and uniform implementation of the regulations, the IMO developed a package of guidance (MSC.1/Circ.1369, 'Interim explanatory notes for the assessment of passenger ship systems' capabilities after a fire or flooding casualty', and related circulars), providing references to stakeholders involved in ship design, construction, surveying and administration. Nevertheless, 20 years after the adoption of the 'safe return to port' concept, there is still a lack of uniform implementation across the passenger ship sector and a need for numerous technical clarifications or interpretations. Additional aspects such as operational matters, the verification of compliance and the associated documentation are also subject to review. Therefore, a new IMO review of MSC.1/Circ.1369 and related circulars was opened. Within the framework of the IMO Sub-Committee on Ship Design and Construction, the corresponding technical discussions started in 2023 and will last at least until 2025.

Notwithstanding the above, the evacuation of passenger ships remains a key safety topic. In 2024, EMSA launched a contract for a comprehensive study on enhancing evacuation effectiveness on passenger ships that incorporates a review of current evacuation design and operation practices, including lessons learnt from recent accidents requiring evacuation, the criteria for the evacuation analysis and the alternative design of large lifeboats. The study started in 2024 and is expected to conclude in the last trimester of 2025.

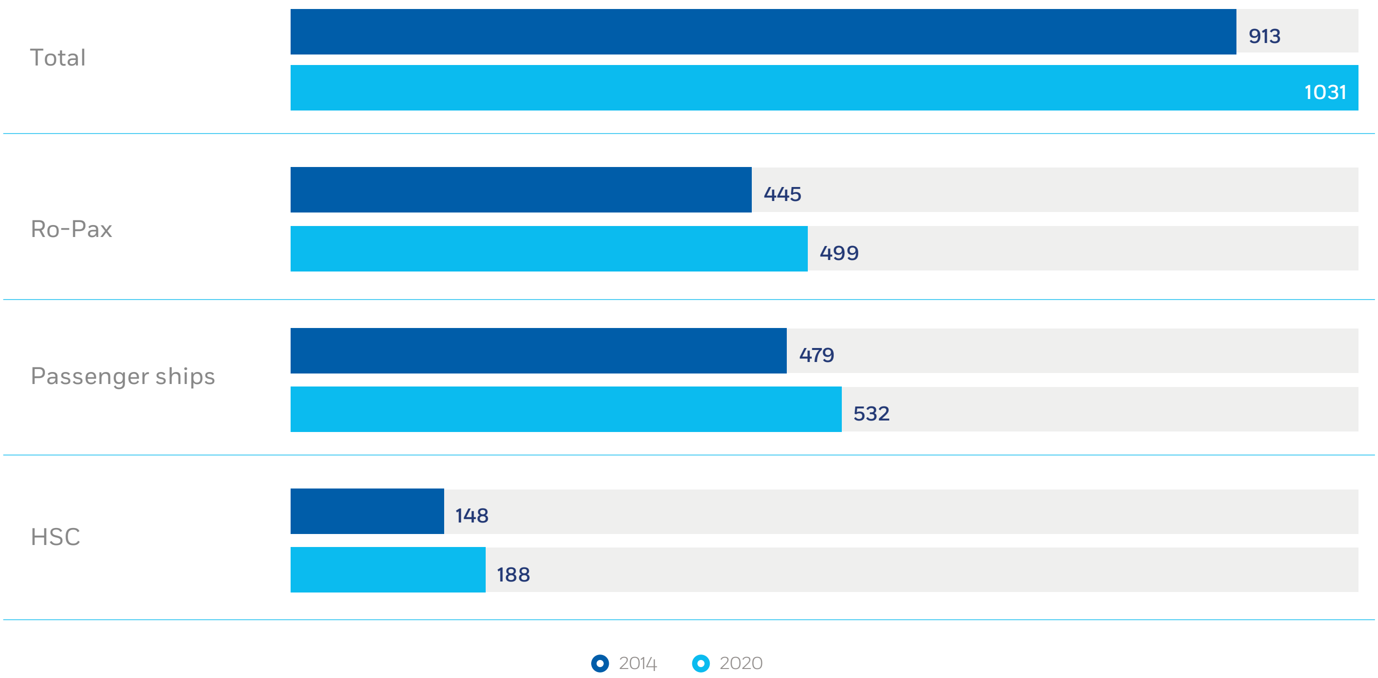
Status of EU passenger ship safety legislation

At the EU level, there are already four pieces of specific legislation dealing with passenger ship safety, which are further described below. These directives were subject to a regulatory fitness and performance process that began in 2015, and is still ongoing for one of the directives in question.

- **Directive 2009/45/EC** establishes the standards for passenger ships engaged in domestic voyages, as SOLAS only covers those ships engaged in international voyages. There are more than 1 000 ships covered under this directive. The fleet profile, as reported to EMSA by the Member States in 2020, is summarised in Figure 115 to Figure 117.

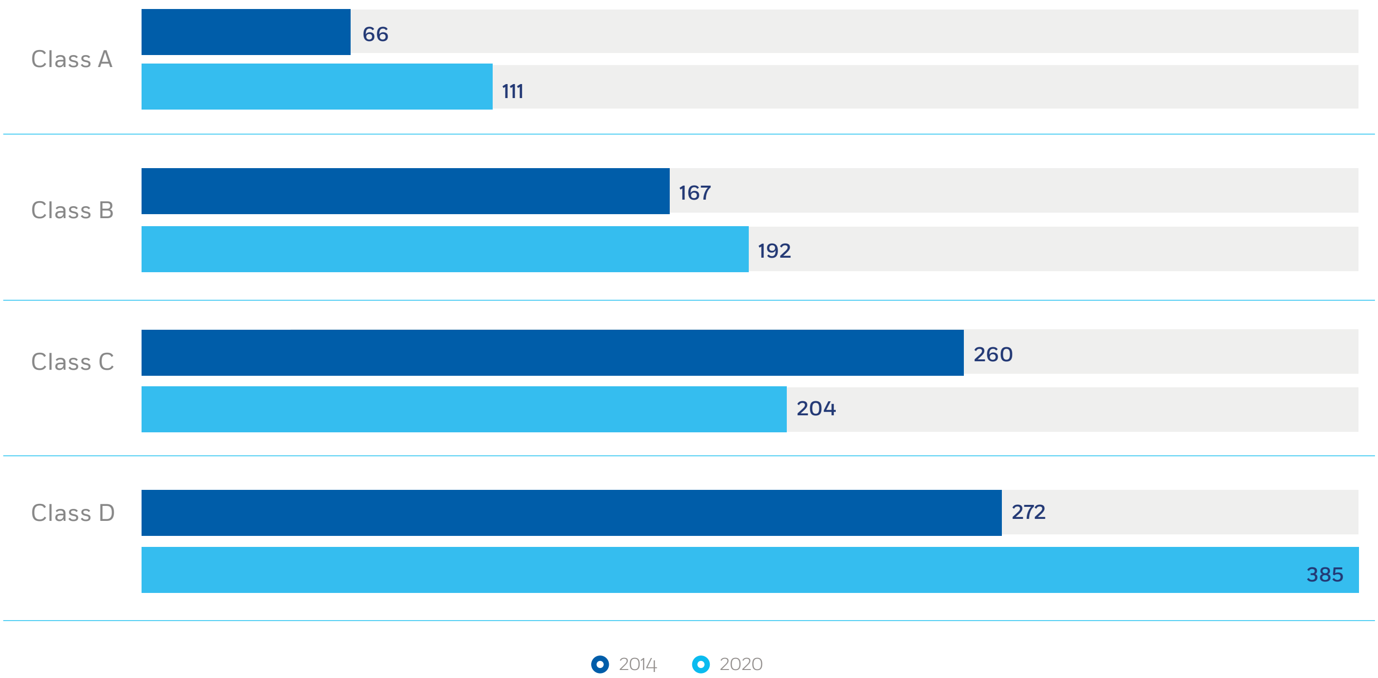
112 https://iumi.com/wp-content/uploads/2024/09/Best-Practice-Recommendations-for-the-Safe-Carriage-of-Electric-Vehicles.pdf.

Figure 115: Evolution of the EU domestic fleet of passenger ships – comparison between 2014 and 2020.



Source: EMSA services based on questionnaire to Member States.

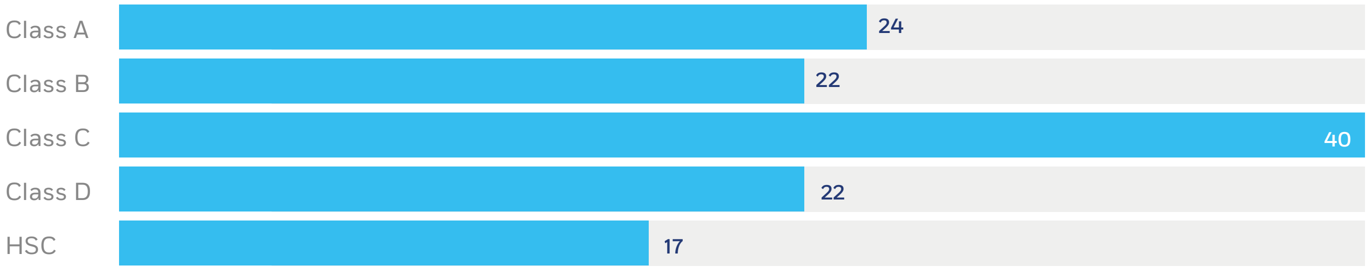
Figure 116: Evolution of the EU domestic fleet of passenger ships by class in accordance with Directive 2009/45/EC – comparison between 2014 and 2020.



Source: EMSA services based on questionnaire to Member States.

As can be seen in Figure 117, the average age of some of these ships is quite high.

Figure 117: Average age of passenger ships by class in accordance with Directive 2009/45/EC – 2020.



Source: EMSA services based on questionnaire to Member States.

Domestic passenger ships below 24 metres in length were excluded from the scope of this directive in 2019. To harmonise the safety standards of these ships, the Commission, supported technically by EMSA, prepared GBS guidance covering only Tiers I and II, which was published in the form of a Council recommendation ([113]). It indicated, in point 2(b), that Member States should:

- *support further analytical work with a view to identify and further assess the goals and requirements … within the performance-based framework, and to identify and assess possible alternative forms for their verification and implementation. This analysis should include assessment of the wide variety of passenger ship types and sizes, materials of construction and operating conditions[.]*

To address this request, the Commission launched a study to assess potential policy options. One of the key topics to be addressed is related to the fire safety aspects of materials other than steel. Most of these ships are built using aluminium, fibre or wood, for which there is no harmonised safety framework. It is also worth noting that the process for the revision of Annex 1 to this directive started in 2024 and is expected to be concluded in 2025.

Since 2020, 14 EU Member States have been visited by EMSA to verify the implementation of this directive. The EMSA visits revealed numerous findings, many of which related to a failure to implement specific safety requirements on domestic passenger ships, including those regarding fire safety, life-saving appliances and stability issues. In some ships, the visits identified major deficiencies that raised serious safety concerns requiring immediate action by the Member States, including the withdrawal of certificates. All in all, the exercise has proved to be not only useful but also necessary, to help Member States with the implementation of this technically complex directive. Measures should be taken to improve the implementation of this key directive.

- **Directive (EU) 2017/2110**, establishing a special regime for the survey of ro-pax, is dealt with in a dedicated section.

- **Directive 2003/25/EC** establishes specific damage stability requirements for ro-pax. In 1995, following the accident involving the ro-pax *Estonia* that resulted in more than 850 fatalities, a group of Baltic countries decided to sign the Stockholm Agreement establishing additional damage stability requirements for ro-ro passenger ships to take into account the effect of water accumulation on the vehicle deck. Some years later, the EU decided to apply this requirement to all ro-ro passenger ships operating to and from EU ports regardless of the flag and type of traffic (international/domestic), through Directive 2003/25/EC. This higher EU stability standard for ro-ro passenger ships in a damaged condition is considered to address the higher level of vulnerability of these vessels in a proportional and necessary manner. Following the adoption of new damage stability standards for passenger ships at the IMO – the SOLAS 2020 standards, which resulted from an EU submission – Directive 2003/25/EC was amended by Directive (EU) 2023/946 ([114]), and its new version has been applicable since December 2024.

- **Council Directive 98/41/EC** (the PAX Directive) deals with passenger registration to facilitate SAR in the aftermath of an accident. The number and the identification of people on board must be recorded and transferred to a passenger register onshore. Since 2023, the passenger details have been communicated using the NSW (see Section 4.3.2.2).

113 Council Recommendation of 9 April 2019 on safety goals and non-binding functional requirements for passenger ships below 24 metres in length (2019/C 142/01) (OJ C 142, 23.4.2019, p. 1, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019H0423%2801%29).

114 Directive (EU) 2023/946 of the European Parliament and of the Council of 10 May 2023 amending Directive 2003/25/EC as regards the inclusion of improved stability requirements and the alignment of that directive with the stability requirements defined by the International Maritime Organization (OJ L 128, 15.5.2023, p. 1, ELI: http://data.europa.eu/eli/dir/2023/946/oj).

5.2.3 Container ships

At the EU level, goods transported in containers via short-sea shipping made up to 17 % of the total freight transport volume, and thus their operation is essential to keeping the EU economy running. The continuous growth in the size of ships of this type in the past decade, driven by economies of scale in the global trade of containerised goods, brings additional design and operational factors into consideration when analysing the safety of these ships.

Container-ship safety was part of the EMSA five-year strategy from 2020 to 2024, as an important topic in the context of ships for which the risk and impact of accidents are high. Container ships are part of the safety agenda at the international level, especially with regard to two topics – loss of containers at sea and fires in cargo – but also in relation to aspects such as cargo handling and structural integrity.

In 2020, EMSA published a safety analysis of the marine casualties and incidents reported in EMCIP (see Section 5.3.4) involving container ships between 2011 and 2019 ([115]). This analysis includes a summary of the recommendations stemming from the investigation of those accidents issued for shipping companies, owners and flag administrations.

Cargo fires

The increasingly large number and high density of containers on and below deck, the very limited space between stacks and the configuration of the ship, which despite the significant increase in size has remained unaltered, means that any fire or explosion in the innermost containers is very difficult to detect at an early stage, and to control or extinguish.

In general, dangerous goods that are being transported and cargo that can potentially ignite should be located in areas where fire can easily be detected and extinguished. However, it is well known that on many occasions such goods are not declared, or are incorrectly declared, in the documentation accompanying the containers. This means the master and crew are not aware of the associated risks and cannot take appropriate preventive measures according to the cargo manual on board. This non-declaration or misdeclaration of cargo is a key factor contributing to cargo fires. Lithium-ion batteries, for instance, are a commodity with fire risk that can even be installed within other cargo and not immediately visible. These batteries, found in many common electronic devices or vehicles, can pose a fire hazard if damaged or mishandled.

In 2023, EMSA published the Cargosafe ([116]) study, carried out by a consortium led by the Danish Institute of Fire and Security Technology together with Bureau Veritas, RISE Research Institutes of Sweden, the University of Southern Denmark and Odense Maritime Technology. In Cargosafe, the contractors formally assessed the cost-effectiveness of RCOs to prevent or mitigate the consequences of container-ship cargo fires following the IMO FSA methodology (see Section 1.3.1.2). The assessment was submitted to the FSA Experts Group at the IMO, which recommended the study be considered by the Sub-Committee on Ship Systems and Equipment. The outcomes of the study ([117]) were supported by the members of the IMO. Accordingly, the sub-committee started working on amendments to SOLAS Chapter II-2 and the Fire Safety Systems Code to enhance provisions for early fire detection and the effective control of fires in container ships. These include, for example, the use of portable infrared cameras for crew to enhance manual detection and the improvement of manual firefighting tools for individual container breaching, such as fire mist lances.

Loss of containers

The loss of containers at sea has a significant impact on both maritime safety and the environment. A ship's movement at sea, especially in bad weather conditions, causes accelerations and forces, particularly in the higher tiers, that can cause containers to fall if not properly secured.

SOLAS requires container ships, through the Code of Safe Practice for Cargo Stowage and Securing, to develop a cargo securing manual tailor-made for the ship's design and the forces it is expected to encounter. The manual must be approved by the flag state. The master and crew must distribute the containers on board according to their weight and to the manual, although in this task they depend on the terminal operators following their instructions, which might not be always the case.

It is already mandatory for every container to be weighed before being loaded on board, unless all the individual cargo packages within the container have been weighed in advance. However, the latter procedure, where the container is not actually weighed, increases the possibility of false weight declarations, posing a challenge to safety on board.

In addition, the distribution of weight and the cargo stowage inside the container is out of the control of the crew, and it is often the case that planned stowage positions are not adhered to by terminals. To address this problem, which can have serious consequences, the IMO, together with the ILO

115 https://emsa.europa.eu/newsroom/latest-news/download/6374/4276/23.html.

116 https://emsa.europa.eu/containership-safety/cargosafe.html.

117 https://iumi.com/wp-content/uploads/2025/01/IUMI_submission_on_containership_fire_safety_to_the_IMOs_SubCommittee_on_Ship_Systems_and_Equipment_SSE.pdf.

and the UN Economic Commission for Europe, developed the Code of Practice for the Packing of Cargo Transport Units to advise those responsible on the safe packing of cargo transport units, including containers.

The strength of the container is also an essential component. Whereas most of the containers nowadays are built to a stacking strength of 213 000 kg, the IMO standard for testing under the International Convention for Safe Containers is limited to 192 000 kg. Although all containers should be marked with the maximum allowable load, this figure should be updated to avoid confusion.

With regard to accidents, a distinction can be made between cases where the origin comes from a ship accident (e.g. grounding) and those coming from a failure of the cargo system.

Image 5: *MSC Zoe* (2018) – loss of 342 containers in the North Sea.

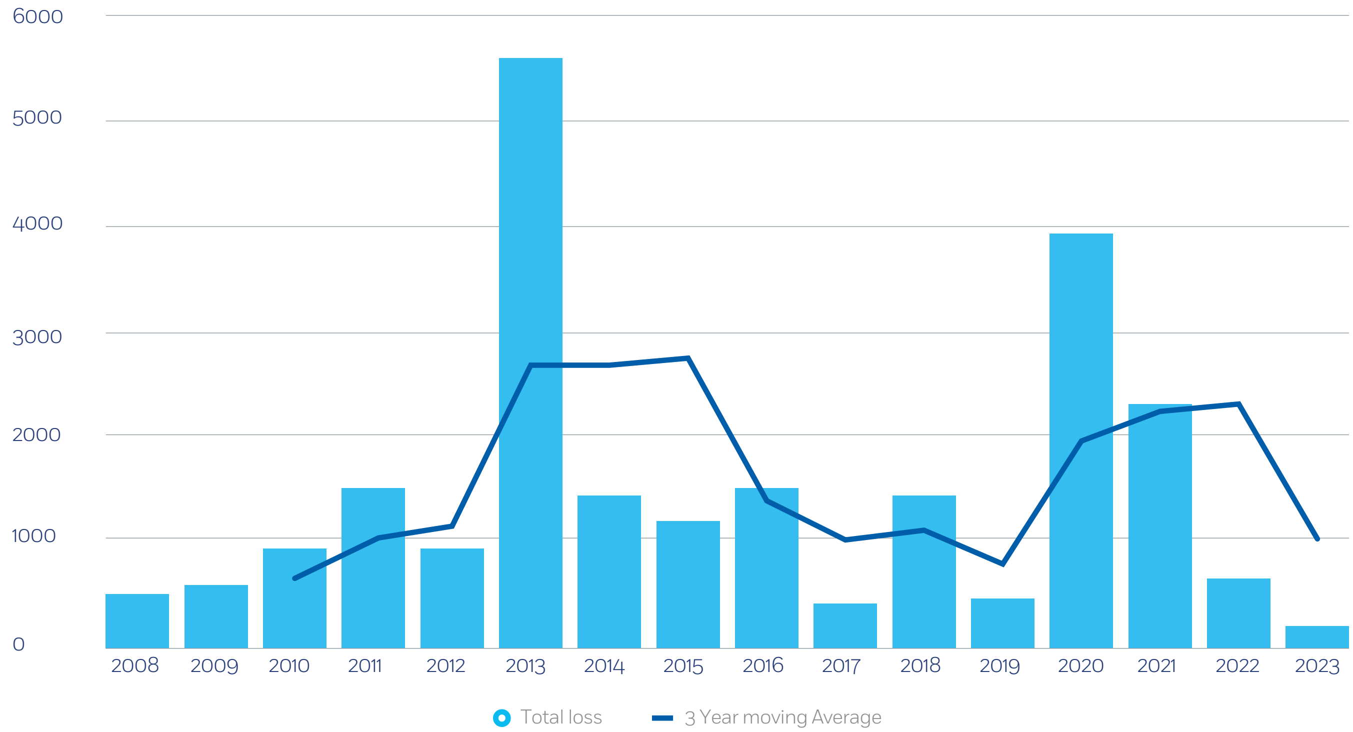
Source: BSU / Netherlands Coastguard.

Image 6: Close up view of wrecked container stacks on board the *MSC Zoe* (2018).

Source: NL/DSB.

Every year, the World Shipping Council conducts a survey of its member companies – which operate more than 90 % of the world's container-ship capacity – to estimate the number of containers lost at sea. There was a decrease in containers lost at sea in 2023, to a total of 221 out of 250 million units transported. This was the lowest yearly loss since 2008, and 33 % of those lost were recovered. The rolling average for the three years between 2021 and 2023 was 1 061 lost containers per year.

Figure 118: World Shipping Council summary of containers lost at sea.



Source: World Shipping Council.

After the *MSC Zoe* incident in the North Sea, which resulted in the loss of 342 containers, the Netherlands initiated an investigation into the causes, a qualitative risk analysis and a targeted inspection campaign. The main conclusions from the study were that there were four main causes of this kind of accident:

- the design specifications, container capacity or lashing system limits were exceeded;
- the weight in the container pile was too high or improperly distributed;
- the container or the cargo in the container was not properly secured;
- there were excessive movements of the ship.

The inspections covered 64 container ships over two months in 2019. Deficiencies were found in 67 % of the ships in relation to the loading and securing of containers and the lashing materials used.

The industry has been working to identify and remove the root causes of container losses at sea in the MARIN Top Tier Joint Industry Project. The project, which started in 2021, was finalised in 2024, with recommendations on the strength of containers and lashing gear; the shore–ship interface to ensure compliance with the planned stow configuration upon departure; assessing motion response during out-of-design conditions; securing container stack loads; and crew awareness and control of the risk of parametric roll.

Two new relevant outputs were added to the agenda of the Sub-Committee on Carriage of Cargoes and Containers in 2024 – one on preventing the loss of containers, the other on revising the guidelines for the preparation of the cargo securing manual (MSC.1/Circ.1353/Rev.2 ([118])) to include a harmonised performance standard for lashing software and permit it as a supplement to the cargo securing manual.

Regardless of the measures taken, accidents do happen, and a coordinated response to the containers lost at sea should be taken, as they can constitute a navigation hazard. In 2024, IMO MSC 108 adopted amendments to the SOLAS Convention regarding mandatory reporting requirements for all containers lost overboard, as a result of a discussion on an initial submission by the EU. The new requirements will become effective as of 1 January 2026.

118 https://www.register-iri.com/wp-content/uploads/MSC.1-Circ.1353-Rev.2.pdf.

Structural strength

With regard to structural strength, following the accident reports of the MV *MOL Comfort* (2013) and the subsequent paper submitted to the IMO by Japan and the Bahamas (MSC 95/16, dated 1 April 2015), which included recommendations with regard to the structure of large container ships, the IACS established a project team to tackle the topic. The result of this work was the publication of two IACS unified requirements (UR S11A and UR S34). Ongoing work relevant to container ships is triggered by improved insight into wave environments and hull girder whipping. Progress in this regard was reported to MSC 103 (MSC 103/20/3).

Image 7(a) and (b): *MOL Comfort* (8 100 TEU, 2013, total ship loss in the Arabian Sea), broken in two following primary hull girder failure.

(a)

(b)

Source: MRCC Mumbai.

Still afloat in these pictures (Image 7), a fire started in containers containing dangerous goods in the forward part of the *MOL Comfort*, and this section subsequently sank. The aft part was subject to a complex towing operation, though this also culminated in the loss of the whole section following a dramatic loss of stability and water ingress. The *MOL Comfort* remains the largest container ship ever to declare a total loss.

The *MOL Comfort* was a post-Panamax container ship, built in 2008 at Mitsubishi Heavy Industries in Japan. After the incident, sister ships were withdrawn from service and their hull structures upgraded to increase the longitudinal strength. The ship's young age – it was only five years old at the time of the accident – is an important factor driving attention to its design and construction rather than its structural maintenance.

5.2.4 Fishing vessels

Safety standards

Fishing vessel safety is often considered the 'elephant in the room' of maritime safety, as the specific nature of fishing operations, working conditions and vessel design are factors that have prevented fishing vessels from being fully included within the scope of the various international safety regulatory instruments implemented for conventional vessels. In the last 50 years there have been several attempts to agree on minimum safety standards for these ships, without success. In 1977, the Torremolinos International Convention for the Safety of Fishing Vessels was presented by the IMO as the first attempt to provide standards on the design, construction and equipment of fishing vessels of more than 24 metres in length, but it never entered into force. The second opportunity arose when the IMO's 1993 Torremolinos Protocol was developed, but with a similar result. At that stage, the EU acted, and adopted Council Directive 97/70/EC ([119]), which makes the Torremolinos instruments mandatory for EU Member State-flagged ships of more than 24 metres in length. Subsequently, in 2012, the IMO prepared the Cape Town Agreement on the Implementation of the Provisions of the Torremolinos Protocol, but it is still not in force today. Only nine EU Member States plus Iceland and Norway have already deposited the accession act.

119 Council Directive 97/70/EC of 11 December 1997 setting up a harmonised safety regime for fishing vessels of 24 metres in length and over (OJ L 34, 9.2.1998, p. 1, ELI: http://data.europa.eu/eli/dir/1997/70/oj).

The institutional partners responsible for the regulations applicable to fishing vessels and operations are very diverse (the IMO, the ILO, the Food and Agriculture Organization of the UN (FAO), the Commission, the European Fisheries Control Agency, the EU Member States, etc.). As a result, the regulatory framework, whether mandatory or voluntary, is complex and multidisciplinary. In collaboration with the FAO and the ILO, the IMO has developed some non-mandatory instruments relating to the safety of smaller vessels:

- Code of Safety for Fishermen and Fishing Vessels, 2005, Parts A and B;
- Voluntary Guidelines for the Design, Construction and Equipment of Small Fishing Vessels of 12 metres in length and over but less than 24 metres in length, 2005;
- safety recommendations for decked fishing vessels of less than 12 metres in length and undecked fishing vessels;
- implementation guidelines on Part B of the code, the voluntary guidelines and the safety recommendations.

The EU has also developed guidance and related publications in this regard:

- EMSA, 'Safety analysis of data reported in EMCIP – Analysis on marine casualties and incidents involving fishing vessels' (120);
- European Agency for Safety and Health at Work, *European guide for risk prevention in small fishing vessels* (121);
- European Parliament, 'Information note – FISH 501 EN – Safety and the causes of accidents in the fishing sector' (122) and 'Report on fishers for the future: Attracting a new generation of workers to the fishing industry and generating employment in coastal communities' (123).

The EU has recently reviewed several directives in which fishing vessels are considered. One of them is the AI Directive (Directive 2009/18/EC), the scope of which was extended to include the reporting of accidents involving fatalities in and the loss of fishing vessels below 15 metres in length.

The revision of the PSC Directive added a new voluntary regime for fishing vessels to its scope. The Paris MoU is conducting a pilot project, which began in 2024, to evaluate whether it could be of added value to implement a harmonised approach to PSC on internationally operating fishing vessels of 24 metres and above. Although all member authorities of the Paris MoU currently have the possibility and the right to inspect fishing vessels visiting their ports, a limited number of Paris MoU members are participating in the pilot. Croatia, Denmark, France, Germany, Ireland, Netherlands, Norway and Spain were, at the time this report was written, the participating EU Member States.

Another open process is the *ex post* evaluation of Council Directive 97/70/EC, for which a roadmap was published in 2021 that indicates the following: The original intention of Directive 97/70/EC was to be a first step in fishing vessel safety and in the light of the implementation of Council Directive 93/103/EC [(124)], the Commission and Member States would consider the appropriateness of developing relevant safety rules for new fishing vessels of a length less than 24 m, — (European Commission: Directorate-General for Mobility and Transport, 2021).

Therefore, the results of these evaluations will be important steps for the future of fishing vessel safety at the EU level.

Fleet

Databases at EMSA provide reliable data on the cargo/passenger fleet. However, for fishing vessels, the database hosted and managed by the Commission's DG Maritime Affairs and Fisheries (125) is the best source to use to characterise the fleet. **At the end of 2023, there were close to 70 000 fishing vessels in the EU Member States** (a decrease in the size of the fleet of around 6 % from 75 000 in 2019), excluding Iceland and Norway, for which no data are available in the DG Maritime Affairs and Fisheries database. This makes this category of ship the most numerous in the EU.

Length is the key parameter used as a threshold within the scope of fishing vessel safety legislation. According to the data available at the end of 2023, and similarly to 2019:

- only 3 % measure 24 metres in length or more (therefore within the scope of Council Directive 97/70/EC, Directive 2002/59/EC and Directive 2009/18/EC);
- 6 % measure between 15 metres and 24 metres in length (therefore fully within the scope of Directive 2009/18/EC and Directive 2002/59/EC);
- 91 % measure below 15 metres in length (partially within the scope of Directive 2009/18/EC).

120 http://emsa.europa.eu/newsroom/latest-news/item/3253-safety-analysis-of-data-reported-in-emcip.html.

121 https://data.europa.eu/doi/10.2767/404084.

122 https://www.europarl.europa.eu/RegData/etudes/note/join/2001/297832/IPOL-PECH_NT%282001%29297832_EN.pdf.

123 https://www.europarl.europa.eu/doceo/document/A-9-2021-0230_EN.html.

124 Council Directive 93/103/EC lays down minimum safety and health requirements applicable to work on board fishing vessels above 15 metres. The requirements are of a very general nature.

125 https://webgate.ec.europa.eu/fleet-europa/index_en.

This means the fleet fully covered under the relevant EU directives is relatively small in terms of the number of vessels, but includes, approximately, the largest 10 %. The smaller ships, typically owned by self-employed people using traditional techniques, were only recently added in relation to the mandatory reporting of very serious accidents under Directive 2009/18/EC. These vessels are in most cases not particularly profitable, and there may therefore be incentives to postpone maintenance or essential repairs. .

Figure 119: Distribution of EU Member States' fishing vessels in terms of length – fleet of 2023.

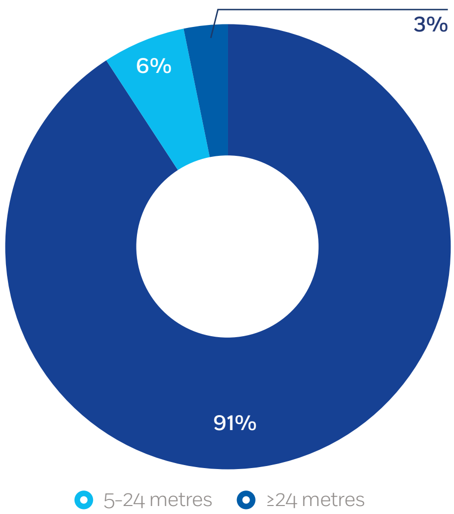
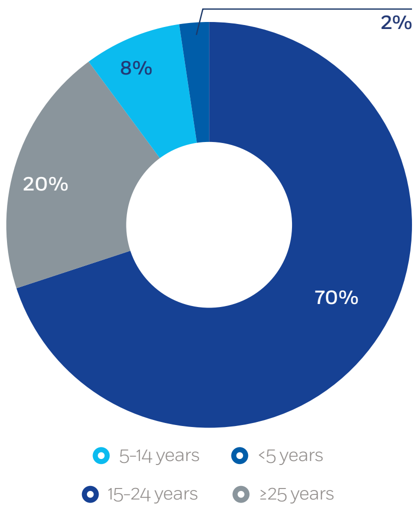


Figure 120: Distribution of EU Member States' fishing vessels in terms of age – fleet of 2023.



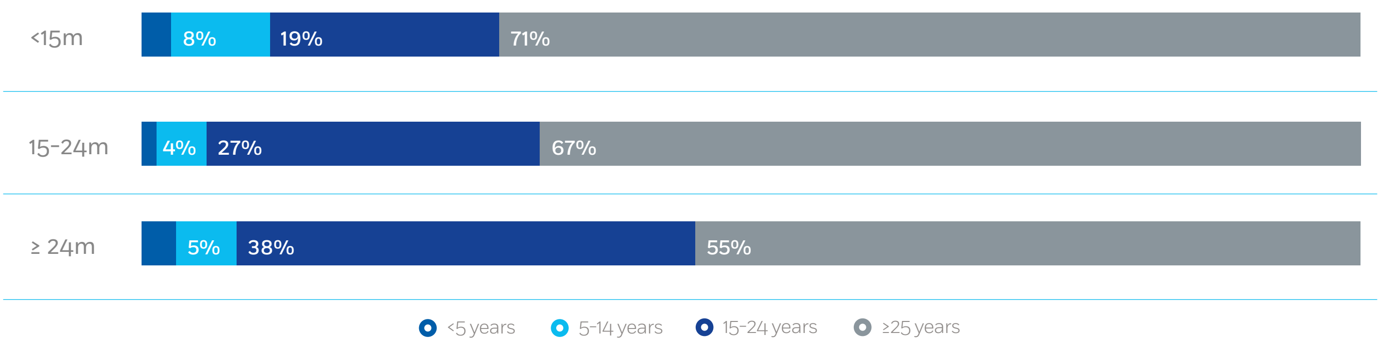
NB: Iceland and Norway fleet registers not available.

Source: 'Fleet register', European Commission: Directorate-General for Maritime Affairs and Fisheries (n.d.).

In terms of age, in 2023, 70 % of the EU fishing fleet (48 811 vessels) was 25 years old or older (65 % in 2020), 20 % (13 910 vessels) was between 15 and 24 years old, 8 % (5 418 vessels) was between 5 and 14 years old and only 2 % (1 648 vessels) of the vessels were built between 2019 and 2023, verifying the ageing trend also for these vessels (see Figure 120). The smallest vessels in terms of length are often the oldest.

Vessels measuring less than 24 metres and more than 25 years old represent most of the overall fleet (68 %). **This age trend is now common across all fishing vessel length ranges, even within the fleet above 24 metres, where more than 50 % are older vessels (see Table 48).**

Table 48: Age distribution of EU Member States' fishing vessels by length – fleet of 2023.



NB: Iceland and Norway fleet registers not available. Age information is available for 99.98% of vessels (meaning that there are 16 vessels without age information).

Source: 'Fleet register', European Commission: Directorate-General for Maritime Affairs and Fisheries (n.d.).

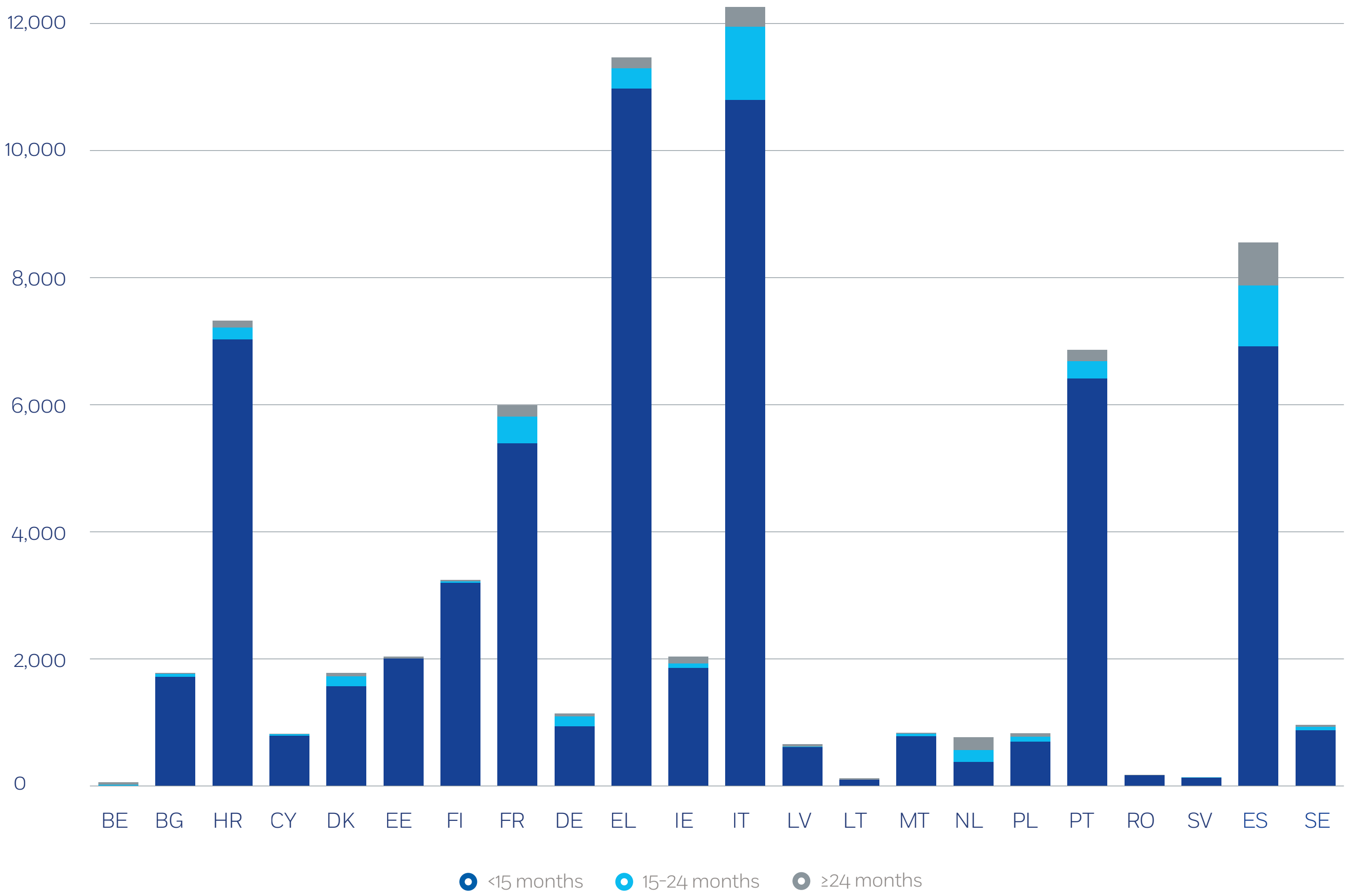
A more detailed analysis of the typology of vessels by length shows (Figure 121) that, for those Member States with a significant fishing fleet (over 6 000 vessels), most of their fleet is composed of vessels below 15 metres (Croatia 96 %, Greece 96 %, Italy 88 % and Portugal 94 %).

The Spanish fleet is quite different: even if the most representative vessels measure less than 15 metres (81 %), the Spanish fleet is also composed of a significant number of vessels of between 15 and 24 metres (950). The percentage of vessels above 24 metres is also higher than the European average (8 %), therefore these larger Spanish vessels account for 30 % of the EU Member States' registered fleet within that size category.

The Italian fleet of between 15 and 24 metres in length, with 1 150 vessels, is the largest, accounting for 27 % of the EU Member States' registered fleet within that size category.

In the Netherlands, most of the registered fleet of fishing vessels is above 15 metres.

Figure 121: Fishing vessels fleet by Member State and length in 2023.

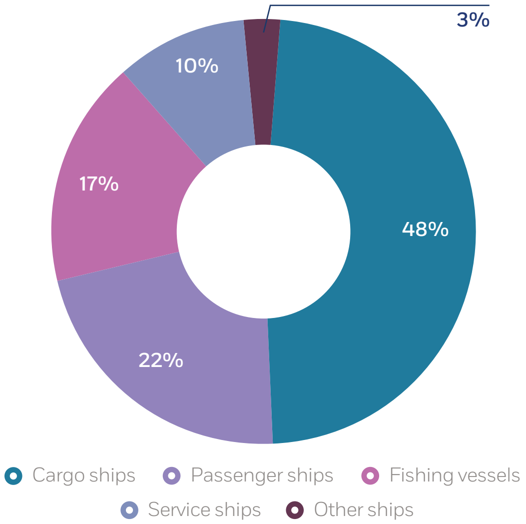


Source: 'Fleet register', European Commission: Directorate-General for Maritime Affairs and Fisheries (n.d.).
NB: Iceland and Norway fleet registers not available.

Accidents

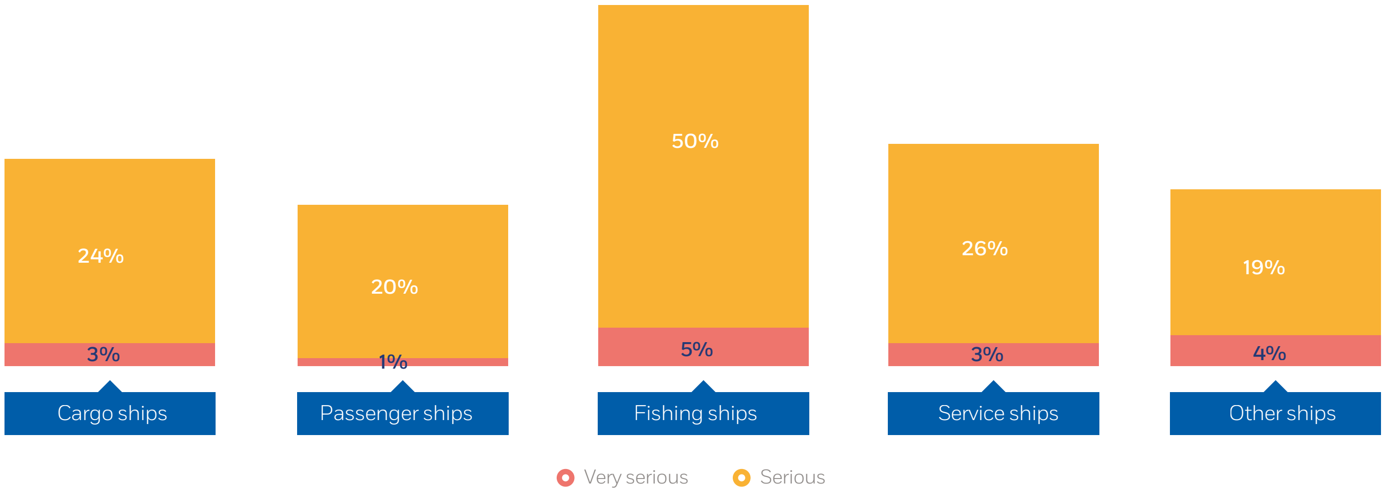
From an accident perspective ([126]), Figure 122 shows that 17 % of all ships involved in the occurrences registered in EMCIP are fishing vessels ([127]).

Figure 122: Distribution of ships involved in occurrences by ship type since 2014 – annual overview of marine casualties and incidents, 2023.



Source: EMCIP (EMSA, n.d.).

Figure 123 Share of very serious and serious occurrences in number of occurrences by ship type – annual overview of marine casualties and incidents, 2023.



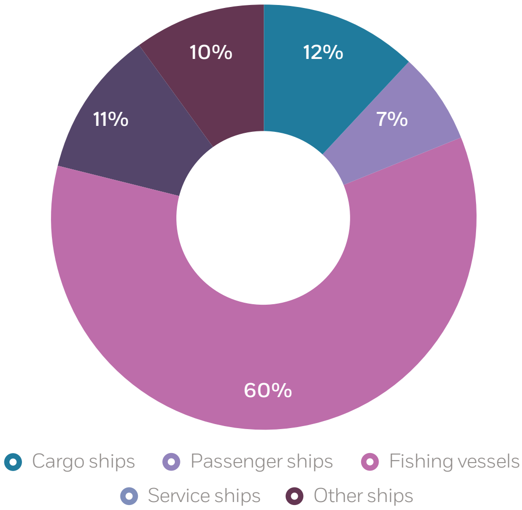
Source: EMCIP (EMSA, n.d.).

However, Figure 123 and Figure 124 are more relevant to analysing the safety of fishing vessels.

126 For more information on accidents involving fishing vessels, see http://emsa.europa.eu/newsroom/latest-news/item/3253-safety-analysis-of-data-reported-in-emcip.html.

127 As can be seen in Section 4.3, the number of accidents involving ships above 24 m and those between 15 and 24 m in length are practically the same despite the fleet of the second group being double than the first. This leads to the conclusion that there is probably some under-reporting associated with these figures, as the national resources needed to investigate accidents are limited.

Figure 124: Ships lost by ship type – annual overview of marine casualties and incidents, 2023.



Source: EMCIP (EMSA, n.d.).

The most important conclusion that can be extracted from the figures above is that fishing vessels are more vulnerable to accidents – not so much in terms of frequency, rather in terms of the seriousness of the consequences when they do occur. The rate of very serious casualties and serious casualties for fishing vessels is much higher compared to the size of the overall fleet. **The majority of the accidents involving fishing vessels (55 %) up until 2022 had very serious or serious consequences.** In addition, even though fishing vessels represent 17 % of the total number of accidents, **the number of fishing vessels lost represents 60 % of total number of lost vessels**, a trend observed in recent years as seen from the slight increase since 2019. It can then be concluded that when an accident occurs involving a fishing ship, the probabilities of total loss or serious consequences are higher than for any other ship type, thus confirming their vulnerability.

Enforcement and reporting

Even though some Member States have comparatively large fleets, the resources available for enforcement and reporting (on the fleets themselves, on accidents, etc.) are often not available.

Qualifications

The STCW-F Convention was adopted on 7 July 1995 to promote the safety of life and property at sea and the protection of the marine environment. It entered into force on 29 September 2012. The convention establishes common international standards of training, certification and watchkeeping for personnel employed on board fishing vessels.

The EU Member States parties to the STCW-F Convention are:

- Belgium
- Denmark
- Spain
- France
- Latvia
- Lithuania
- Netherlands
- Poland
- Portugal
- Romania.

Iceland and Norway have also ratified the convention.

The STCW-F Convention is currently being comprehensively reviewed by the IMO's Sub-Committee on Human Element, Training and Watchkeeping to align it with the current state of the fishing industry.

Since fishing at sea is one of the most hazardous professions, and fishing vessels and their crew face the same hazards and risks in the open seas as commercial seagoing vessels, appropriate training and qualifications are essential in reducing the number of accidents and contributing to the safety of the crew on board.

Furthermore, the STCW-F Convention may also facilitate the free movement of workers. Fishers could become more mobile through having the possibility of working on board the fishing vessels of all Member States parties to the convention. Therefore, not only would the harmonisation of their qualifications through the introduction of a common minimum level of training for fishing vessel personnel improve safety at sea, but it could also further facilitate the free movement of workers. Moreover, it could establish a level playing field both within the EU and in relation to non-EU countries. It is also the intention at the IMO level and on the part of certain stakeholders that the STCW-F Convention requirements should facilitate mobility between fishing and commercial vessels, the latter regulated by the main STCW Convention.

Living conditions

The MLC Convention does not apply to fishing vessels, so the ILO developed a convention to address this gap. The Work in Fishing Convention, 2007, entered into force on 16 November 2017, after being ratified by 10 ILO Member States, and is applicable to all types of commercial fishing vessel. It establishes provisions to protect those who work on fishing vessels in various aspects of their work: safety on board fishing vessels; food, accommodation and medical care at sea; employment practices; and insurance and liability. It is important to note that this convention requires the implementation of specific port state inspection practices to ensure that its provisions are applied on fishing vessels operating in areas under the jurisdiction of the states that have ratified it.

The Work in Fishing Convention represents a significant step forward in terms of working conditions on board fishing vessels. This convention contains provisions regarding habitability, respect for hours of rest, etc., which also contribute to safety on board. So far, seven Member States have ratified the convention. However, several Member States with significant fishing fleets have not yet ratified it.

The application of the Work in Fishing Convention by all Member States would make it possible to create a complete common regulatory framework for fishing safety based on ship safety (Council Directive 97/70/EC), the qualification of seafarers (STCW-F), environmental protection (relevant MARPOL regulations) and health and safety at work (Work in Fishing Convention).

5.2.5 Ships carrying industrial personnel

With the EU's emphasis on climate change, offshore renewable energy production is a rapidly growing sector. The offshore wind capacity installed in the EU in 2023 was 19.38 gigawatts. The revised Renewable Energy Directive ([128]), adopted in 2023, sets an EU target for renewables of at least 42.5 %, which will require the installed wind capacity to grow to more than 500 gigawatts by 2030 (European Commission: Directorate-General for Energy, n.d.).

The development of offshore wind farms in EU waters means that there is a need to transport personnel offshore to construct and maintain these set-ups.

As these workers do not fit into any of the traditional categories in maritime legislation, the IMO has developed a new International Code of Safety for Ships Carrying Industrial Personnel (IP Code) at sea, such as offshore technicians. It takes account of the risk scenarios for transporting such personnel with common knowledge of ships' layout and possible emergency scenarios, and thereby recognised to be a category between passengers and ship's crew.

In 2022, the IMO adopted Resolution MSC.521(106) ([129]), which includes a new chapter for SOLAS Chapter XV on safety measures for ships carrying industrial personnel, making the IP Code mandatory for ships and HSC within that scope. The new code entered into force on 1 July 2024. It was possible for ships existing before that date to have been authorised by their flag state in accordance with the interim guidance on the safe carriage of more than 12 industrial personnel on board vessels engaged in international voyages (Resolution MSC.418(97) ([130])), taking advantage of a grandfathering provision that waived some of the new requirements in the IP Code.

The Paris MoU has developed guidelines ([131]) for PSC inspections of these ships that will comply with SOLAS Chapter XV and the provisions of the IP Code. However, many such ships are operating domestically, and Member States are developing national standards to regulate these vessels for domestic voyages. The lack of harmonisation, especially for smaller ships, creates difficulties when these vessels change their flag to operate in a different Member State.

128 Directive (EU) 2023/2413 of the European Parliament and of the Council of 18 October 2023 amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652 (OJ L, 2023/2413, 31.10.2023, ELI: http://data.europa.eu/eli/dir/2023/2413/oj).

129 IMO Resolution MSC.521(106) adopted on 10 November 2022, Amendments to the International Convention for the Safety of Life at Sea, 1974 (Chapter XV) https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/MSCResolutions/MSC.521%28106%29.pdf.

130 IMO Resolution MSC.418(97) adopted on 25 November 2016, Interim recommendations on the safe carriage of more than 12 industrial personnel on board vessels engaged on international voyages, https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/MSCResolutions/MSC.418(97).pdf.

131 https://parismou.org/2024/07/guidelines-psc-inspections-ships-carrying-industrial-personnel-ip-code.

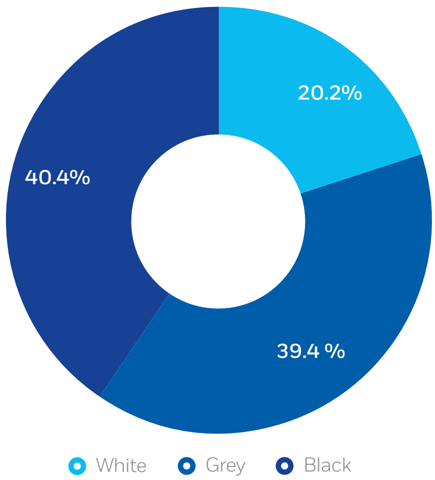
5.2.6 Other safety topics

5.2.6.1 Livestock carriers

At the end of 2023 there were 145 livestock carriers in the world fleet with an average age of 38.5 years. **While only a fraction of those ships are flying an EU Member State's flag (10 %, i.e. 14 ships, with an average age of 15.8 years), many older ones are flying a high-risk flag and are calling at EU ports.**

The Paris MoU provides information on the flag performance for 75 % of these ships (see Section 3). The distribution of the flag performance for these ships can be seen in Figure 125, with 40 % of them on the black list, posing a high risk to maritime traffic and to the lives of the crew and animals on board.

Figure 125: Livestock carriers' flag performance according to the Paris MoU.



Source: EMSA services based on Paris MoU (ParisMoU 2022 Performance lists).

A report by the German non-governmental organisation Animal Welfare Foundation and the French environmental non-governmental organisation Robin des Bois recently called the livestock fleet the most dangerous ships in the world, while urging the EU to prohibit the use of substandard ships and their calling at EU ports (Robin des Bois et al., 2024).

In December 2023, a proposal for a new regulation on the protection of animals during transport was adopted [132]. This regulation would require, among other things, livestock exports from the EU to use white or grey flags. Accordingly, this measure is expected to improve the overall safety level of this type of ship in the EU.

5.2.6.2 Pilot transfer arrangements

Pilot transfer arrangements are those that enable pilots to embark and disembark safely upon arrival at and departure from a port area. This is a very risky operation, in which a small boat has to come close to a bigger ship and the pilot may have to climb heights of more than 25 metres using a ladder, sometimes of simple arrangement, while the boat and the ship are moving up and down. The possibility of falling, slipping or being trapped between the boats is not unlikely. According to EMCIP, since 2011 there have been at least 35 incidents involving pilots, with 13 of them being serious or very serious, with some fatalities.

The requirements for pilot transfer arrangements are part of SOLAS Chapter V Regulation 23.

In 2023, the Paris MoU conducted an inspection campaign focused on pilot transfer arrangements. The purpose of the campaign was to verify whether such arrangements on board the ships inspected were fulfilling the SOLAS requirements. A total of 1 262 PSC inspections were carried out, during which 100 ships were found to have one or more related deficiencies. The findings were as follows.

- Upon inspection, pilot ladders were not properly rigged to allow pilots to embark and disembark safely. On several occasions it was found that the weight of the ladder was not taken by its strongest point but, for example, by the steps.
- Pilot ladders were damaged or not properly maintained.
- Identification of ladders and record keeping of surveys and repairs were missing.

At the time this report was written, the IMO's NCSR had agreed to revise the requirements for pilot transfer arrangements under SOLAS Chapter V. The work of the International Maritime Pilots' Association is to be commended. A new edition of the *Shipping Industry Guidance on Pilot Transfer Arrangements* [133] was issued in 2022 to remind seafarers and companies of the vital importance of adhering to the rules and established procedures concerning the provision of safe boarding arrangements for pilots.

132 Proposal for a regulation of the European Parliament and of the Council on the protection of animals during transport and related operations, amending Council Regulation (EC) No 1255/97 and repealing Council Regulation (EC) No 1/2005, COM(2023) 770 final of 7 December 2023, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52023PC0770.

133 https://www.ics-shipping.org/wp-content/uploads/2022/01/Shipping-Industry-Guidance-on-Pilot-Transfer-Arrangements-v3.pdf.

5.2.7 Marine equipment

International legislation lists several pieces of equipment that must be carried on board ships, either to ensure the safety of operations or to protect the marine environment. Detailed performance and testing standards for this marine equipment have been developed by the IMO and by international and European standardisation bodies.

However, the agreed international regulatory framework leaves a significant margin of discretion to the flag administrations in terms of how to implement the rules. This can lead to different interpretations and, consequently, different levels of safety for the certified marine equipment on the market. In addition, the international framework does not cover quality standards, either for the final product verification or for the manufacturing process. Ensuring that this equipment is of high quality is indispensable for the safe operation of a ship, life-saving capabilities and the protection of the marine environment.

The MED lays down common rules for the certification of marine equipment and is intended to eliminate differences in the interpretation and implementation of international standards by means of a clearly identified set of requirements and uniform certification procedures. In addition, it adds quality certification mechanisms. The main aim of the directive is to ensure, as far as possible, that marine equipment on EU Member State-flagged ships is designed and constructed to appropriate standards. This directive is based on the EU's new legislative framework ([134]), which defines a set of measures for use in product legislation that aim to improve market surveillance and boost the quality of conformity assessment for the majority of products.

Following that, the MED outlines the conformity assessment procedures (known as modules) to be carried out for a specific item of marine equipment by the manufacturer or its authorised representative in the EU, as mentioned in Table 49.

Table 49: Conformity assessment modules under the MED.

Module B	o Type examination, verification and testing of the technical design of the equipment, including its technical documentation.
Module D	o Type conformity based on the quality assurance of the production process (verification during manufacturing and verification of final product). Ensures that the final products are the same as the reference product (a product that meets the standards and essential requirements). Applicable mainly when in high-volume production. o The notified body assesses the quality system as provided by the manufacturer.
Module E	o Type conformity based on the quality assurance of the product (verification of final product). o The notified body assess the quality system as provided by the manufacturer.
Module F	o Type conformity based on product verification. o Applicable mainly for small production batches. o The notified body carries out product examinations (testing of every product or statistical checks).
Module G	o Conformity based on unit verification. o Applicable mainly for production of small quantities or individual products, and not in series or in mass. o The notified body verifies every individual product.

134 https://single-market-economy.ec.europa.eu/single-market/goods/building-blocks/market-surveillance/organisation/adcos_en

Conformity for marine equipment products can be achieved by the application of a combination of type examination (module B) and one of the quality assurance procedures (modules D, E or F) or by the application of module G only. The manufacturer can choose the quality assurance inspection model and order the verification (tests, type examination, periodic post-verification) from any notified body – an organisation designated by one of the competent EU national administrations to carry out conformity assessment tasks – which then issues a certificate for each successfully tested module.

After the conformity assessment procedure has been completed, the manufacturer drafts the declaration of conformity stating that the requirements determined by the directive have been fulfilled and affixes the conformity mark (wheel mark symbol or electronic tagging (e-tagging)). A copy of the declaration of conformity is provided to the ship that installs the equipment, and must be kept on board.

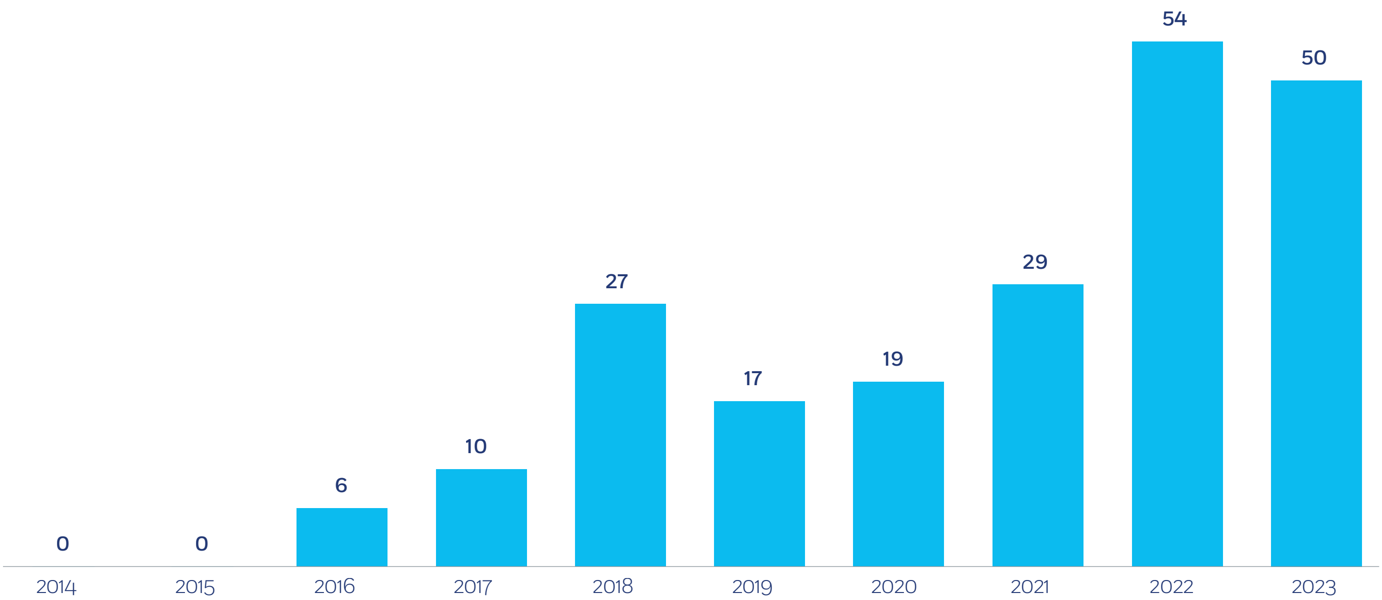
The directive also requires Member States to undertake market surveillance of marine equipment, which is a demanding task given that the equipment is placed on board ships at the time of their construction or repair all over the world. Member States are required to ensure that only compliant equipment is installed on board ships flying their flags and that this obligation is fulfilled through issuance, endorsement and renewal of the certificates of such ships. In this way, the national market surveillance authorities (MSAs) are responsible for drawing up market surveillance programmes that include checks on pieces of equipment (documentary, on-board and sample checks), the identification of specific equipment posing a potential hazard and all the related actions to communicate the outcome of these activities to interested parties. A summary of the MED procedures is presented in Figure 127.

An example of the benefits of market surveillance was the identification of non-compliant fire safety divisions on board some passenger ships. The system alerted the EU flags affected and the manufacturer was requested to put in place measures to ensure compliance with the international safety legislation.

The Commission provides support to the MSAs of all Member States by facilitating the exchange of their experience within suitable administrative cooperation groups ([135]).

Based on the number of records available in the Commission's Information and Communication System for Market Surveillance ([136]), from 2016 to December 2023 the EU MSAs reported 212 potential cases of marine equipment in non-compliance. The final date for adoption and publication of the MED by the Member States was September 2016. The establishment of market surveillance activities has resulted in a growing number of suspected cases of non-compliant equipment, as evidenced by the latest figures available for 2022 and 2023. Following the EMSA cycle of visits, these activities intensified significantly, leading to the identification of more cases of non-compliant equipment.

Figure 126: Yearly number of reported suspected cases of MED non-compliant equipment by the EU MSAs since 2014.

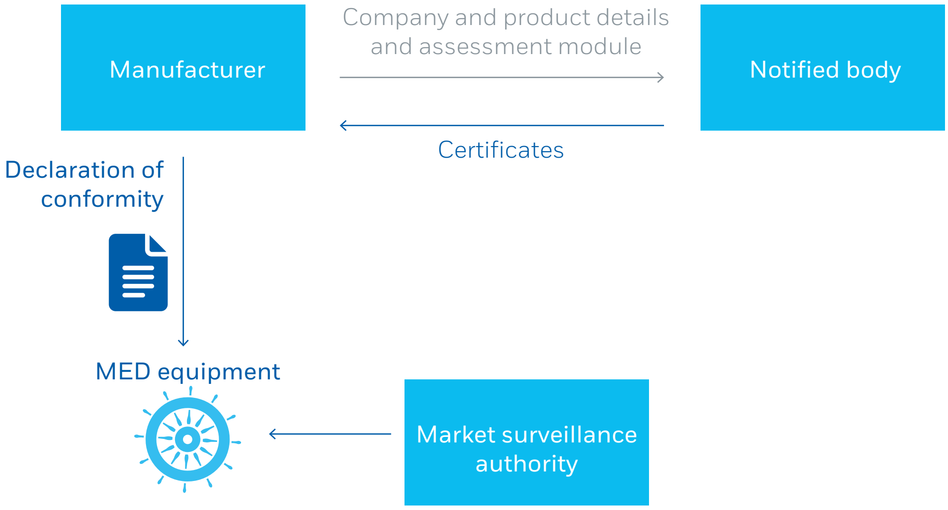


Source: Information and Communication System for Market Surveillance.

135 https://ec.europa.eu/growth/single-market/goods/building-blocks/market-surveillance/organisation/adcos_en.

136 https://webgate.ec.europa.eu/icsms/.

Figure 127: Summary of MED procedures.



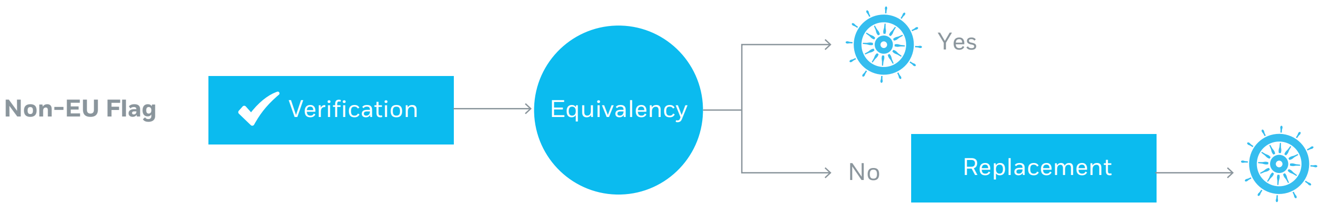
Source: EMSA services.

To facilitate bilateral trade and promote cooperation on international marine equipment regulations, there is an agreement between the EU and the United States on the mutual recognition of certificates of conformity. This type of agreement allows for the extension of the European market of marine equipment based on the same regulatory requirements. Accordingly, US-flagged ships can directly install on board those pieces of equipment included in the agreement.

The MED is only applicable to EU Member State-flagged ships, meaning that competing ships trading in EU ports do not need to comply with the directive. When a non-EU ship is transferred to an EU flag, the ship must be inspected by the receiving flag state to verify that the safety certificates are valid and correspond to the actual condition of the equipment. The receiving flag can either state that the equipment is compliant with the MED, and therefore bears the wheel mark, or that it is equivalent in terms of safety level, to the satisfaction of the administration in question, in which case a certificate of equivalence is issued. Otherwise, the equipment needs to be replaced. The transfer of the flag under the MED is explained in Figure 128. The process of flagging in non-EU-flagged ships in the context of the application of the MED is very complex. Therefore, a common guideline developed through close cooperation between Member States could significantly improve the horizontal application of MED rules.

There are no consolidated statistics on this topic apart from the samples taken during EMSA visits, which appear to suggest that equivalency can be achieved for pieces of marine equipment on which the safety requirements originating at the IMO are properly applied.

Figure 128: Transfer of flag under the MED.



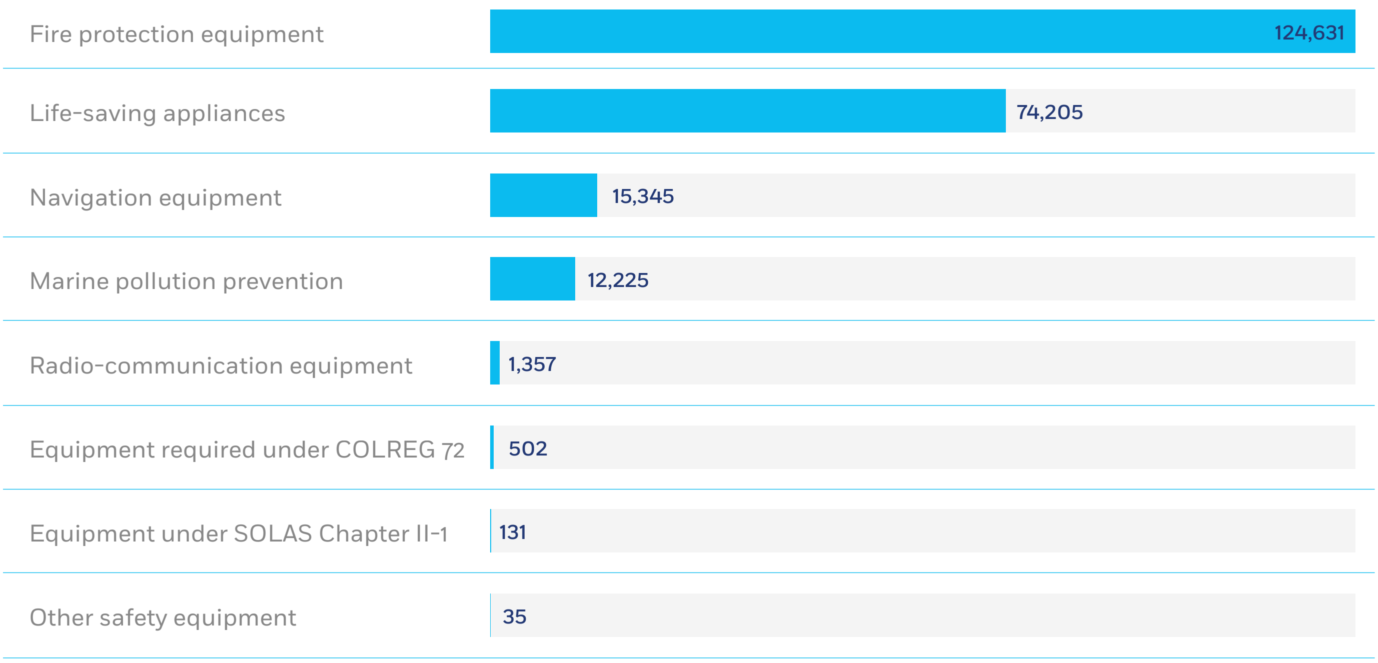
Source: EMSA services.

Member States are supported in fulfilling their obligations under the MED by the information systems made available by the Commission for the assessment, notification and monitoring of bodies authorised to carry out conformity assessment tasks ([137]); the sharing of information in relation to approved marine equipment; applications withdrawn or refused; and non-compliance. In this regard, since 2020 EMSA has hosted a database known as the MED Portal ([138]), a repository of this information. In addition, the MED Portal contains all of the documentation of the MarED group, the cooperation group for the notified bodies assigned by the Member States, which meets twice a year to discuss technical issues relating to difficulties in the interpretation of certain requirements. The MarED group develops interpretations in the form of draft recommendations, which are subsequently approved (or rejected) by Member States at the Committee on Safe Seas and the Prevention of Pollution from Ships. EMSA acts as the technical secretariat of this group, which facilitates the harmonisation of the procedures and the internal market.

In addition, every year, EMSA coordinates, from a technical perspective, the annex that includes all the standards and requirements for all the items included in the MED, which currently number more than 300, including life-saving appliances, fire safety, pollution prevention, radiocommunication and navigation elements.

As indicated above, the MED Portal is the reference database for products certified under the directive. They are uploaded directly by the notified bodies through a dedicated interface. Currently, there are more than 220 000 products registered, as shown in Figure 129.

Figure 129: Number of products registered in the MED Portal per category.



Source: MED Portal.

According to the product register**, 45 % of the marine equipment allowed to be installed on board EU Member State-flagged ships is manufactured by companies based in the EU**.

The MED Portal receives more than 200 000 monthly visits by more than 11 600 worldwide registered users representing industry stakeholders, including manufacturers and authorised representatives, administrations, market surveillance authorities, notified bodies, notifying authorities and public users. The number of registered users has more than doubled compared with 2021. The distribution of the database entries for February 2024 is depicted in Figure 130.

137 https://ec.europa.eu/growth/tools-databases/nando/index.cfm.

138 https://portal.med.emsa.europa.eu/.

Figure 130: Number and location of users of the MED Portal – February 2024.

Source: EMSA services.

The future steps of the MED Portal are focused on improving accessibility to product information, particularly with the facilitation of the declaration of conformity and the digitalisation and online publication of documents (manuals, certificates, etc.).

Also notable is the e-tagging of marine equipment, which was introduced as a supplement to the wheel mark. This aims at facilitating market surveillance with direct and easy access to the relevant databases, preventing the counterfeiting of specific items and making it easier for shipowners and operators to carry out equipment traceability and stock control. Based on the MED Portal and on the principle of the e-tagging of marine equipment, EMSA is developing a new MED Mobile application for the scanning of MED e-tags in the Data Matrix and RFID formats. This idea is still in the initial phase of implementation, and has not yet been fully embraced by the industry. In 2023, EMSA received the first items of MED e-tagged equipment from the manufacturers, which were then presented to the maritime sector at one of Europe's largest maritime technology promotion events. The agency is making an effort to raise awareness among the manufacturers of marine equipment through web content ([139]). One of the possible solutions for the further digital identification of items of MED-approved equipment could be to include the marine sector in the concept for the implementation of the European digital product passport under Regulation (EU) 2024/1781 on ecodesign for sustainable products ([140]), which in 2024 began gradually to cover various ranges of products.

139 https://emsa.europa.eu/we-do/safety/marine-equipment.html.

140 Regulation (EU) 2024/1781 of the European Parliament and of the Council of 13 June 2024 establishing a framework for the setting of ecodesign requirements for sustainable products, amending Directive (EU) 2020/1828 and Regulation (EU) 2023/1542 and repealing Directive 2009/125/EC (OJ L, 2024/1781, 28.6.2024, ELI: http://data.europa.eu/eli/reg/2024/1781/oj).

Figure 131: e-Tag scheme demonstration.

Source: EMSA services.

Figure 132: MED Mobile application.

Source: EMSA services.

5.3 Accident investigation framework

5.3.1 Introduction

Despite the prevention and implementation measures in place, accidents continue to happen. In recent maritime safety history, some marine accidents have attracted the interest not only of maritime authorities or shipping companies, but also of the public in general. The *Costa Concordia* accident on 13 January 2012 (32 fatalities) generated widespread public interest, as did the fire on board the *Norman Atlantic* on 28 December 2014 (11 fatalities). There have been other accidents with similar consequences that have not attracted such attention, however, such as the collision between MV *Lady Aziza* and the *Gokbel*, during which six people lost their lives, on the very same day as the *Norman Atlantic* accident. Another such tragedy was the sinking of MV *El Faro* on 1 October 2015, in which 33 people died, including six EU nationals. The list of such casualties is long – much longer than one would expect. Few outside the fishing community are aware, for example, that more than 100 people lost their lives on board fishing vessels between 2019 and 2023. Therefore, no analysis of maritime accidents could be complete without referencing the many tragedies that have taken place at sea, a great deal of which have passed unnoticed by those outside the maritime community. Added to this are the thousands of accidents that have resulted not in deaths but in injuries, many of which have had life-changing consequences for those affected.

Marine casualties also affect ships and the marine environment, along with shipping activities, and they cannot be disregarded, whatever their nature, location or reduced consequences. Therefore, it is crucial to learn from all such events in order to improve safety measures and prevent the same kind of accident from happening again.

This section outlines the EU's approach to safety investigation, describing its founding pillars. It also indicates the main accident trends of EU interest by category of ship and, where possible, puts forward safety indicators.

The main purpose of accident investigation is to improve maritime safety and prevent pollution by ships to reduce the risk of future marine casualties, by:

- understanding why marine casualties and incidents occur;
- preventing or lessening the seriousness of marine casualties or marine incidents in the future; and
- developing lessons learnt after accidents at sea.

To support Member States in these tasks, EMSA has established a new operational service consisting of the provision of underwater surveys via remotely operated vehicles (ROVs) supporting safety investigations.

5.3.2 Regulatory framework

At the international level, the IMO adopted the Casualty Investigation Code in 2008 by means of Resolution MSC.255(84) ([141]), and made it mandatory. This code put forward standards and recommended practices for a safety investigation into a marine casualty or marine incident.

At the EU level, the AI Directive establishes the fundamental principles governing the investigation of accidents in the maritime transport sector. It aims to facilitate the expeditious holding of safety investigations and the proper analysis of marine casualties and incidents to determine their causes, ensuring the timely and accurate reporting of safety investigations and proposals for remedial action.

The AI Directive lays down obligations regarding the organisation, conduct and enforcement of accident investigation by the Member States, thereby harmonising safety investigations at the EU level. It also establishes an EU reporting framework and data analysis platform. The directive was recently reviewed, and the amended version was published at the end of 2024. One of the main modifications is the introduction of a new requirement to report accidents involving fatalities and loss of fishing vessels below 15 metres in length and, having conducted a preliminary assessment, to decide whether an investigation should be carried out to ascertain whether there are lessons to be learnt.

The scope includes casualties that:

- involve ships flying a flag of one of the EU Member States;
- occur within a Member State's territorial sea and internal waters; or
- involve other substantial interests of the Member States, regardless of the seriousness of the accident.

There are other pieces of legislation dealing with accident investigation, which are summarised in Table 50.

141 Resolution MSC.255(84) (adopted on 16 May 2008), Adoption of the Code of the International Standards and Recommended Practices for a Safety Investigation into a Marine Casualty or Marine Incident (Casualty Investigation Code), https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/MSCResolutions/MSC.255(84).pdf.

Table 50: Legislation on accident investigation.

	Level	Instrument	What it regulates
Legislation	International	UNCLOS Article 94 (7)	Provides the duties of the flag state. o Inquiry into marine casualties or incidents on the high seas. o Cooperation between states.
Legislation	International	MARPOL Article 8, 12	Incidents involving harmful substances: o reporting of incidents. Casualties involving ships: o casualty investigation.
Legislation	International	MLC Regulation 4.3	Seafarer Health and Safety Protection and Accident Prevention.
Legislation	International	SOLAS	Special measures to enhance maritime safety. o Chapter I, R21, casualty investigations. o Chapter XI-1, R6, additional requirements for the investigation of marine casualties and incidents.
Legislation	International	International Convention on Load Lines	Article 23, casualty investigation.
Legislation	International	MSC.225(84)	International Standards and Recommended Practices for a Safety Investigation into a Marine Casualty or Marine Incident (Casualty Investigation Code).
Legislation	International	Resolution A.1075(28)	Guidelines to assist investigators in the implementation of the Casualty Investigation Code.
Legislation	International	Resolution A.1070(28)	IMO Instruments Implementation Code. Enhances global maritime safety and protection of the marine environment and assists states in the implementation of IMO instruments.
Legislation	International	Resolution LEG3(91)	Guidelines on fair treatment of seafarers in the event of a maritime accident.
Legislation	EU	Directive 2009/18/EC	Fundamental principles governing the investigation of accidents in the maritime transport sector in EU.
Legislation	EU	Commission Regulation (EU) No 1286/2011	Adopts a common methodology for investigating marine casualties and incidents developed pursuant to Article 5(4) of Directive 2009/18/EC.
Legislation	EU	Commission Implementing Regulation (EU) No 651/2011	Adopts the rules of procedure of the PCF established by Member States in cooperation with the Commission pursuant to Article 10 of Directive 2009/18/EC.

5.3.3 Accident investigation at work

5.3.3.1 Main principles

Safety investigations are conducted with the sole objective of preventing marine casualties and marine incidents in the future. In no circumstances are they deemed to determine liability or apportion blame.

The AI Directive establishes that Member States shall ensure that safety investigations are conducted under the responsibility of an impartial permanent investigative body, or AIB ([142]).

The directive classifies accidents according to the severity of their consequences. All very serious ([143]) accidents must be investigated, and in the case of serious ([144]) accidents, a preliminary assessment must be conducted to decide whether a safety investigation needs to be undertaken. The AI Directive also considers marine casualties other than very serious and serious accidents and marine incidents ([145]). The common methodology for investigating marine casualties and incidents (Commission Regulation (EU) No 1286/2011) provides elements ensuring a harmonised approach when conducting preliminary assessments. It also provides information about the various steps of a safety investigation, such as evidence to be collected, analysis of the information gathered and issuance of the investigation report.

Data on marine casualties and incidents are stored and analysed within EMCIP, presented further in this section.

The key principles leading safety investigation are summarised in Figure 133.

Figure 133: Key principles ruling an accident investigation.

Source: EMSA services.

142 Twenty-seven AIBs and two focal points were established following the implementation of the AI Directive. The contact details of these authorities can be found at https://portal.emsa.europa.eu/emcip-public/#/organizations. Landlocked Member States that have neither ships nor vessels flying their flag can identify independent focal points to cooperate in safety investigations.

143 Accidents involving a ship's total loss, or death, or severe damage to the environment.

144 Serious occurrences involve a fire, explosion, collision, grounding, contact, heavy weather damage, ice damage, hull cracking or suspected hull defect. This category also includes events resulting in immobilisation of main engines; extensive accommodation damage; severe structural damage, such as penetration of the hull under water, rendering the ship unfit to proceed; pollution (regardless of quantity); or a breakdown necessitating towage or shore assistance.

145 A marine incident means an event or sequence of events, other than a marine casualty, that has occurred directly in connection with the operations of a ship and that has endangered – or, if not corrected, would endanger – the safety of the ship, its occupants or any other person or the environment.

5.3.3.2 Phases of accident investigation

A typical investigation process generally includes the phases and outcome shown in Figure 134.

Figure 134: The marine safety investigation process.

Notification	When the AIB is notified of a marine casualty or incident, an assessment has to be conducted to decide whether or not to investigate. AIB are provided with adequate resources in terms of qualified investigators and means ensuring the operational readiness when the accident occurs.
Gather evidence	Once the investigation is launched, gathering expeditiously evidence, including witness interviews, is crucial to understand the circumstances of the occurrence and the sequence of the events.
Analyse evidence	Evidence has to be properly analysed to identify the factors that led to the marine casualty or incident. The focus is on understanding the reason why an unsafe action or condition leads to the casualty and the context, physical and organisational, in which the casualty or incident occurred.
Draw conclusions	Conclusions identify the safety issues and the missing or inadequate defences (material, functional, symbolic or procedural) for which safety actions should be developed to prevent marine casualties. They can also highligh the different perspectives of the various actors involved explaining why their behaviour made sense in a given point of time and space.
Determine remedial actions	Where appropriate, the AIB could issue safety recommendations. These are proposals for remedial actions to prevent future marine casualties and incidents, to the parties that are best placed to implement them. In this context, an AIB might also consider the possible safety actions directly taken by a concerned entity (e.g. shipowner etc.) to improve safety in the aftermath of an accident. Safety recommendations should be taken into account by the addressees and adequately followed up by the issuing Member State.
Report	The investigation shall result in a safety report providing, among other things, the circumstances of the event, the analysis of contributing factors and conclusions. The safety report has to be published in order to spread the safety lessons to the maritime community. Moreover, data on marine casualties and incidents shall be stored in EMCIP and the IMO GISIS databases, thus supporting their analysis.

Source: EMSA services.

Some of the above steps may be conducted by the AIBs of other substantially interested states; therefore, cooperation between the AIBs is crucial to ensuring an investigation is conducted effectively.

5.3.3.3 Permanent cooperation framework for the investigation of accidents in the maritime transport sector

Commission Implementing Regulation (EU) No 651/2011 ([146]) established the PCF for the investigation of accidents in the maritime transport sector to provide AIBs with an operational platform to cooperate and attain the objectives of the AI Directive. The PCF also enables EMSA to facilitate cooperation and operational support in accident investigation, as required by the agency's founding regulation.

The tasks of the PCF are to:

- enable AIBs to share equipment and facilities supporting safety investigations;
- provide technical cooperation and expertise;
- share information on casualty-data analysis;
- share information on safety recommendations at the EU level;
- prepare principles for the follow-up of safety recommendations;
- prepare principles for adapting the investigative methods to the technical and scientific progress;
- manage early alerts;
- establish confidentiality rules for the sharing of investigation data;
- organise training activities for investigators ([147]);
- develop the EMCIP database schema and notification method, together with the Commission.

The PCF, for which EMSA provides the Secretariat, establishes a work programme setting priorities and targets and meets at least once per year. When there is substantial interest, the Commission may participate in the meetings or other PCF activities.

5.3.3.4 Training and qualification of investigators for marine safety investigations in the EU

Investigations of marine casualties and incidents by administrations should be carried out by appointed investigators ([148]).

At the EU level, Directive 2009/18/EC establishing the fundamental principles governing the investigation of accidents in the maritime transport sector mentions the necessity of suitably qualified investigators with a working knowledge of, and practical experience in, those subject areas pertaining to their normal investigative duties ([149]). However, the directive and its complementing instruments do not require specific experience, qualifications or training on the part of the investigators, such as those required of PSCOs under Directive 2009/16/EC.

At the time of the 2012–2017 cycle of visits,EMSA found that most of the investigative bodies provided external and internal training for their investigators in some form, but 60 % of the Member States had no formal standards, no training achievement structures and no qualification schemes (including the regular assessment of staff knowledge). In most cases, post-recruitment training was based upon on-the-job and shadowing/tutoring activities.

To support the national capacities of the EU Member States, EMSA has provided training to their marine safety investigators since 2013. In the 2019–2023 period, the agency provided eight core skills courses for accident investigators, seven advanced courses for accident investigators and four courses on voyage data recorders and the Electronic Chart Display and Information System, for a total of 180 participants trained.

In 2024, EMSA launched a common core curriculum for marine safety investigators, a more comprehensive and thorough learning service that is rooted in well-established pedagogical principles of adult learning and professional development. This curriculum is designed to develop the necessary individual competencies for carrying out duties associated with the conduct of marine safety investigations by flag states. It aims to provide the knowledge, skills and attitudes required to conduct the relevant investigations professionally, efficiently and effectively. The curriculum has been completed by 18 maritime safety investigators.

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146 Commission Implementing Regulation (EU) No 651/2011 of 5 July 2011 adopting the rules of procedure of the permanent cooperation framework established by Member States in cooperation with the Commission pursuant to Article 10 of Directive 2009/18/EC of the European Parliament and of the Council (OJ L 177, 6.7.2011, p. 18, ELI: http://data.europa.eu/eli/reg_impl/2011/651/oj).

147 In this context, EMSA prepared specific training courses on accident investigation available to the national authorities, including the 'Core skill courses' for beginners, the 'Advanced course' for experienced investigators and the brand-new course on 'VDR and electronic evidence collection'.

148 SOLAS Regulation XI-1.6, IMO Resolution MSC.255(84).

149 Article 8 of Directive 2009/18/EC.

5.3.4 European Marine Casualty Information Platform

Operational since June 2011, EMCIP is a database and a data distribution system operated by EMSA, the Commission and the EU–EEA Member States that aims to deliver a range of potential benefits at the national and European levels by:

- improving the information background about marine casualties and incidents;
- widening and deepening the analysis of the results of casualty investigations;
- providing at-a-glance information, thus enabling general risk identification and profiling; and
- sharing lessons learnt and safety issues detected in the course of safety investigations.

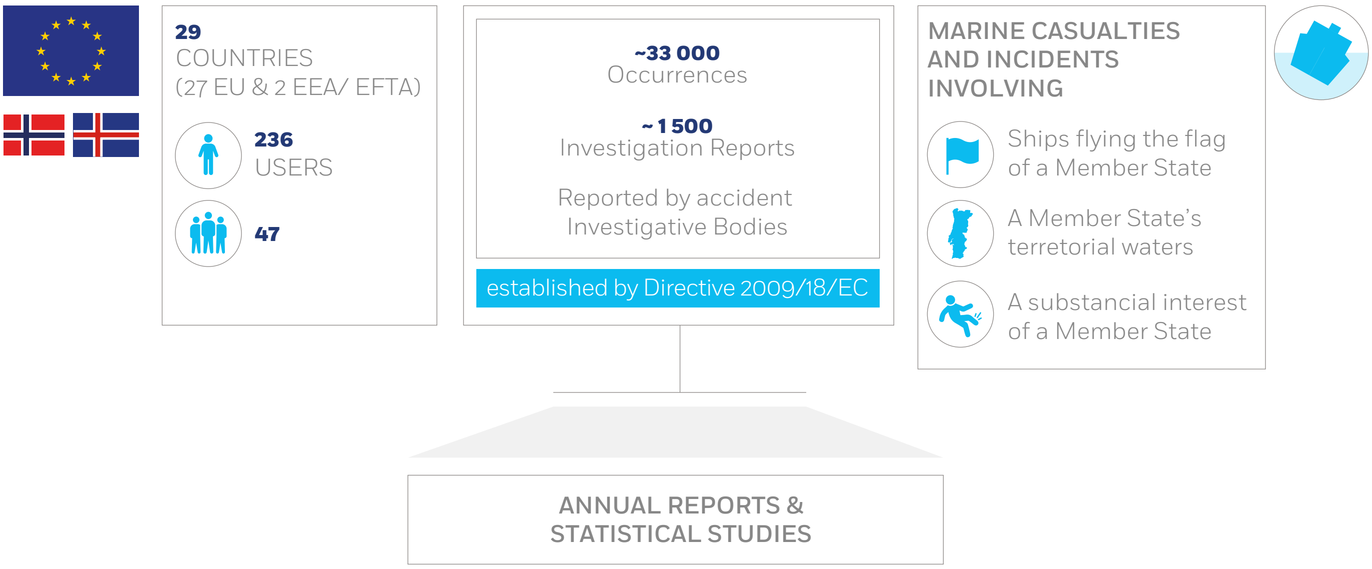
EMCIP also offers a public portal allowing the public and academia to access the dataset agreed by the PCF and statistics on marine casualties and incidents, thus supporting the dissemination of data to wider stakeholders.

EMCIP provides the means to store data and information relating to marine casualties and incidents involving all types of ships, including occupational accidents related to ship operations. It also enables the production of statistics and analysis of the technical, human, environmental and organisational factors involved in accidents at sea.

EMCIP is also connected to the IMO's GISIS, thereby supporting the dissemination of investigation data reported by EU Member States at the global level without any duplication of effort. It is used to reduce the administrative burden of the Member States when complying with their reporting obligations, EMSA having signed agreements relating to data provision with Eurostat and HELCOM.

Information about marine casualties and incidents is also accessible to the public ([150]), such as the investigation reports published by the AIBs and anonymised data about casualties and incidents notified by Member State authorities. **In 2024, the EMCIP public portal was given a new interface with enhanced functionalities.**

Figure 135: EMCIP – occurrences recorded from June 2011 to December 2023.

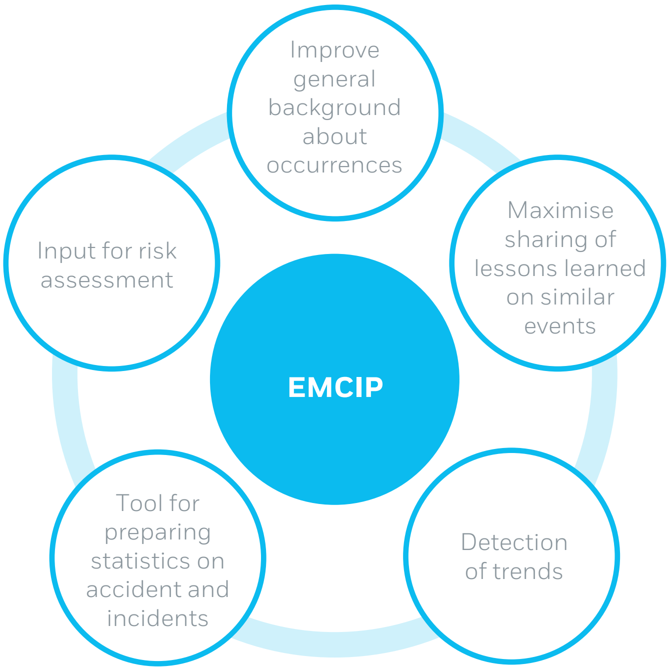


Source: EMSA services.

150 Public access to EMCIP data: https://portal.emsa.europa.eu/emcip-public/#/dashboard.

EMCIP is a powerful tool for sharing knowledge about marine casualties and incidents, given its wide scope, comprehensive reporting scheme and data-sharing policy agreed by the Member States. EMSA uses EMCIP data extensively for the publications described hereafter. Moreover, these data are used in the context of safety projects relating to a wide range of topics (e.g. fire safety, manoeuvrability, passenger ship safety) and for coordinated studies, and also to support the Commission in the revision of safety legislation at the EU level.

Figure 136: EMCIP added value.



Source: EMSA services.

5.3.4.1 Annual overview of marine casualties and incidents

In accordance with EMSA's founding regulation, since 2014 the agency has published an annual overview of marine casualties and incidents, based on EMCIP data ([151]). These statistics refer to accidents and incidents falling within the scope of the AI Directive, i.e. involving ships flying a flag of one of the EU Member States, occurring within the territorial seas or internal waters of the EU Member States or involving other substantial interests of EU Member States.

The PDF version of the annual overview includes advanced functions, such as the downloading of consolidated figures from charts and tables and a read-aloud capability, increasing accessibility to visually impaired people.

5.3.4.2 European Marine Casualty Information Platform safety analysis

EMSA has developed a methodology for analysing the findings of the safety investigations reported in EMCIP to detect potential safety issues. This methodology assesses and identifies specific core attributes, such as the accident events, the factors that contributed to the occurrences, the safety recommendations issued and the safety actions taken by the parties concerned.

Four analyses have been published so far ([152]). Three of them focused on accidents involving a specific vessel type (fishing vessels, ro-ro passenger ships and container ships), while an HA encompassing navigation accidents concerning passenger ships, cargo vessels and service ships was published in 2022.

Safety recommendations and actions taken

Safety recommendations concentrate the main lessons learnt from an accident investigation. They are proposals from the accident investigation authority that are intended to prevent accidents. Each recommendation is addressed to a relevant party involved in maritime safety, such as authorities, shipowners and ROs.

On the other hand, actions taken are those already implemented by one of the relevant stakeholders during the accident investigation process, before the publication of the report, with the intention of preventing accidents or incidents.

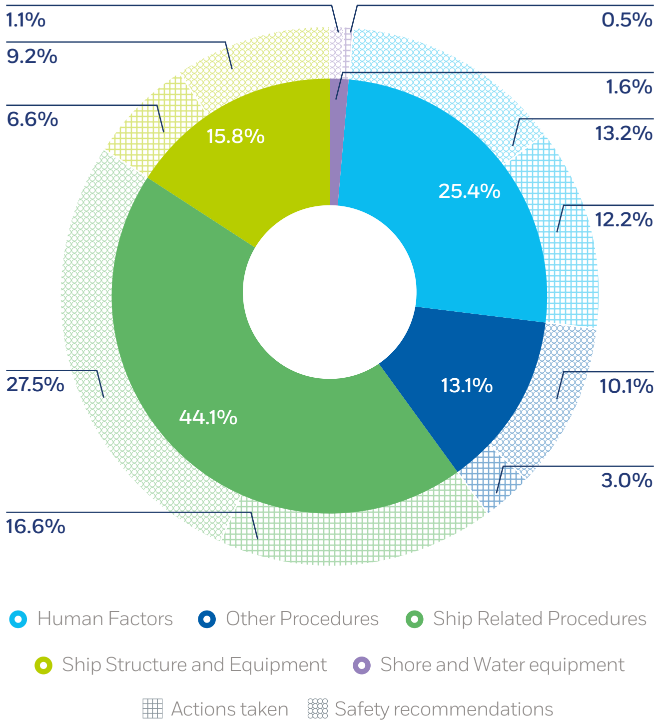
These two terms are further categorised into the human factor, ship structure and equipment, shore and water equipment, ship-related procedures and other procedures. According to the Annual Overviews of Marine Casualties and Incidents, , more than 75 % of occurrences were related to the human element (with human behaviour being a contributing factor or human action causing the events). However, associated safety recommendations do not necessarily need to be addressed through the human factor category, as they could be related, for example, to deficiencies in the safety management procedures on board.

Figure 137 shows the distribution of safety recommendations and actions taken by category.

151 http://www.emsa.europa.eu/accident-investigation-publications/annual-overview.html.

152 http://www.emsa.europa.eu/accident-investigation-publications/safety-analysis.html.

Figure 137: Safety recommendations and actions taken by focus area in the 2019–2023 period.



Source: EMCIP (EMSA, n.d.).

Almost half (44.1 %) of the remedial actions targeted ship-related procedures, with the second-largest category being human factors (25.4 %). The first refers to actions linked with operational procedures, the dissemination of information, compliance, maintenance, the carriage of cargo, maintenance, etc. The latter refer to actions in areas such as training, skills and experience, the working environment, medical aspects, company and organisational aspects, management, etc.

5.3.5 Remotely operated vehicle service

Gathering videos and pictures of shipwrecks may significantly improve the quality of safety investigations and, ultimately, enhance ship safety. This additional evidence can, for example, help to assess hull damage and confirm or disprove hypotheses on accident causes or contributing factors.

ROVs play a crucial role in conducting surveys, repairs and monitoring in hazardous or hard-to-reach environments, minimising the need for a human presence in dangerous situations. This reduces the risk of injury to personnel while ensuring critical tasks are completed efficiently and safely. Their ability to operate underwater or in extreme conditions makes them particularly valuable in maritime and offshore safety operations. At the request of the PCF, in January 2023 EMSA started a new operational service consisting of the provision of underwater surveys via ROVs supporting safety investigations.

The underwater survey services are delivered via observation-class ROVs. If needed, EMSA can provide the support vessel necessary to conduct the operation.

Member States may request ROV services for both real operations and exercises, for deployment within the sea areas surrounding the EU–EEA Member States and beyond.

Observation-class ROVs are light (less than 20 kg), highly deployable underwater platforms that, although compact, can embed various payloads, including sonar, HD cameras, grabbers, measuring lasers and water samplers (e.g. to collect polluted water to be analysed). The estimated maximum operational depth of these machines is around 150 metres; however, the possibility of operating at greater depth can be discussed with the contractor on an ad hoc basis.

EMSA has successfully deployed this service in more than 10 underwater operations, with very positive feedback from the requesting authorities. Although the service is aimed at the needs of AIBs, it is also offered to national authorities in the context of coast guard functions, for instance for marine safety and counter-pollution operations. It is considered that, in view of users' needs, this service might be expanded. For this reason, in March 2025, EMSA launched a new tender procedure to contract subsea services through multipurpose inspection/intervention-class ROVs, observation-class ROVs, sonar and other tools to cope with a wider variety of underwater interventions.

Image 8: EMSA ROV.

Image 9: EMSA ROV underwater survey picture.

Source: EMSA services.

5.4 Maritime autonomous surface ships

5.4.1 Introduction

The shipping industry continues to move towards increased automation. Recent developments include trials in controlled environments, commercial voyages in national waters and even international voyages under bilateral agreements. Progress has also been made in establishing common principles for designing autonomous ship systems, as reflected in the non-mandatory IMO Maritime Autonomous Surface Ships (MASS) Code.

The term MASS is commonly used to describe vessels with higher degrees of automation. The IMO defines MASS as ships that, to varying extents, can operate independently of human intervention or control, relying increasingly on automation.

As life at sea becomes less attractive to younger generations, highly automated systems are expected to reshape the maritime workforce – shifting roles from on-board operations to onshore supervision and from manual tasks to monitoring automated processes. Beyond these societal changes, many expect that human actions contributing to maritime accidents can be minimised.

While it would be irrational to ignore the potential of technological advancement in the field of automation to improve safety, it must be kept in mind that increased automation will neither eradicate accidents nor remove the need for human supervision, at least in the initial decades of its implementation.

The potential benefits of MASS extend beyond safety, with possible improvements in environmental performance and seafarers' working conditions. These advantages, along with a potential reduction in operating costs, are driving commercial interest in autonomous shipping. However, the actual value of the technology remains to be assessed in terms of practical use and profitability.

5.4.2 Safety challenges

The main safety challenges associated with autonomous ships, excluding those relating to regulatory and liability, have been identified in various research papers (e.g. Dreyer et al., 2019) and can be subdivided into the following categories.

Technological challenges

Technological	Hardware	Sensors
		Communication
		Fire safety
		Mooring
		Etc.
	Software	Decision systems
		Software errors
		Cybersecurity
		MaintenceEtc.

The most controversial technological concerns relate to the software side, particularly to the decision system, which includes the ability of MASS to avoid collisions with other ships while complying with COLREG and their ability to react to and avoid unfavourable weather conditions or other potentially dangerous or unpredictable situations at sea. In today's shipping landscape, reacting to such situations includes following procedural guidelines to some extent, but also depends upon the critical decision-making of the crew.

In addition, cybersecurity is a growing challenge, and its relevance is elevated in the case of systems with a degree of autonomy that rely heavily on IT while making use of internet communication systems and networking technologies based on satellite or terrestrial communication systems.

The human factor

Human factor	Training	
	Effect of technology on human operator	
	Human-centered system	Migration of workplace
		Presentation of data

The two main challenges are the following:

- the change of paradigm in the training of all people involved in the design, construction and operation of ships, from seafarers and shore-based operators to naval architects, technicians and engineers;
- the impact the high level of reliability thought to be achieved when deploying these systems has on the performance of the operator, as overconfidence in the system often results in a lack of vigilance.

Procedural challenges

Procedural	Undesirable events	Anticipated
		Unanticipated
	Standard operations	Navigation
		Maintence
		Cargo care
		Risk assessment
		Safety controls
		Absence of regulations
		Inspection and surveys

- Dealing with unanticipated undesirable events, corrective maintenance at sea and cargo management on board for cargo that requires maintenance or monitoring
- As mentioned previously, societal consensus and acceptance is also a challenge for this kind of technology.

Research needs

In 2020, the main research institutes of Norway and Singapore, two of the states that are most active in this field, prepared a roadmap identifying the most important research challenges in the journey towards smart and autonomous ships and ports.

Building on this roadmap and the results of the EU-funded project Autoship, an updated roadmap is currently proposed based on analysis of the political, economic, societal, technological, legal and environmental elements necessary to realise large-scale intercontinental autonomous maritime logistics (Nordahl et al., 2023). At the technological level, the standardisation of the autonomous ship–ROC interface is highlighted as a key enabler for improving the business case for investment in MASS.

For the 2025–2030 period, the current roadmap envisages the introduction of the first periodically unattended operations for short-sea shipping, i.e. the ship steering itself autonomously for extended periods but with crews on board to handle more complex situations. **In the next five years, the replacement of the on-board crew for operations in remote-control centres is expected to remain a challenge for short-sea shipping, mainly due to legislative constraints at the regional and international levels (Figure 138).**

Figure 138: Factors constraining MASS development steps.

	2025	2030	2035	2040	2045
Regulation	Using existing legislation with special permits	New national regulations allowing operation in national waters and IWW. Voluntary IMO guidelines	EU legislation for IWW and possibly SSS. Mandatory IMO goal based standards. Performance standards emerging (typically by IMO).	IWW EU legislation FA	Updates to international regulations to enable interactions MASS and conventional ships (COLREG).
Standards	No special standard required	Improved process standards for lower cost development. Physical interface standards for IWW infrastructure are emerging	RCC interoperability, equipment test and interoperability, standards are emerging.	Port call physical interface standards are emerging.	Conventional-MASS communication standard are emerging.
Business models	Unclear what business models are needed for MASS related services	Business models are appearing for shuttles and IWW, but depend on financial support to be sustainable	Some business models are becoming self-sustainable	Business models are mostly self-sustainable	Business models are self sustainable
Economy	Lack of infrastructure and port services, and complicated approval. high dependency to public financing benefits. threat to job market high. Little knowledge on societal benefits. Trust in technology is low.	Some reduction in costs: some standards and services appear Dependency to public funding is still high.	Costs reduction: more standards, technology maturing, more ships sharing services. Reduced dependency to public funding	Costs reduction: more standards, technology maturing, more ships sharing services. Dependency to public funding low	No dependency to public funding
Societal acceptance	Perceived threat to job market high. Little knowledge on societal benefits. Trust in technology is low.	Societal benefits common knowledge, still perceived as a threat to job market by many. Trust is somewhat improved	Understanding for need to mitigate crew shortage challenges and benefits to society. Trust established		
Policy actions	Allowing national tests by exemption. Drive regulatory development. Supporting R&D and first movers. Public tenders.	Drive regulation and standardisation. Supporting innovation (high TRL), and first movers. “Polluter pay”: External costs as taxes.	Drive regulations and standardisation. Supporting innovation, first movers, and infrastructure. “Polluter pay”.	Drive regulations and standardisation (COL REG). Supporting innovation and infrastructure	Continued support regulations and standardisation.

Source: Nordahl et al. (2023).

5.4.3 Regulatory framework

The development of the regulatory framework poses at least as many challenges as the technological one.

The IMO's MSC started the discussion around automated ships as early as 1964 ([153]). However, it was only recently that the IMO embarked on the process of addressing MASS holistically, carrying out regulatory scoping exercises on the different areas, including safety, to find gaps and identify the best way to regulate them. The safety work on this exercise undertaken by the MSC concluded that there was a need to develop a non-mandatory goal-based code for MASS that would serve as the basis for the future development of a mandatory instrument regulating MASS operations in coordination between several IMO committees.

The MASS Code focuses on system design principles for autonomous and remotely controlled ships and functions, and is being developed at a fast pace, despite the fact that there are questions remaining around the high-priority issues identified at the time of the regulatory scoping exercises, i.e.:

- the definition of the role of the shipmaster and how the various responsibilities and obligations placed upon the master are applied to MASS;
- the functional and operational requirements of any remote-control centre and whether a remote operator should be considered a seafarer.

The non-mandatory MASS Code is under development. It is intended to supplement applicable regulations and to apply to cargo ships, excluding HSC. The plan of the committee is to consider the feasibility of application to passenger ships only at a later stage. Following the adoption of the non-mandatory code, an experience-building phase will provide critical insights, supporting the efforts to a develop the mandatory MASS Code.

The draft code considers risk assessment pivotal for design approval, and requires it at a high level for both the ship's concept of operations and individual functions that are to be automated.

The code also highlights the need for an oversight mechanism for MASS and associated ROCs to complement the ISM Code and SMSs. In addition, the IMO Sub-Committee on Human Element, Training and Watchkeeping should develop detailed competency requirements based on the non-mandatory MASS Code.

The expected date of entry into force of a mandatory MASS Code is 1 January 2032.

The preexisting high-level IMO 'Interim guidelines for MASS trials' remain applicable to trials with new designs, indicating that:

> *Trials should address the risks to safety, security and protection of the environment. The risks associated with the trials should be appropriately identified and measures to reduce the risks to as low as reasonably practicable and acceptable should be put in place* (IMO, 2019b).

At the EU level, the EU operational guidelines for MASS trials (European Commission, 2020), published in December 2020, provide for methods for designating test areas or a ship safety zone when conducting trials of MASS-related systems and infrastructure. These guidelines also address the risks and vulnerabilities inside and outside the determined area/zone by ensuring the safety of navigation and consider environmental and third-party interests. In addition, they cover any monitoring and communication issues from the land side, including how, in the future, VTSs may have to interact with MASS in all conceivable situations, taking into consideration and complementing, as far as possible, the IMO's interim guidelines.

Building on the existing guidelines – and looking to facilitate international testing of MASS, including non-SOLAS ships, in the region of the North Sea – Belgium, Denmark, the Netherlands and the United Kingdom have had an MoU in place since 2023 to ensure that such operations can be conducted safely under the different national frameworks that cover their territorial waters.

5.4.2 Risk-Based Assessment Tool

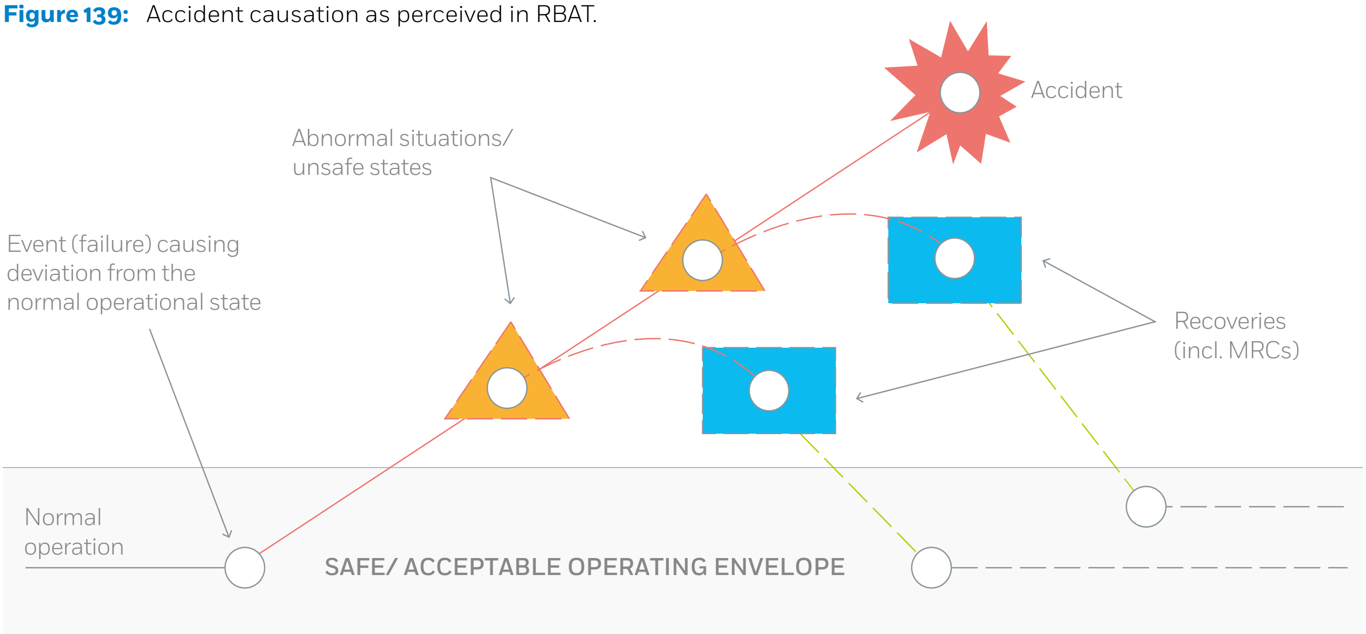
Back in 2020, in the absence of specific rules and standards for autonomous ship technologies, safety instead had to be ensured through alternative design. For that reason, and for harmonisation of the safety level in the evaluation of these innovative solutions, EMSA contracted a study, in August 2020, for the development of a Risk-Based Assessment Tool (RBAT). Its purpose was to facilitate the work of the maritime administrations in the analysis and approval of preliminary MASS designs. While the regulatory framework evolved as explained above, RBAT became even more relevant as a risk-assessment methodology.

RBAT was developed to become a methodology for preliminary risk analysis, allowing for the identification of the concept's most critical aspects in terms of safety, to which more resources are assigned in maturing the

153 MSC VIII/11, 9 March 1964.

operational solutions and the vessel's or infrastructure's design. A specific risk model was developed based on the accident causation model depicted in Figure 139. Accidents are depicted as a combination of events (e.g. failures) that cause the system to deviate from a normal and safe operational state into an abnormal and unsafe state. Unless recovery actions are in place and are successful in bringing the system back into a safe and acceptable operating envelope, the situation may escalate to an accident.

Figure 139: Accident causation as perceived in RBAT.



Source: EMSA/DNV (2023).

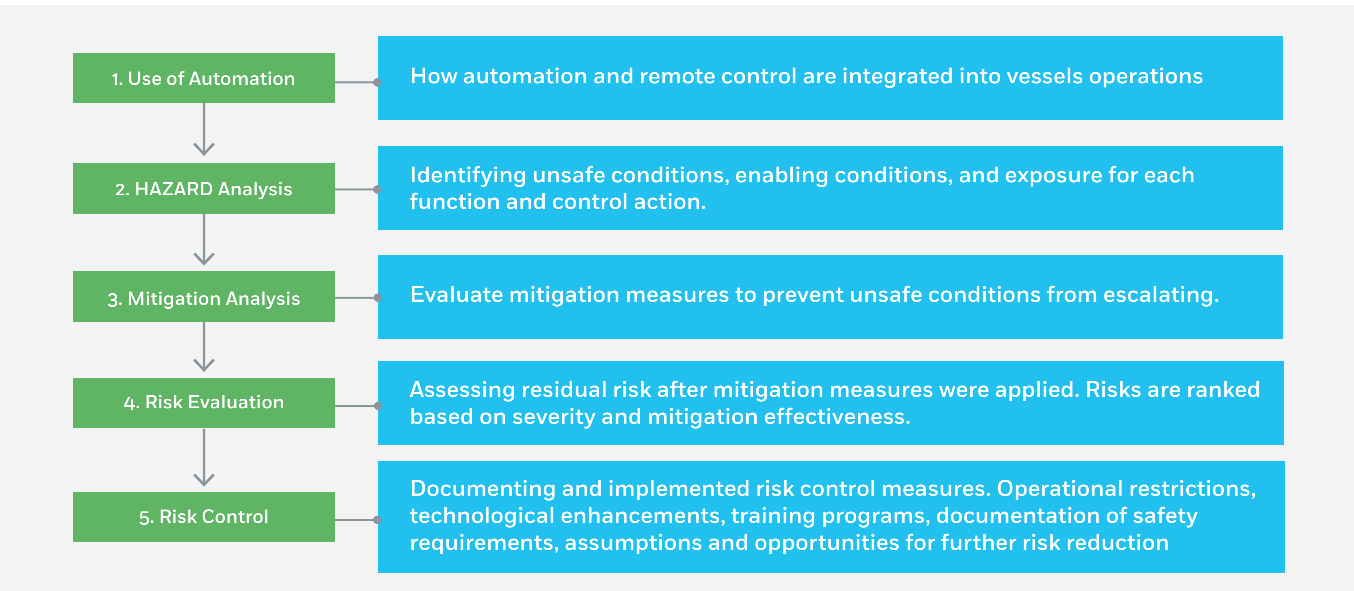
Considering the complex nature of software-related failures and the associated uncertainty relating to the likelihood of such failures, RBAT is directed towards event mitigation instead of risk calculation through failure probability.

In RBAT the risk is thus evaluated as a function of the consequences of the unwanted event and the mitigating measures implemented to bring the system to a safe state.

The severity level of the consequences is combined with the level of mitigation effectiveness in the RBAT risk matrix.

A key part of RBAT is the proposed means for the evaluation of whether specific mitigation layers can be considered effective for specific types of failures in a given operational context.

Figure 140: RBAT framework and tool blocks.



Source: EMSA/DNV (2023).

The methodology is implemented in a piece of software that is available to authenticated users of the EU maritime administrations and their stakeholders [154].

5.4.5 Commercial applications

The roadmap by the Autoship project, mentioned in Section 5.4.2, considers the possible applications of MASS split into the following four main groups of vessels or shipping segments.

- **Sheltered water shuttles** built for specific operations, with low operational complexity and sailing close to shore. Their operation concerns short routes with personnel going on board on a daily basis for maintenance, cargo handling and other operations. Three autonomous vessels within this segment that have already been built and delivered are the MV *Yara Birkeland* – a container feeder operated by the Norwegian company Kongsberg in collaboration with Yara – and the two ASKO [155] ferries MS *Marit* and MS *Therese*.

Image 10: MV Yara Birkeland.

Source: Knut Brevik Andersen, Wilhelmsen Ship Service. © Yara International ASA.

154 https://www.emsa.europa.eu/mass/rbat.html.

155 ASKO is Norway's largest grocery wholesaler.

- **Inland waterways** for operation within national and international inland waters. The *Zulu 4* owned by Blue Line Logistics NV set sail autonomously in Belgium in 2023 as a demonstrator of Autoship-developed technology. Another example is the *X-Barge* under development for Continental Shipping (CS) Logistics for operation in EU inland waters.

- **Short-sea shipping** in national and international waters (intra-EU) by more complex ships on longer voyages. The *ZULU MASS* is one example – a 200 TEU (twenty-foot equivalent unit) autonomous container ship currently under development for the Anglo Belgian Shipping Company and designed for possible operation within the English Channel. At least three more autonomous container ships are in the delivery pipeline for short-sea operation in the EU in the years to come: two 500 TEU hydrogen-powered, remotely controlled and autonomous-ready vessels planned to operate between Oslo and Rotterdam in a partnership between Samskip and Ocean Infinity; and one for the cargo owner Ekornes with a design similar to that of the ASKO ferries.

- **Deep-sea shipping** is the segment covering intercontinental voyages with a duration of one to several weeks. The roadmap considers it unlikely that there will be deep-sea vessels appearing before around 2050, with the main constraints until then being compliance with COLREG, maintenance and a lack of trust in the technology by investors and main stakeholders. Nevertheless, there are some commercial demonstrators outside the EU.

5.5 Alternative fuels and power technologies

This section summarises the various safety challenges arising from the unique characteristics of new fuels and their adoption for use in on-board energy converters. Aspects relating to sustainability, cost-effectiveness, availability or fuel-production pathways are beyond the scope of this report and can be found in the *European Maritime Transport Environmental Report 2021* (European Environment Agency et al., 2021).

Alternative fuels and energy options are presented here without assessment of their relative merits or eligibility. The focus is on their technological maturity, standardisation and regulatory development, and on the key safety challenges associated with their use on board ships.

The transition to alternative fuels and power sources is central to international efforts relating to the 'greening' of the maritime sector. The replacement of conventional fuels, such as heavy fuel oil and marine diesel oil, by new fuels, such as ammonia or methanol, has a substantial impact on the way ships are designed and operated, introducing new safety challenges. These challenges must be consistently and harmoniously addressed across the industry to maintain current safety standards and prevent an increase in accidents, particularly those with severe consequences for ships and crew.

In September 2023, Regulation (EU) 2023/1805 on the use of renewable and low-carbon fuels in maritime transport was published in the Official Journal ([156]). Starting on 1 January 2025, vessels over 5 000 GT calling at EU ports must report and gradually decrease the greenhouse gas (GHG) intensity of the energy used on board, targeting an 80 % reduction by 2050 compared to 2020 average levels. Additionally, passenger and container ships must meet zero-emission requirements at berth by connecting to an onshore power supply or using alternative zero-emission technology. In this regard, ports play a crucial role in this transition. They are essential for the safe and efficient storage, handling and bunkering of alternative fuels and electricity while also ensuring fuel safety, operational continuity and system resilience as the sector moves towards low-emission solutions.

The path to the fuel transition, now solidified by recent regulations, began over a decade ago.

156 Regulation (EU) 2023/1805 of the European Parliament and of the Council of 13 September 2023 on the use of renewable and low-carbon fuels in maritime transport, and amending Directive 2009/16/EC (OJ L 234, 22.9.2023, p. 48, ELI: http://data.europa.eu/eli/reg/2023/1805/oj).

Initially, the use of LNG as fuel generated great interest as an option to address the issue of air pollution, and has thereafter continued to grow based on the experience of the transport of LNG as cargo. Depending on its life cycle, LNG, e-LNG and bio-LNG can offer lower-carbon and carbon-neutral solutions for the energy transition. The adoption of LNG as fuel for propulsion required the adaptation and introduction of new technological solutions for fuel bunkering, storage, conditioning and multi/dual-fuel engines, among other things. While boil-off gas was already used for propulsion in LNG carriers, other ship types ranging from ro-pax to very large container carriers, cruise ships and small service vessels have successfully integrated LNG as an alternative fuel.

At the international level, in July 2023 the IMO adopted the 'IMO strategy on reduction of GHG emissions from ships'. More recently, the 83rd session of the IMO's Maritime Environment Protection Committee finalised and approved the draft legal text for the 'IMO net-zero framework', to be included as a new chapter in MARPOL Annex VI. The framework includes a set of midterm measures with a view to reducing GHG emissions from international shipping, considering the reduction targets set out in the IMO's GHG strategy. These measures introduce a goal-based marine fuel standard designed to gradually lower the GHG intensity of marine fuels and a pricing mechanism for maritime GHG emissions. At the same time, the organisation is undertaking regulatory developments to provide safety standards for the use as fuels of hydrogen, ammonia and other fuels with a low flashpoint. These may include a diversity of biofuels (e.g. Fischer-Tropsch diesel (FT-diesel), dimethyl ether (DME), hydrogenated vegetable oil (HVO) and fatty acid methyl ester (FAME)) and bio-alcohols (e.g. bio-methanol) that have shown their potential to replace conventional fuels without the need for substantial modifications to the engines and fuel supply systems.

As a baseline for the safety of LNG as fuel, the International Code of Safety for Ships Using Gases or Other Low-flashpoint Fuels (IGF Code) has been developed, approved and used. The code has been used to provide functional requirements to the several front-runner projects, designed, developed and launched into operation prior to any relevant regulatory development using new fuels such as methanol, ammonia and hydrogen. Collaborative development, classification societies and the acceleration of research and development are key building blocks in the design, certification/approval and safe use of alternative fuels and power technologies. As experience and knowledge builds up and consolidates through the energy transition in shipping, it is expected that design options, safety risk evaluation and certification processes will become increasingly streamlined and robust, which will also allow investment in new technologies to become increasingly less risky. The regulatory development ongoing at the IMO is an essential element to build trust in the industry. When approved, it will be able to rely on internationally accepted codes, albeit of a non-mandatory nature.

The energy transformation brings with it cross-sectoral challenges, but also synergies and common opportunities. Shipping is poised to benefit from technological advancements and experience gained across the broader economy.

Joining these efforts, EMSA has contracted a series of studies on alternative fuels safety. At the end of 2023, a study on the bunkering of biofuels was published (EMSA, Henriksen et al., 2023), and the final results of the twin studies on the safety of ammonia and hydrogen for use on board are expected at the end of 2025. The latter studies aim to complement the latest regulatory developments with a reliability analysis of systems and components in contact with these fuels.

The sections below will introduce the specific challenges to the maritime sector relating to the uptake of new fuels and energy systems. In general, these include the following.

- **Energy and power density.** Alternative fuels and power systems have, in general, a significantly lower energy density than and a different power density from conventional systems. Their adoption leads to the rethinking of some ship's spaces (e.g. for batteries and fuel cells) and to larger ships fulfilling the same operational needs with higher design arrangement footprints for fuel storage, machinery spaces and associated systems.

- **Safety.** Flashpoint, auto-ignition temperature, flammability range, explosivity and toxicity are key properties of fuels that may lead to hazardous events for the ship and for people on board when they are not properly handled. This leads to an immediate need for a conceptual redefinition of the conventional arrangements for on-board fuel systems, including bunkering, fuel storage, fuel preparation, distribution and energy conversion. Different fuels and power systems present different challenges; however, for gaseous and low-flashpoint fuel applications it is still possible to establish a general approach to risk mitigation that is based on the principles of prevention of release and exposure by strengthening detection systems and having a deep understanding of the failure mechanisms leading to possible releases (see Figure 141).

Figure 141: Safety layers – safety concept for gaseous and low-flashpoint fuel applications.

Prevention		Mitigation – first layer		Mitigation – second layer
Prevent release	First accidental event ***Loss of containment***	Second containment barrier	Second accidental event ***Ignition, exposure***	Fire detection
		Detection		Fire suppression/extinguishing
		Avoid ignitable atmosphere		Damage control and impact mitigation
		Prevent ignition		Survivability strategies
		Prevent exposure		Acute toxicity exposure response

Source: EMSA services.

- **Integration.** Ships are complex systems that include within their hull and superstructures various hotel, cargo and service spaces, often adjacent to machinery spaces and other service-purpose spaces. Design decision-making is often challenged by the need to optimise volume and area arrangements within the ship, maximising cargo or hotel areas with a view to increasing profitability. Alternative fuels and innovative power systems require integration into the entire ship design, and minimising safety risks often requires inventive and innovative approaches. Integration engineering is essential for optimising all energy systems on board and for enhancing the safety, reliability and survivability of ships using alternative fuels and power systems.

- **Operating profile.** Ships are designed and built according to a well-defined operating profile. This encompasses not only operational parameters, such as speed and autonomy, but also the area of operation.

The choice of alternative energy/power systems is directly affected by both angles of the operating profile. In that sense, both speed and autonomy play an important role in the definition of 'energy'- or 'power'-sensitive designs. The former are meant for endurance, while the latter are meant for speed or work. Figure 142 and Figure 143 show two examples of such designs, for an LNG-fuelled bulk carrier and a hybrid electric tug. In the bulk carrier the fuel tank is located aft above deck, and in the tug the battery groups are located below the main deck. In the first design, the need for a large amount of LNG fuel is directly related to the requirement for longer autonomy. In the second, the hybrid design decision relates to instantaneous high-power availability provided by the battery groups.

Figure 142: The CMA CGM Jacques Saade, an LNG-fueled containership.

Source: CMACGM.

Figure 143: Battery powered tug boat design of integrated power systems by Kongsberg Maritime AS.

Source: Kongsberg Maritime AS.

In addition, the area of operation is another aspect related to the operating profile that is highly relevant to the choice of the alternative energy/power. The availability of alternative fuels is not supported by worldwide production and distribution, and different fuels may be easier to obtain or bunker in specific locations. While this may not now present an issue with LNG, other alternative fuels face an uneven distribution of availability in different regions and areas of operation. Thus, it is important to take into consideration the area of operation when deciding on an alternative fuel for a specific application. Electrification is also an energy solution for which the choice of region / ports of operation can be quite relevant. The unavailability of sufficient onshore power supply and charging infrastructure may dictate the choice of a different energy system.

While the following sections will explore alternative fuels such as LNG, liquefied petroleum gas (LPG), biofuels, methanol, ammonia and hydrogen, along with technologies such as batteries and fuel cells, it is important to remark that, to achieve the GHG-reduction objectives, other technical solutions such as on-board carbon capture, wind-assisted propulsion systems and nuclear energy are being explored or revived. For all these solutions, the safety assessment is the key enabler of a rapid and accepted deployment.

5.5.1 Safety dimensions

The introduction of alternative fuels poses new safety risks, mostly relating to their distinct chemical properties. Therefore, it seems only logic that the development of safety standards for storage, transfer and use is first based on a deep knowledge of the fuels' properties and environmental behaviour.

The current risk management framework is designed to meet the demands of traditional fuels. The properties that characterise alternative fuel options and the need for larger quantities on board due to the abovementioned generally lower energy density of those fuels mean that the safety risks for crew, passengers and others can differ greatly from those posed by fossil fuels. Safety standards will be achieved through the risk-based development of relevant provisions to ensure that ships using alternative fuels are considered equivalent in terms of safety to conventionally fuelled ships. On board, more sophisticated risk mitigation measures are required, including specific equipment and safeguards alongside improved knowledge and skills for the design, manufacture, inspection, installation, commissioning, surveying, operation and maintenance of these systems.

Developing adequate criteria for safety is a prevailing challenge, multiplied by the number of different options available for fuelling/powering ships.

Establishing a safety equivalency with conventionally fuelled/powered ships is not an easy exercise, especially following a century of experience with oil-based power.

International standards are needed to ensure the harmonised development of the necessary safety equivalency criteria. Knowledge is still developing, but it is important to ensure that risk assessment techniques and alternative design-based approval are an international common ground to promote safety.

Various dimensions should be considered for the safe use of alternative fuels and new powering technologies. These dimensions together contribute to the mitigation of associated safety risks. In addition to the risks posed by the physical and chemical characteristics of these fuels – such as the flashpoint, flammability range, burning velocity, corrosivity and toxicity – safety hazards associated with integration and operation should be considered. The diagram in Figure 144 highlights six dimensions that play a part in ensuring the safe use of alternative fuels and power technologies.

Figure 144: Six dimensions of the safe use of alternative fuels and powering technologies.

Regulatory Development	Risk Assessment
The key pillars of the international regulatory framework for safe innovative energy and power options for shipping are 1) the IGF Code and 2) IMO Guidelines for the safe use of alternative fuels and power. These instruments aim to ensure an equivalent level of safety for ships using alternative solutions compared to conventional fuel-powered ships. They cover requirements for the arrangement, installation, control and monitoring of machinery, equipment and systems to minimize risks to the ship, its crew and the environment. However, as the industry gains practical experience with these emerging technologies, these guidelines shall be refined and expanded to reflect possible new challenges and insights.	Evaluating the safety risks associated to the use of innovative energy and powering options involves many challenges, including lack of data on probability and consequence of different failure scenarios. The use of risk assessment techniques for safety risk mitigation and identification of cost-effective risk control options is the standard approach to address new challenging sustainable energy and power solutions.

Technology Developement	Operations	Standardization / Human Element
Innovative technologies have progressed from research to pilot projects and beyond, driven by the need to achieve high Technology Readiness Levels (TRL). Key aspects of technology development for future shipping include systems integration, automation and control, life-cycle considerations, scalability and the human-technology interface, amongst others.	New fuels, safety concepts, power systems and interface characteristics, amongst others, introduce distinct processes, that create both operational constraints and opportunities. Factors such as survivability, reliability and limitations to the operational profile should all be carefully evaluated when operating ships equipped with innovative energy and powering technologies.	**Standardization:** Standardization is an essential pillar of safety. It facilitates certification processes and gives quality reassurance across different applications, allowing for scalability of innovative solutions. Standardization is also essential for iinterconnectivity and interoperability in bunkering and other **Human Element:** New fuels and innovative power systems are leading to a transformation in ship design, systems, operational aspects and introduction of technology- II critical elements. The role of and the impact on the maritime workforce is an essential element to address, with training and safety culture requiring particular attention.

Source: EMSA services.

In the following subsections, several technology options for alternative fuels and powering systems are presented, together with updates on their developing regulatory framework, highlighting for each the main challenges within the safety-related dimensions presented above.

An updated summary table with information relating to the safe use of these alternative fuels is included in Annex 4. All the information regarding the fleets provided in this section is sourced from the Alternative Fuels Insight platform (DNV, n.d.).

5.5.2 Liquefied natural gas

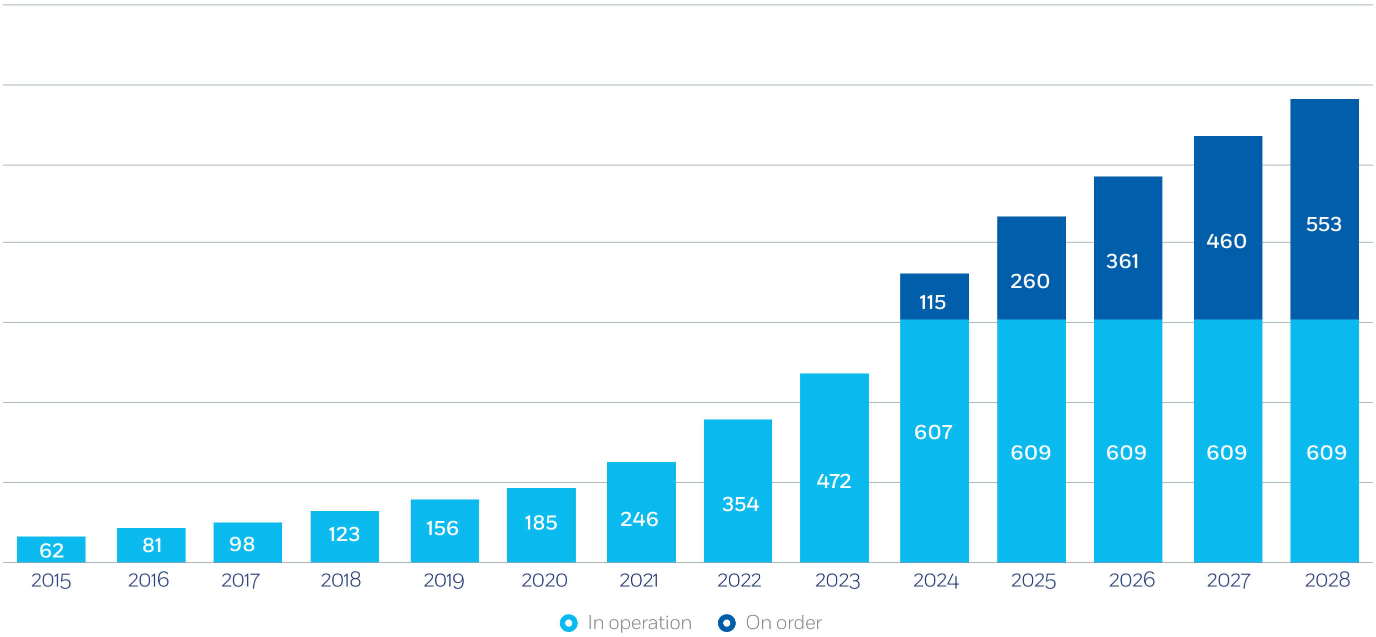
5.5.2.1 Introduction

In maritime transportation, the term ‘natural gas’ typically refers to LNG because compressed natural gas (CNG) has a lower energy density, making it less suitable for maritime transport. The main component of LNG is methane (CH_4), the hydrocarbon fuel with the lowest carbon content. With a boiling point of approximately −163 °C at 1 bar of absolute pressure, LNG must be stored in insulated tanks. Natural gas is lighter than air and, following a possible spillage, it vaporises.

5.5.2.2 Fleet

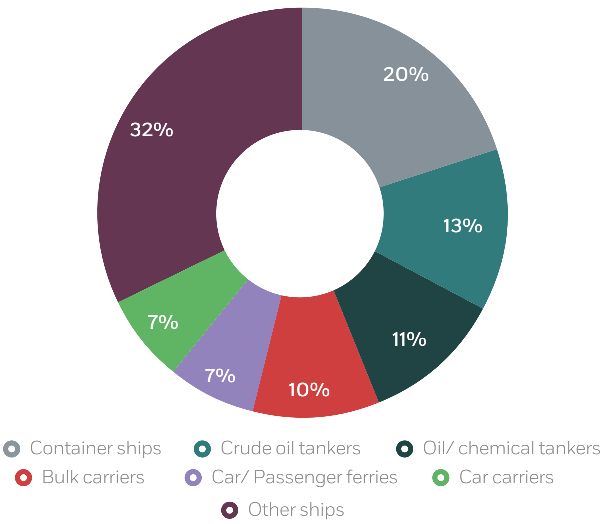
There has been a clear increase in the number of LNG-ready seagoing vessels (other than LNG carriers) in operation in the world in recent years – from 2019 to 2023 the number of ships in operation more than tripled. This trend should continue in the coming years, based on the status of the order books (Figure 145). In 2024, 20 % of the LNG-ready fleet (other than LNG carriers) in operation consisted of container ships. 34 % of these ships were operating mainly in Europe and 50 % globally.

Figure 145: Number of LNG-ready ships in operation – estimate based on the order books up to 2028.



Source: Alternative Fuels Insight. Extracted on 01-10-2024.

Figure 146: LNG-ready vessels in operation worldwide by ship type – fleet of 2024.



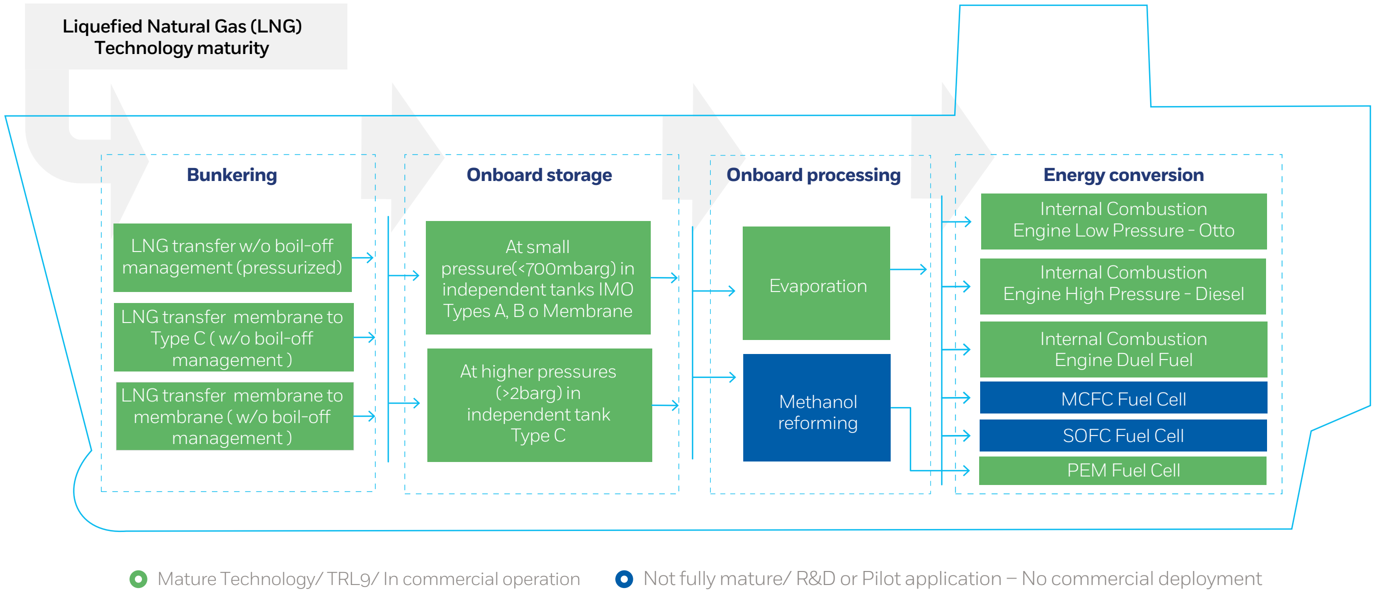
NB: The ship types used are those in the database.

Source: Alternative Fuels Insight. Extracted on 01-10-2024. Using the ship types in the database.

5.5.2.3 Technology

Exploring possibilities for gas methane reforming to produce hydrogen on board from the LNG storage to use in fuel cells or hydrogen ICEs.

Figure 147: Technology blocks for the safe use of LNG as fuel.



NB: MCFC: molten carbonate fuel cells; SOFC: solid oxide fuel cells; PEM: proton exchange membrane.
Source: EMSA services.

5.5.2.4 Safety

Flammability limit
4.5–16.5 %
Narrow
Low concentration

Cryogenic liquefied gas
Compressed at 250 bar
Asphyxiant

Boiling liquid expanding vapour explosion (BLEVE)
Rapid phase transition

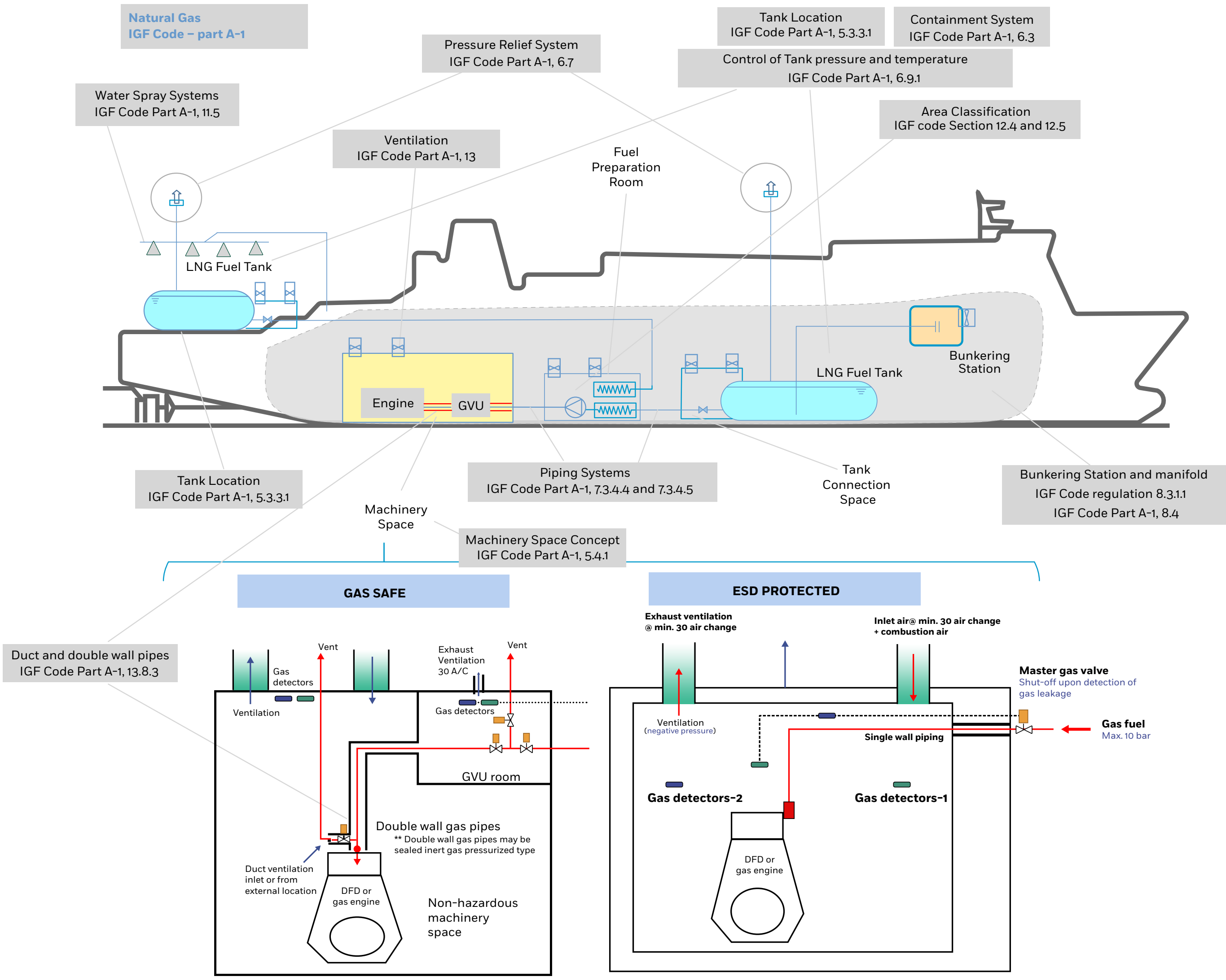
The safety concept for the use of LNG as fuel on board ships is based on the combination of strategies to ensure:

- no loss of containment – should a loss of containment occur, the focus is on mitigation of ignition risk and protection of steel structures to avoid brittle cracking leading to structural failure;
- no formation of explosive atmospheres (no natural gas–air mixtures) in piping or LNG fuel service equipment;
- the avoidance of pressure build-up at any point in the LNG fuel containment, preparation and distribution system.

5.5.2.5 Regulatory framework

Parts A-1, B-1 and C-1 of the IGF Code contain all relevant provisions specific to the use of natural gas as fuel. The diagram below includes a visual summary of the application of the different sections in the IGF Code relevant to LNG as fuel. The generic ship design presented is only meant to provide an overview of the different functional groups typically present in an LNG-fuelled ship design.

Figure 148: IGF Code – diagram with application of the different LNG-related Part A-1 provisions.



Source: EMSA services in interpretation of the IGF Code.

In addition to Part A of the IGF Code, relevant standards were published and updated between 2019 and 2023 that collectively contribute to the safe and sustainable deployment of LNG as fuel. Safety standards for LNG bunkering operations are defined in ISO/TS 18683:2021 ([157]) and ISO 20519:2021 ([158]), while technical requirements for LNG bunkering connectors are standardised by ISO 21593:2019 ([159]).

157 ISO/TS 18683:2021 – Guidelines for safety and risk assessment of LNG fuel bunkering operations.

158 ISO 20519:2021 – Ships and marine technology – Specification for bunkering of liquefied natural gas fuelled vessels.

159 ISO 21593:2019 – Ships and marine technology – Technical requirements for dry-disconnect/connect couplings for bunkering liquefied natural gas.

5.5.3 Hydrogen

5.5.3.1 Introduction

Hydrogen (H_2) is a colourless, odourless and non-toxic gas. For use on ships, it can be stored either as a cryogenic liquid, as compressed gas or chemically bound.

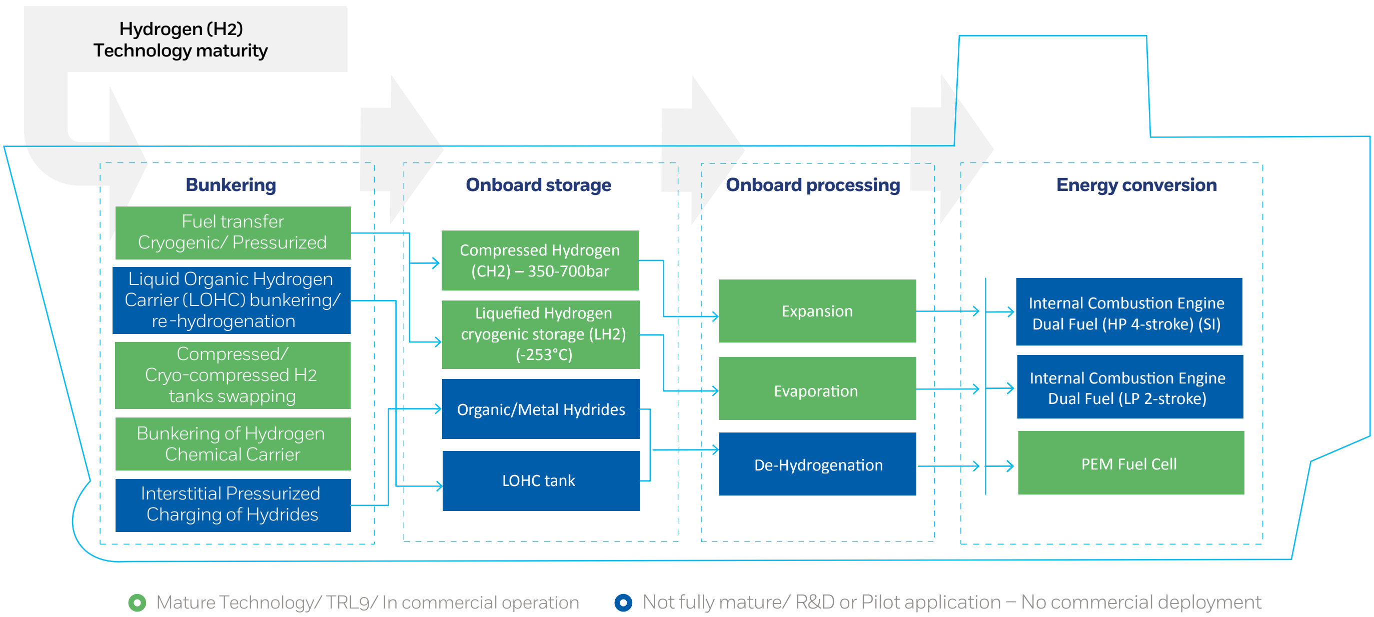
The general principles, guidelines and recommended practices established based on the knowledge acquired in other industries are vital for the safe handling of hydrogen. There are, however, principal differences to be considered when moving hydrogen technologies on board ships. This relates to a variety of conditions, as mentioned below.

- A ship operating out in the open seas is self-reliant and, in most instances, cannot rely on help from outside.
- Crew and passengers cannot escape to safety in the same way as from a car or from within a building on shore.
- Due to space constraints, the safety distances are much smaller on a ship than on a comparable installation on shore.
- The environmental conditions on board ships with dynamic loads, humidity, sea spray, vibrations and inclinations are more challenging than on land.
- The power demand for a ship is typically of a different order of magnitude compared to other applications (e.g. automotive) considering similar fuel technology.
- Low-temperature materials are a necessity for liquefied hydrogen. Unlike supporting structures for onshore facilities, normal ship steel grades are not resistant to low temperatures.
- Shutting off the hydrogen supply may be necessary as an automatic safety action. For a ship, this may also result in loss of propulsion power and auxiliary power generation capabilities.

5.5.3.2 Technology

Hydrogen can be used in fuel cells to produce electrical power or, together with other fuels, in multi/dual-fuel ICE concepts. Figure 149 illustrates the different technology blocks involved in a generic possible hydrogen-fuelled installation on any ship type. The Alternative Fuels Insight platform (DNV, n.d.) reports that there are currently three ships in operation, primarily in Europe, capable of using hydrogen in their fuel mix in dual-fuel ICEs. Additionally, there are 10 ships in the order books for delivery up to 2026.

Figure 149: Maturity diagram for hydrogen as fuel.



NB: The green and grey colour coding gives a qualitative indication on the maturity of the different technology blocks.
Source: EMSA services.

5.5.3.3 Safety

Flammability limit
4–77 %
Extremely wide
Low concentration

Liquefied gas – cryogenic
Compressed at 350–700 bar
Asphyxiant

BLEVE
Rapid phase transition
High flame velocity (> 7× more than LNG)

The safety principles of segregation, double barriers, leakage detection and isolation are equally important for hydrogen as for natural gas. However, additional barriers are needed to account for hydrogen-specific properties that increase the flammability risk.

The wide flammability range (4–77 % volume in air) and low ignition energy lead to an **increase in the explosion risk in a large number of different loss-of-containment scenarios**. Not only is the likelihood of having an explosive/flammable concentration high, but the probability of ignition is also significantly increased. Detonation in confined spaces is more likely due to the high flame velocity.

The following additional assumptions for hydrogen use are essential to ensuring a safety level comparable to that of a conventional ship:

- safety barriers shall be designed to withstand substantial leakage from fuel piping systems;
- design should always consider that there is some probability of ignition even after measures such as installing certified safe electrical equipment have been taken;
- hydrogen leakages are prevented from reaching areas where combustion could be supported.

In addition, hydrogen can significantly deteriorate the mechanical properties of metals, causing hydrogen embrittlement. Many metals absorb hydrogen, especially at high pressures. Brittle failures of hydrogen-containing components can lead to the release of significant amounts of hydrogen, with corresponding hazards stemming from both low temperatures from cryogenic releases and high pressures and temperatures from a potential ignition. The choice of materials for hydrogen systems is also an important part of hydrogen safety.

5.5.3.4 Regulatory development

The use of hydrogen, in principle, falls under the remit of application of the IGF Code, which provides an international standard for ships operating with gas or low-flashpoint liquids as fuel. Hydrogen is currently not covered by the specific requirements in the IGF Code, which means that compliance with the high-level goals and functional requirements in Part A of the code must be demonstrated through alternative design.

However, there are challenges in demonstrating the safety equivalency of hydrogen fuel systems solely based on the IGF Code, which was devised for natural gas. In particular, existing safety barriers in the IGF Code do not fully account for hydrogen's extreme flammability properties.

This has been addressed by the development of the draft non-mandatory 'Interim guidelines for the safety of ships using hydrogen as fuel', which are expected for approval at MSC 111 in 2026. The guidelines will remain non-mandatory to gain experience with their application before being included as mandatory regulations through amendments to the IGF Code or as a separate instrument.

5.5.4. Methanol

5.5.4.1 Introduction

Methanol, also called methyl alcohol, is a chemical compound with the formula CH_3OH. It is the simplest alcohol with the lowest carbon content and highest hydrogen content of any liquid fuel. It is liquid at normal temperature and pressure and can therefore be stored in tanks comparable to those used for conventional fuel oil tanks. It can be produced via gasification of biomass (bio-methanol), using electricity (e-methanol) or from fossil feedstocks (fossil methanol).

Methanol is already used as marine fuel, and based on the order books it will be a primary alternative fuel choice for the energy transition in the years to come.

The pictures below are examples of applications of methanol as fuel.

Image 11: The *Laura Maersk*, the world's first methanol-enabled container ship, was presented in 2023.

Source: HenSti / Wikimedia Commons.

Image 12: The methanol-fuelled ship *Stena Germanica*.

Source: Wolfgang Fricke / Wikimedia Commons

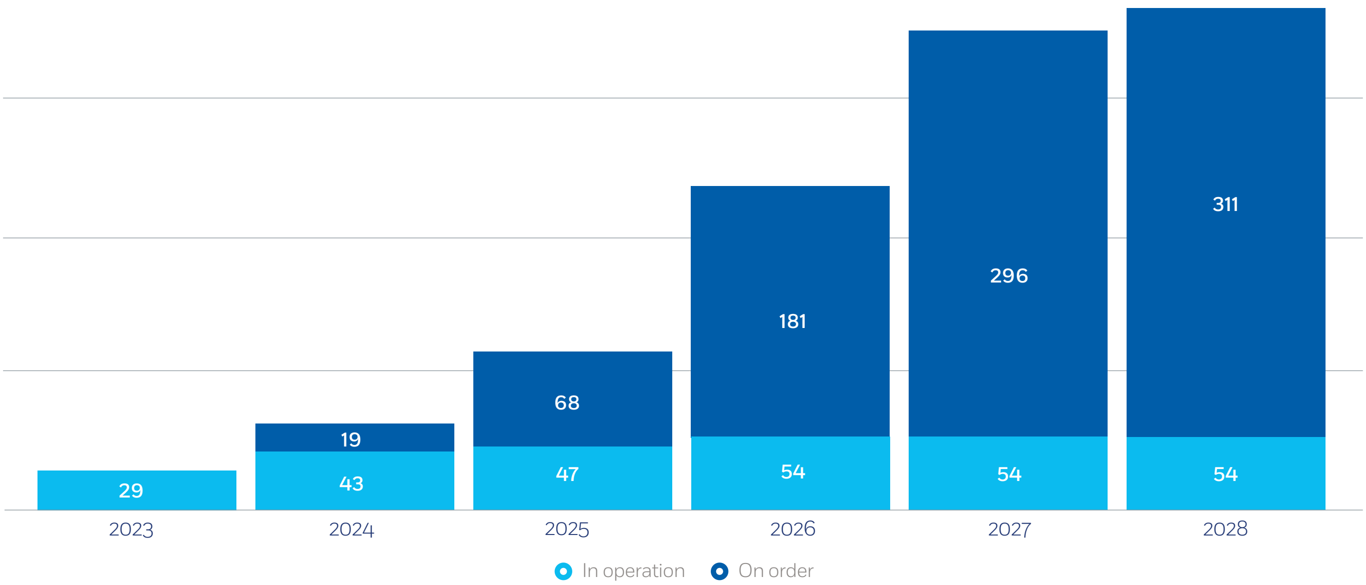
A 240-metre-long, 51 000 GT ro-pax has undergone retrofit conversion for the use of methanol as an alternative fuel under the project entitled 'Methanol: The marine fuel of the future', a pilot action that was granted 50 % support by the Commission under the 2012 trans-European transport network programme.

5.5.4.2 Fleet

The global methanol-fuelled fleet is relatively small, with 43 ships in operation at the time this report was written. At that point, 313 methanol-fuelled ships were on order worldwide, more than 60 % of which were container ships.

From 2019 to 2023 the number of ships capable of using methanol as fuel doubled. A steep increase in the fleet of methanol-fuelled vessels should be observed in the coming years based on the status of the order books. By 2028, more than 300 additional vessels are expected for delivery (Figure 150).

Figure 150: Evolution of the number of methanol-fuelled ships in operation – estimate based on the order books up to 2028.



Source: Alternative Fuels Insight platform (DNV, n.d.).

5.5.4.3 Safety

Flashpoint
10 °C
Flammability limit
5.5–44 %
Wide
Low concentration

Toxic
200 ppm (8 h)
IDLH 6 000 ppm

Corrosive

With a flashpoint of about 10 °C, methanol is flammable in air, burning at a concentration of anywhere between 5.5 % and 44 % upon ignition, and evaporates easily. It is also flammable in a solution with water in concentrations as low as 25 %. In addition, methanol is toxic and poisonous to the central nervous system, and may cause blindness, coma and death if ingested in even small quantities.

The lower explosive limit of methanol is about 6 % by volume, which is 10 times the concentration that is immediately dangerous to life or health (IDLH). Since methanol vapour concentrations in the explosive range are toxic, **keeping the air concentration safe for health also makes it safe from fire and explosion**. **However, keeping it safe from fire and explosion does not make it safe to breathe.**

Methanol has a relative density in air of 1.11, which means that methanol vapour is practically neutrally buoyant in air. A methanol vapour cloud can be heavier than air if colder than its surroundings, or lighter than air if warmer. Safety measures such as ventilation arrangements, escape routes and fixed gas detection systems should be designed with this in mind.

Methanol vapour is invisible, with a high odour threshold, and methanol liquid is clear, colourless and easily mistaken for water. Most importantly, **methanol flames are invisible in bright light and produce no smoke**. **These poor warning properties make it challenging to detect before exposure has occurred.**

Unlike marine gas oil (MGO) and other hydrocarbons, methanol is a polar molecule. As a result, it can be corrosive to some materials, including metals and alloys, along with elastomers and polymers. Examples of unsuitable materials are aluminium, copper, titanium and polyvinyl chloride. Typically, methanol fuel tanks on board ships are made of carbon steel with zinc coating systems.

Hence, the safety concept is heavily based on the prevention of fire and explosion hazards by, for example:

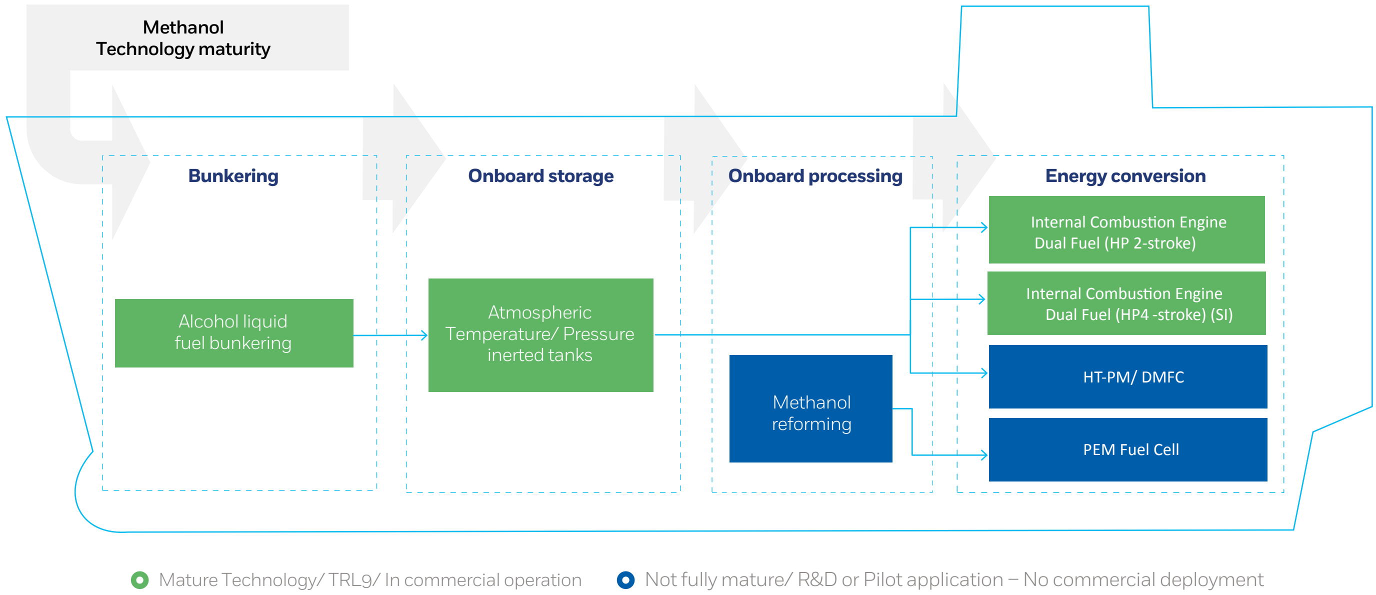
- avoiding the accumulation of methanol vapours in confined spaces;
- reducing ignition sources;
- adapting detection and firefighting systems to the characteristics of methanol fires (burn with clean flame requiring infrared imagery support, use of alcohol resistant foams, etc.);
- selecting suitable materials and spare parts that will be in contact with methanol to prevent corrosion.

Most of the information contained in this section was collected during the EMSA study on the safe bunkering of biofuels (EMSA, Henriksen et al., 2023).

5.5.4.4 Technology

Along with safeguards to tackle its specific hazards, technology is ready to facilitate bunkering and on-board storage. The use of methanol as fuel requires ICEs specifically optimised for or adapted to that purpose, which are already commercially available. There are two options for using methanol as fuel in conventional ship engines: in two-stroke or in four-stroke dual-fuel engine configurations. These engines typically use a small amount of pilot fuel, such as diesel, to initiate the combustion of methanol. Notably, methanol can be used in blends containing water – sometimes up to 50 % – without significantly compromising engine performance. Methanol can also be blended with marine diesel at a low percentage, which requires only minimal engine modifications. Beyond combustion engines, methanol can serve as a hydrogen carrier for fuel cells. Through on-board reforming, it can be converted into hydrogen to power fuel cells. However, this latter possibility has not yet been put into commercial application.

Figure 151: Maturity diagram for methanol as fuel.



Source: EMSA services.

5.5.4.5 Regulatory development

Due to its low flashpoint, the use of methanol as fuel falls under the IGF Code. IMO finalised the 'Interim guidelines for the safety of ships using methyl/ethyl alcohol as fuel' (MSC.1-Circ.1621 ([160])), and adopted them at MSC 102 in 2020. Relevant experience has since been gathered by some flag states from the voluntary application of these guidelines, and is being considered in the process for the drafting of a future mandatory instrument.

Despite the significant development in terms of the definition of a safety standard for alcohols as fuels achieved with the publication of the interim guidelines, there are still relevant aspects that remain to be addressed from a regulatory perspective.

Fire detection and extinction.

The current provisions of the IMO guidelines for ships using alcohols as fuels do not sufficiently cover aspects relating to fire detection by visual aids such as infrared imagery (IMO, 2019c). Equally, the extinction of a methanol fire may pose specific issues, such the person extinguishing a fire not being able to see the flame or the possibility that extinction may not be effective. Issues for specific fire suppression systems are as follows.

- **Alcohol-resistant foam.** May not cover the edges of a fire and continue to burn.
- **CO_2.** Reignition after space ventilation is distinctly possible if surfaces have not been cooled sufficiently.
- **Water-based systems.** In order to use the dilution effect to make the material non-flammable, large quantities are needed.

Vapour detection.

- Guidance is needed on the calibration of MeOH detectors.
- Another gap relating to vapour detection is the reliability of detection under high-air-flow conditions.

Standardisation/interoperability/interconnectivity.

- ISO 6583:2024 – Methanol as a fuel for marine applications – General requirements and specifications is now available.

Other standards are missing.

- Standard specification for MeOH connectors.
- Inert gas generator quality and control systems.
- System certification of water-based and gas-based firefighting systems to extinguish alcohol fires.

Toxicity.

- Toxicity requirements for transport as cargo or as a fuel are not consistent between the interim guidelines and the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk.

160 https://wwwcdn.imo.org/localresources/en/MediaCentre/MeetingSummaries/Documents/MSC.1-Circ.1621%20-%20Interim%20Guidelines%20For%20The%20Safety%20Of%20ShipsUsing%20MethylEthyl%20Alcohol%20As%20Fuel%20%28Secretariat%29%20%282%29.pdf.

5.5.5 Ammonia

5.5.5.1 Introduction

Ammonia is a carbon-free compound of nitrogen and hydrogen (NH_3), and at atmospheric temperature and pressure is a colourless gas with a strong, sharp and irritating odour. At higher pressures ammonia becomes a liquid, making it easier to transport and store. It is a widely used and available chemical, notably used for fertiliser. It is important to differentiate between anhydrous ammonia and aqueous ammonia. Anhydrous ammonia contains almost no water; it is at least 99.5 % pure ammonia. On the other hand, aqueous ammonia is a water-based solution that normally has a concentration of between 10 % and 35 % ammonia.

Ammonia is easily liquefied due to the strong hydrogen bonding between molecules. At atmospheric temperature and pressure, it turns into a liquid below −33.5 °C and freezes to crystals at −77.7 °C. Although it can be liquefied at around 8.5 bar at ambient temperature, it is commonly stored at 17 bar to keep it in a liquid state, even when the surrounding temperature increases.

5.5.5.2 Technology

The maturity of the technology framework for ammonia as fuel remains low. There are no commercially operating vessels using this alternative fuel. Despite this, several shipowners and shipping companies have recently made public their plans to adopt this alternative fuel in the short to medium term – as demonstrated by the 25 vessels in the order books for deployment up to 2027 – and the first ammonia-powered vessel demonstrations have emerged.

In December 2023, after the successful conversion of a four-stroke dual-fuel engine to run on ammonia and diesel, and land-based testing, the *Fortescue Green Pioneer* set sail in international waters from Singapore to the Middle East. This ship was also the first to be bunkered with ammonia as part of its fuel and propulsion tests.

The feasibility of ship-to-ship transfer of ammonia was also demonstrated for the first time in June 2024, an operation that took place in international waters near Spain and the strait of Gibraltar.

Major engine manufacturers are working in the short term towards the commercial deployment of ICEs capable of using ammonia.

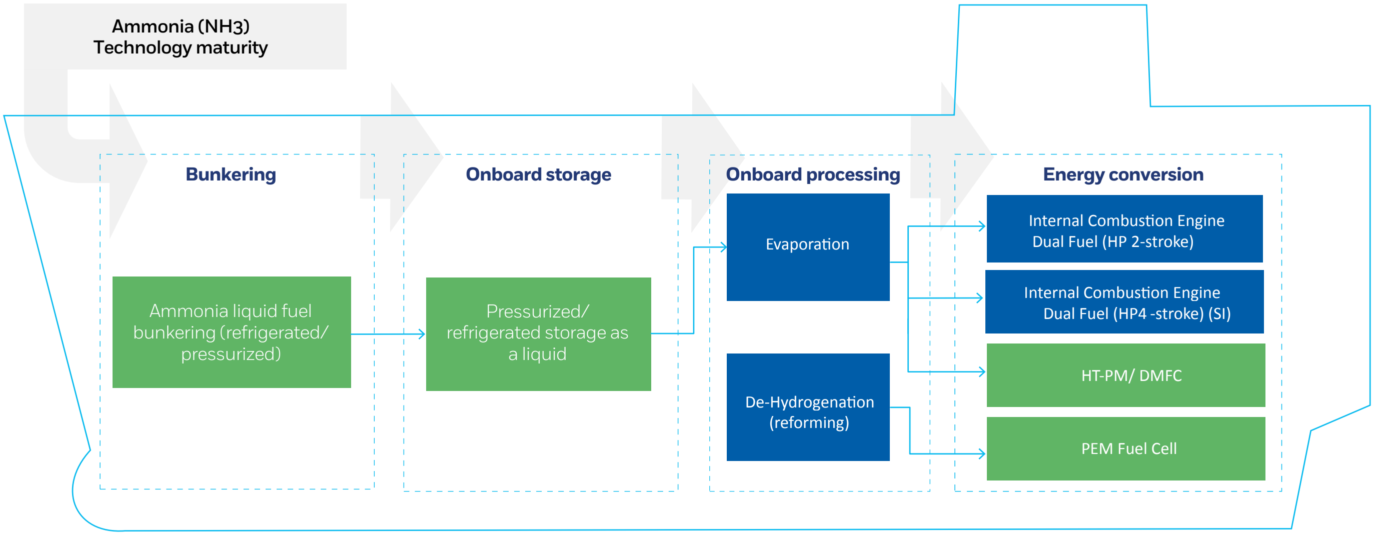
Image 13: The *Fortescue Green Pioneer* – use of ammonia as marine fuel in a dual-fuelled ammonia-powered vessel.

Source: Fortrescue.

Image 14: The NH3 Kraken, a tugboat originally constructed in 1957 and retrofitted with an ammonia-to-electrical power system.

Source: Amogy.

Figure 152: Maturity diagram for ammonia as fuel.



Mature Technology/ TRL9/ In commercial operation

Not fully mature/ R&D or Pilot application – No commercial deployment

Source: EMSA services.

5.5.5.3 Safety

Flammability limit
15–28 %
Narrow
Medium
concentration

Toxic
20 ppm (8 h)
EU-EOL
IDLH 300 ppm

Corrosive to metals and skin

Exposure to an ammonia atmosphere, by contact or inhalation, causes serious health hazards. Ammonia vapour causes irritation to the eyes and respiratory tract and contact with skin can cause burns and blisters. Several global agencies and organisations establish exposure limits and guidelines for safe exposure to ammonia due to its toxic properties. These guidelines, established by the European Chemicals Agency at the EU level, are critical to ensuring the safety of workers and the public who may be exposed to ammonia in various work, industrial or other settings.

The occupational exposure limit is an upper limit on the acceptable concentration of a particular hazardous substance in workplace air. It is an important indicator in risk assessment and is typically set by competent authorities at the national or regional level.

Despite being toxic, ammonia has the advantage of having a very low odour threshold (2–5 parts per million (ppm)), which allows it to be detectable by smell long before the concentration reaches dangerous values.

Ammonia is a flammable gas in the presence of oxygen and a suitable ignition source. A source of ignition, such as a spark, an open flame, intense heat or an electrical discharge at temperatures higher than 160 °C, is needed to initiate the combustion of ammonia. Without a source of ignition, ammonia will not ignite spontaneously below 650 °C. Proper safety measures, such as appropriate storage and handling, and the prevention of ignition sources in areas where ammonia is present, should be taken to minimise the risk of fire or explosion in enclosed spaces.

Toxic concentration levels are far below the flammability limits.

Ammonia is also incompatible with various metals. In the presence of moisture, it reacts with and corrodes copper, brass, zinc and other alloys, forming a greenish/blue colour. Ammonia is an alkaline-reducing agent and reacts with acids, halogens and oxidising agents. These properties add challenges relating to the selection of materials for on-board equipment and tanks. Any study and selection of materials should therefore be extensive and consider the metals, rubbers and polymers typically used for gaskets and sealing. Its compatibility with elastomers used in protective equipment, plugging, valve seals, etc., varies; contact with natural rubber, nitrile, polyurethane, viton (fluoroelastomer) or silicone is not recommended at low temperatures.

In addition, the use of ammonia may cause stress corrosion cracking – cracks formed in carbon steel due to contact with ammonia. The cracks are small at the surface, but can be deep, even going through the entire thickness of the metal. The presence of oxygen and residual stress can lead to stress corrosion cracking.

5.5.5.4 Regulatory development

As a gas, the IGF Code is seen as the most appropriate instrument to deal with ammonia as fuel. Ammonia is also not currently covered by the specific requirements in the IGF Code, which means that compliance with the high-level goals and functional requirements in Part A of the code must be demonstrated through alternative design.

The protective tank location criteria, cryogenic and pressurised fuel containment and distribution requirements, the double barrier concept for fuel supply piping, the use of ventilation and gas-detection methods to detect leaks and mitigate their increase to the lower explosive limit, hazardous area classification, and requirements for training, personal protective equipment and operational measures form a strong set of safety concepts that are very transferrable to other gases. In the case of ammonia, this suite of requirements can be applied to reduce the likelihood of and mitigate accidental releases based on toxicity levels, i.e. ppm levels, rather than the percentage (%) levels required for fire and explosion protection. Nevertheless, most of the considerations in the IGF Code derive from the need to tackle flammability risks, and specific measures to address potential toxic releases in areas on board are of paramount importance in the case of ammonia, including the determination of toxic areas based on gas dispersion analysis and the strengthening of personal protective equipment requirements.

The IMO has recently developed the non-mandatory 'Interim guidelines for the safety of ships using ammonia as fuel' (MSC.1/Circ.1687 ([161])), which were approved at MSC 109. The guidelines will remain non-mandatory to gain experience with their application before being included as mandatory regulations though amendments to the IGF Code or as a separate instrument.

5.5.6 Biofuels: DME, FAME, FT-diesel and HVO

5.5.6.1 Introduction

Various biofuels are emerging as viable options in the market for use as drop-in fuels to replace distillate marine fuels, as they do not require substantial modifications to engines and the overall fuel supply system either as 100 % biofuel or when blended.

However, depending on their properties and without appropriate procedures for handling, storing and bunkering, these fuels can still be hazardous to human health and equipment.

The selected biofuels – DME, FAME, FT-diesel and HVO – ranked top in a recent EMSA study on the potential of biofuels in shipping (EMSA, American Bureau of Shipping et al., 2023) that examined a broad range of biofuels based on overarching criteria such as fuel availability, sustainability, technology readiness levels (TRLs) for production, on-board use and cost.

A summary description of these biofuels with relevant characteristics for their safety assessment can be found in Table 51.

Table 51: DME, FAME, FT-diesel and HVO.

DME (CH_3OCH_3)	• Flammable gas at standard temperature and pressure. • Stored as liquefied gas, it can be liquefied if cooled at low temperatures (below −24.8 °C) or pressurised (5.3 bar at 20 °C). • Heavier than air.
FAME	• Liquid fuel. • Reduced flow capabilities at low temperature. • Sensitive to contamination and exposure to water may facilitate microbial growth or hydrolysis.
FT-diesel	• Liquid fuel. • Fully compatible with existing diesel infrastructure and ICEs, fuel storage and fuel supply systems on board. • Poorer cold flow properties than MGO. • FT-diesel used as ship fuel is expected to have flashpoint of at least 60 °C.
HVO	• Liquid fuel. • Flashpoint ≥ 60 °C. • May exhibit poorer cold flow properties than MGO.

161 https://www.bimco.org/media/bxvcygg1/msc1-circ1687-interim-guidelines-for-the-safety-of-ships-using-ammonia-as-fuel-secretariat.pdf

5.5.6.2 Safety

For DME
Flammability limit
3.4–27 %
Medium
Low concentration

For DME
Liquefied gas – low temperatures
(−24.8 °C at 1 atmosphere)
Stored under pressure (5.3 bar at 20 °C)

- **DME** is categorised as a highly flammable gas, necessitating precautions to avoid heat, hot surfaces, sparks, open flames and other ignition sources. Contaminated clothing poses a fire hazard and should be handled accordingly. In the event of a major fire, foam or water fog should be used for extinguishing, while dry chemical powder, carbon dioxide or sand/earth are suitable for minor fires. Due to the vapour's heaviness, it may travel along the ground or water surface, posing a risk of distant ignition. Additionally, pressurised content can potentially explode when exposed to heat or other ignition sources. DME has similar safety profile to that of LPG.

- **FAME** offers favourable properties with regard to lubricity and ignition. Nevertheless, potential challenges may arise relating to storage and handling of FAME fuels in marine environments, such as oxidation, corrosion, long-term storage issues, risk of microbial growth due to its affinity to water, degradation as a result of low temperatures and formation of solid deposits. In general, FAME can be considered quite similar to petroleum diesel.

- **FT-diesel** is thought to exhibit similar properties to fossil diesel with respect to safe handling and toxicity. All ignition sources should be eliminated during handling and storage. Tank headspaces should be regarded as potentially flammable. The auto-ignition temperature of FT-diesel is given as 208 °C, compared to > 250 °C for MGO. This must be considered wherever heated surfaces may be in contact with FT-diesel. Class rules for ship design typically use equipment surface temperatures of 220 °C as a cut-off point for insulation requirements.

- **HVO**, when compared with traditional petroleum diesels, exhibits a comparable flashpoint, good tolerance to cold temperatures, robust stability and oxidation properties, and minimal concerns regarding microbial growth or material-compatibility issues. Similar safety hazards and mitigation measures relating to flammability apply to HVO and to conventional marine distillates.

5.5.6.3 Regulatory development

As a liquefied gas, the use of DME as fuel would fall under the IGF Code.

For liquid biofuels, because of their similarities in risk profile compared with traditional marine fuels, no requirements in addition to those already applicable to such fuels are currently considered necessary.

5.5.7 Liquefied petroleum gas

5.5.7.1 Introduction

LPG is by definition any mixture of propane (C_3H_8) and butane (C_4H_{10}) in liquid form. Specific mixtures of propane and butane are used to achieve the desired saturation, pressure and temperature characteristics.

Propane is gaseous under ambient conditions, with a boiling point of −42 °C. It can be handled as a liquid by applying moderate pressure (8.4 bar at 20 °C).

Butane can be found in two forms, n-butane and iso-butane, which have boiling points of −0.5 °C and −12 °C, respectively. Since both isomers have higher boiling points than propane, they can be liquefied at lower pressure. Regarding land-based storage, propane tanks are equipped with safety valves to keep the pressure below 25 bar. LPG fuel tanks are larger than oil tanks due to the lower density of LPG.

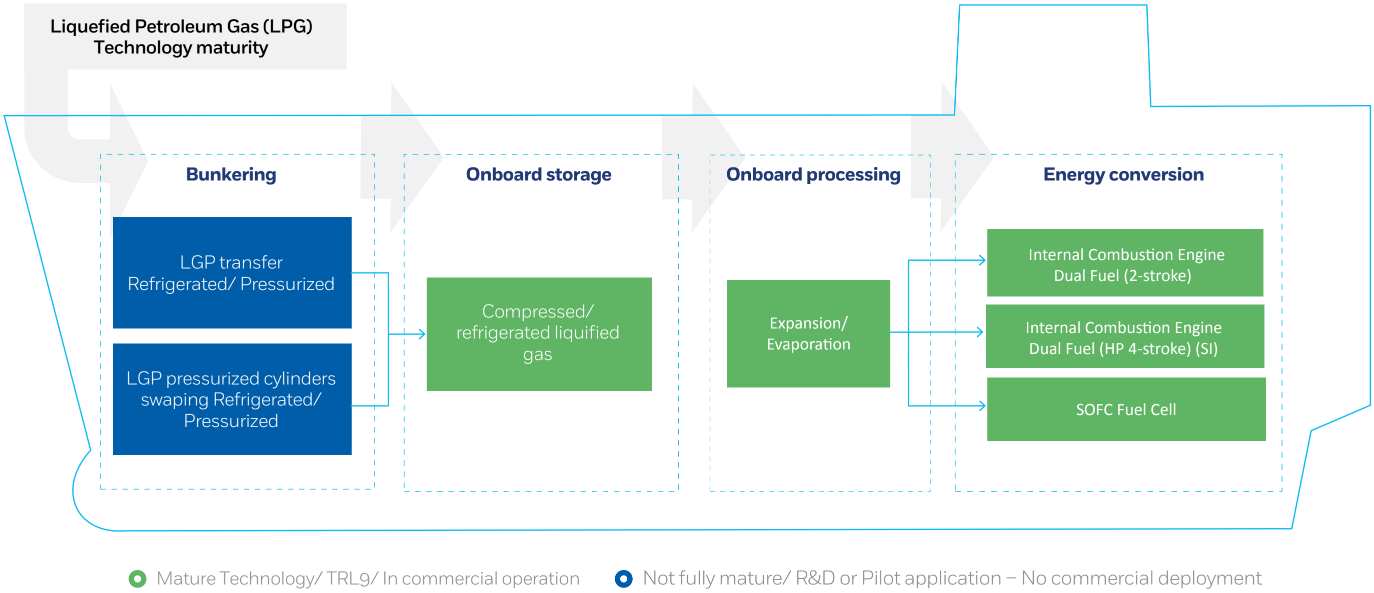
LPG can be stored under pressure or refrigerated. The preferred way of storing it for use as fuel is in a pressurised tank at ambient temperature. Storage in a semi-refrigerated tank made of cheaper types of steel than for LNG is also possible, but for such an arrangement to be sufficiently reliable, backup systems must be in place to ensure a low temperature in the tank. Despite the more convenient containment storage of LPG on board, without the requirement of cryogenic liquefaction, LPG has limited application as fuel for ships other than LPG carriers. Conditions for on-board storage are like those required for ammonia. For this reason, a small part of the LPG tanker fleet is formed of combined LPG/ammonia tankers.

5.5.7.2 Technology

LPG as fuel for maritime transport is not widely applied and, except in gas tankers, there are no other applications. Figure 153 highlights the maturity owing to the experience with LPG cargo as fuel. Maturity is significantly reduced for applications other than LPG cargo as fuel, with no evidence of other ship types, operating or on order, using this fuel.

There are three main options for using LPG as ship fuel: in a two-stroke diesel-cycle engine; in a four-stroke, lean-burn Otto-cycle engine; or in a gas turbine.

Figure 153: Maturity diagram for LPG as fuel.



Source: EMSA services.

5.5.7.3 Safety

Flammability limit
1.8–9 %
Narrow
Low concentration

Liquefied gas – low temperatures
Stored under pressure (8.4 bar at 20 °C)

From a general perspective, in comparison to LNG, LPG gives rise to fewer concerns with respect to structural protection in case of a loss of containment. Not requiring cryogenic storage temperatures also reduces the risk of brittle fracture.

Flammability and explosion hazards and risk are considered similar to those of LNG. In addition, the safety concept for LPG must consider the following fuel-specific characteristics.

LPG is heavier than air. In general, LPG is heavier than air and may be present in a liquid state at normal temperature. In particular, in order to reduce the risks associated with LPG fuel properties, LPG-fuelled ships should be given special consideration compared to LNG-fuelled ships as follows, among other ways:

- arrangement of gas detectors and liquid detectors;
- arrangement of equipment for use of liquid fuel;
- arrangement of LPG engines and exhaust system due to low auto-ignition temperature;
- arrangement of mechanical ventilation system.

Auto-ignition temperature. The auto-ignition temperature of LPG (490 °C) is lower than that of LNG (580 °C), which may require a lower surface temperature near electrical equipment. Compared to LNG, LPG has fewer challenges relating to temperature because it is not cryogenically stored. However, it has challenges relating to higher density as a gas and a lower ignition range, with a lower flammability limit of about 2 %.

LPG composition. Since LPG composition may vary in the relative content of butane/propane, some safety characteristics, such as the flammability range, may vary.

5.5.7.4 Regulatory development

As a gas, the use of LPG as fuel falls under the IGF Code. In 2022, the IMO finalised the development of the non-mandatory 'Interim guidelines for the safety of ships using LPG fuels' (MSC.1/Circ.1666 ([162]), adopted at MSC 107 in June 2023) to provide guidance on the application of the specific provisions of the code to ships using this fuel.

5.5.8 Fuel cells

5.5.8.1 Introduction

Fuel cells are a form of prime-mover energy conversion equipment that transforms electrochemical potential energy from hydrogen into electrical energy, which can be consumed either directly or, as in most cases, indirectly from storage in batteries. There is the possibility to have different technical arrangements in which fuels other than hydrogen (e.g. LNG, ammonia or methanol) are fed into the fuel cells and, following a transformation process, used as chemical carriers for hydrogen.

The concept has matured from a technology perspective, and fuel cells are currently being developed for use in multi-megawatt applications. Due to the lower power density of fuel-cell systems than traditional systems, scaling the technology still represents a significant step to be met by any modularisation approach. From 2003 to 2010, the *Viking Lady* ship was part of a pilot project that used LNG as fuel. This installation provided 320 kilowatts of power and used molten carbonate fuel cells. The project was a technical success and marked the first large-scale use of a fuel cell in a merchant vessel (DNV GL et al., 2017). Currently, there are further solutions available on the market that have been specifically engineered for the marine environment – Figure 154 is depicted as an example. These types of solutions are compact, designed to be scalable for megawatt (MW) outputs and compatible with the use of different fuels as chemical hydrogen carriers.

Image 15: The MF Hydra is the world's first liquid hydrogen-powered ferry.

NB: The project is based on the use of LNG as fuel on a fuel-cell power installation.

Source: Norled.

Figure 154: Fuel-cell power module – Ballard's FCwave™.

NB: FCwave™ is a cabinet-based modular fuel-cell system scalable to MW. It is designed to provide zero-emission power to a broad range of marine vessels and stationary applications.

Source: Ballard.

5.5.8.2 Fleet

On 1 October 2024 there were 5 ships in operation, 1 under testing and 20 on order for delivery up to 2029 (according to the Alternative Fuels Insight platform (DNV, n.d.)).

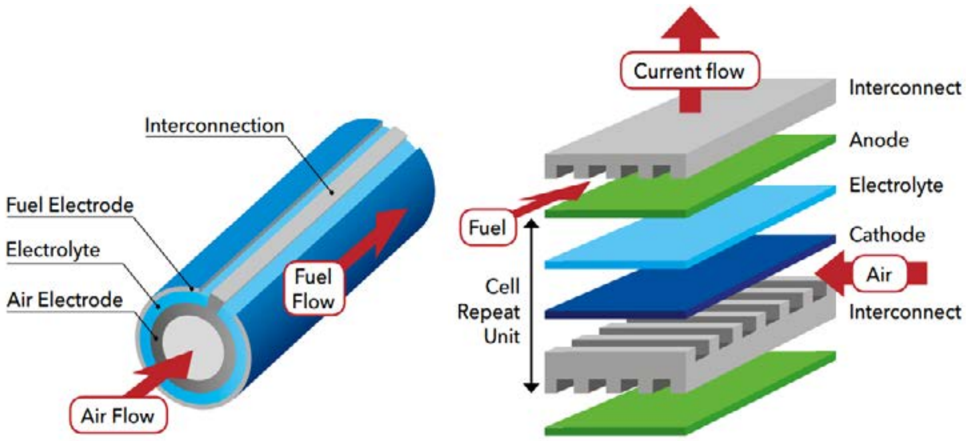
162 https://www.mardep.gov.hk/filemanager/en/share/msnote/pdf/msin2360anx1.pdf.

5.5.8.3 Technology

Electrical energy is produced by the electrochemical reactions between the oxidising side (anode) and the reducing side (cathode). Fuel cells are a technology from which several sub-technology categories have now been derived. A previous EMSA study on fuel cell technology (DNV GL et al., 2017) identified and assessed these sub-technologies using chemical, design and operating criteria. The study details all the analysis on the potential for the different technologies.

The study allowed the three technologies with the highest potential to be identified: proton-exchange membranes (PEMs), high-temperature proton-exchange membranes (HT-PEMs) and solid oxide fuel cells (SOFCs). These technologies are further described in Table 52. It should be noted that HT-PEMs and SOFCs operate at high temperatures, which provides for improved efficiency but raises additional safety concerns with respect to the associated higher fire risk due the temperature and the potentially accelerated degradation of the fuel-cell-stack materials.

Figure 155: Cell structure of tubular and planar solid oxide fuel cells.



NB: Hydrogen is used as fuel, reacting with oxygen to produce electricity and water.
Source: DNV GL et al. (2017).

Table 52: Most promising fuel-cell technologies for applications in maritime transport.

Technology	TRL	Note/reference	Research and development needs for TRL increase
PEM	9	PEM fuel-cell technology is the most mature fuel-cell technology used in mobile applications, particularly for road applications.	o Catalyst chemistry and cost-reduction materials. o Water and air management. o Efficiency improvement. o Prevention of carbon monoxide poisoning.
HT-PEM	7/8	o HT-PEMs are currently applied in stationary applications. o With higher operating temperatures and the elimination of water-management issues, HT-PEMs present the potential for improved efficiency and tolerability of hydrogen impurities.	o High-temperature membrane. o Heat activation and heat waste management. o Structural solution and integration for mobility. o Hazardous area certification of fuel-cell stack – high-temperature stack not considered in current version of fuel-cell guidelines.
SOFC	7	Along with PEMs, SOFCs represent the largest number of applied fuel-cell technologies.	o Advanced materials. o Temperature management (ideal 500 °C for trade-off of materials versus performance). o Heat activation and heat waste management necessary for efficiency improvement. o Hazardous area certification of fuel-cell stack – high-temperature stack not considered in current version of fuel-cell guidelines.

Source: DNV GL et al. (2017).

5.5.8.4 Safety

The same study identified the most safety-critical events for fuel-cell installations, which, for those relating to the specific technology, include:

- strong exothermic reaction of reformer material when charged with oxygen;
- internal leakage in fuel-cell module leading to high stack temperatures, oxidation or internal fire;
- failures of the electrical power output conditioning system leading to high voltage in fuel cell module, high stack temperature and fire, or loss of fuel-cell control system;
- thermal runaway of on-board energy buffer – battery failures.

Hydrogen safety must be considered due to possible leakages from piping, fixtures and the cell itself (DNV GL et al., 2017), along with other hazards linked with the properties of the primary fuel (other than hydrogen) during fuel supply and reforming.

5.5.8.5 Regulatory development

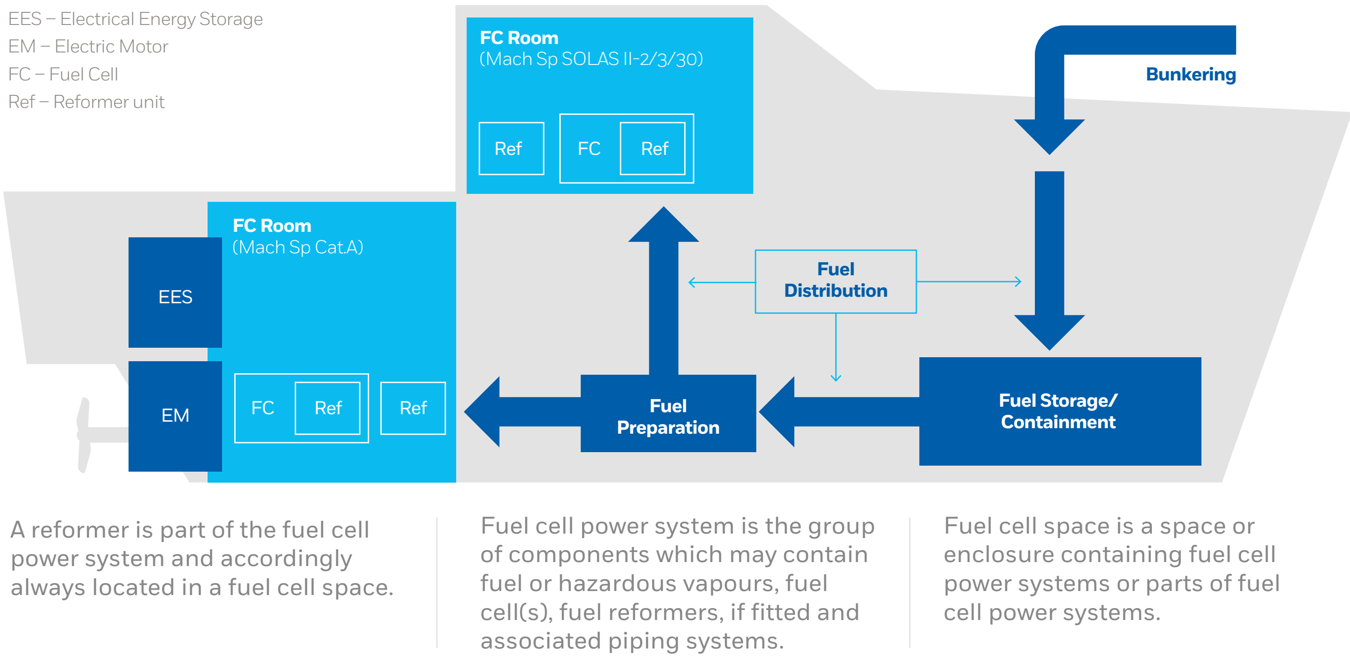
The IMO's 'Interim guidelines for the safety of ships using fuel cell power installations' were finalised at IMO CCC 7 in 2021 and approved in MSC.1/Circ.1647 ([163]) in June 2022. However, their application remains non-mandatory until experience gained through their use has been gathered and used to review and consolidate them.

The guidelines can assist ship designers and operators with important safety provisions relating to the installation of fuel-cell powering systems to ensure a level of safety and reliability equivalent to conventional oil-fuelled machinery installations, regardless of the specific fuel cell type and fuel. However, they **do not include provisions regarding the fuel-reforming unit and process, i.e. the transformation and supply of those fuels to the fuel cell that are used as chemical hydrogen carriers**.

Depending on the primary fuel used, other regulations (e.g. Part A of the IGF Code) and provisions (e.g. the 'Interim guidelines for the safety of ships using methyl/ethyl alcohol as fuel') are applicable to the arrangement and design of fuel-supply system, piping, materials and storage, in addition to these guidelines. In particular, the safety considerations most recently included in the draft regulatory framework for the use of hydrogen and ammonia as fuels may lead to important inputs into the future update of the interim guidelines. The lack of requirements and standards for the use on board and bunkering of primary fuels has been a significant roadblock preventing the uptake of fuel cells.

Figure 156 highlights in blue the areas covered under the IMO's interim guidelines, essentially focusing on the fuel-cell installation, irrespective of the fuel type.

Figure 156: Scope of the IMO's 'Interim guidelines for the safety of ships using fuel cell power installations'.



Source: EMSA services.

163 https://greenvoyage2050.imo.org/wp-content/uploads/2023/02/MSC.1-Circ.1647-Interim-Guidelines-For-The-Safety-Of-Ships-UsingFuel-Cell-Power-Installations-Secretariat.pdf.

5.5.9 Electrification

The use of electricity on board ships is primarily driven by operational, design and sustainability aspects, and has several applications in the maritime transport sector. From an operational perspective, electrical propulsion systems present opportunities in terms of propeller-speed variation, stationary positioning systems, manoeuvring and on-board comfort, avoiding the complexity of a traditional propulsion system involving shafts and gearboxes with associated vibration and maintenance. It provides flexibility to ship designers in relation to the internal layout, as there is no need to align the energy converters with the propulsion units.

The current low energy density of battery systems leads to applications on ships that are either involved in short-distance routes or engaged in services that do not require a high degree of autonomy. For deep-sea shipping, engaged in longer routes, hybrid options that include other renewable and low-carbon energy sources are being considered as a valid option to support GHG reduction. However, battery installations exceeding 10 MW of installed power have been already deployed at sea.

Inland waterway transport, in comparison to its maritime counterpart, presents increased opportunities for the use of electricity. Using well-defined inland waterway routes, with regular port calls along the way, inland waterway vessels are today adopting electrification solutions such as hybridisation and all-electric concepts, based on the possibility to recharge frequently along regular trading routes. Battery swapping and other relevant modular concepts have been developing in a way that reveals how modularisation and simplified retrofitting can assist in the transformation of this sector.

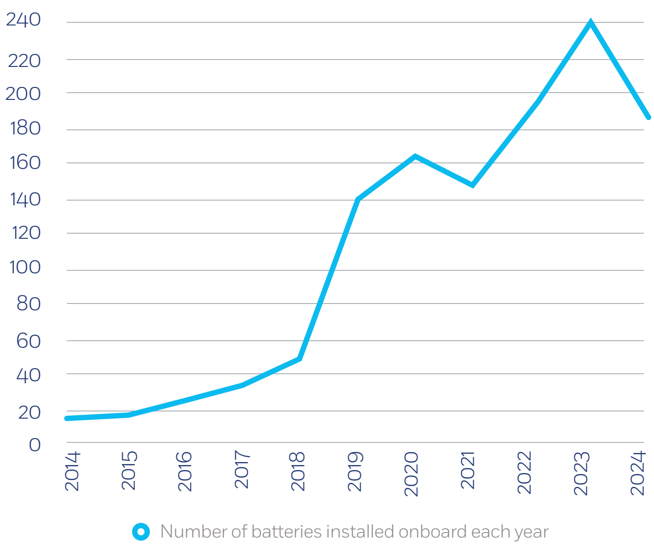
5.5.9.1 Electrical energy storage – batteries

Introduction

Battery energy storage system installations on board ships have been increasing in number and in amount of installed power as battery technology develops. According to the Alternative Fuels Insight platform (DNV, n.d.), there are more than 900 battery ships in operation worldwide, across all ship types and sizes – a figure that nearly tripled between 2019 and 2023. An additional 451 battery-powered ships are on order for delivery up to 2027.

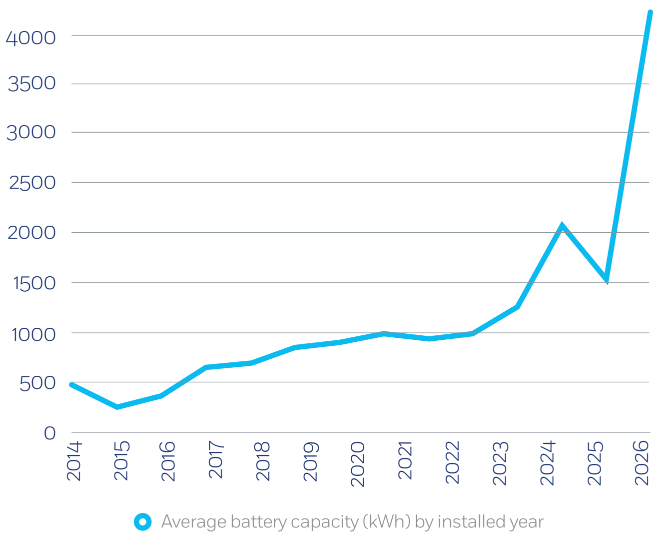
Figure 157 illustrates the growth in the number of batteries installed on board each year over the past decade. The increase in the average battery capacity over the years is shown in Figure 158.

Figure 157: Number of batteries installed on board each year.



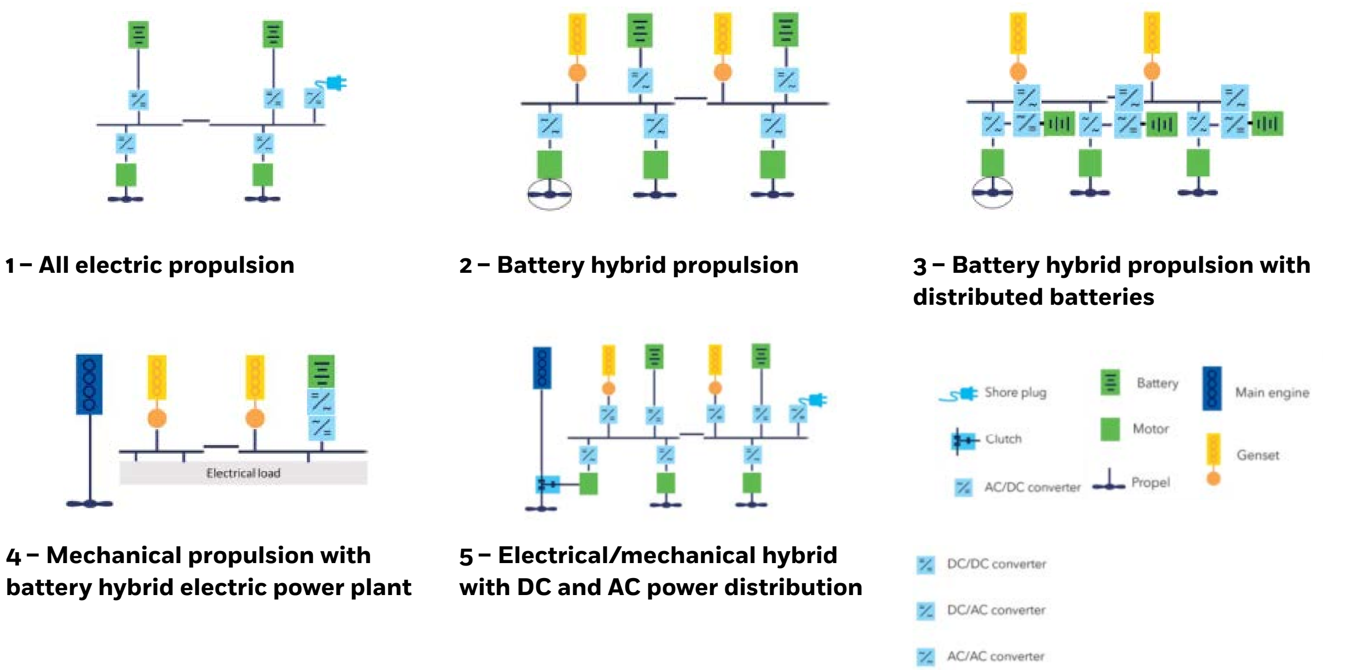
Source: Alternative Fuels Insight platform (DNV, n.d.).

Figure 158: Average battery capacity (kWh) by installed year – worldwide fleet (in operation and on order).



Source: Alternative Fuels Insight platform (DNV, n.d.).

Figure 159 Integration of EES into different power train configurations.



Source: EMSA.

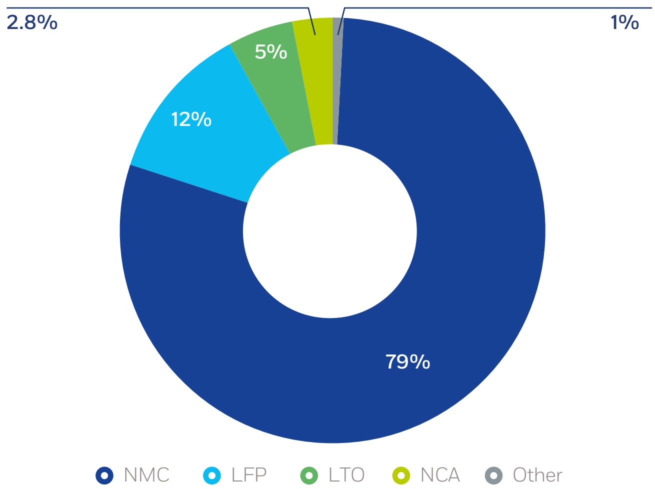
The use of electrical energy storage (EES) on board may take place in different configurations depending on the ship's operational requirements (Figure 159). Hybrid applications are the most common (61 % of ships in operation), followed by pure electric (22 %) and plug-in hybrid (17 %). On board a ship, batteries can adopt various topological configurations, from fixed to containerised or distributed.

Technology

A recent paper (He et al., 2024) reviewing the lessons learnt from the commercial exploitation of marine battery energy storage systems highlights the need to enhance risk management, develop onshore power supply and charging solutions and optimise multi-objective operations to increase the number of commercial applications.

Lithium-ion batteries are currently understood to be the best solution for powering ships that include different cell chemistry types. The most common cell chemistry by percentage of the battery fleet is nickel, manganese and cobalt cathode, used in 79 % of the fleet, followed by lithium iron phosphate, in 12 % of installations.

Figure 160: Cell chemistry by percentage of battery fleet (all type of ships), in operation and on order– worldwide fleet.



NB: NCA: nickel cobalt aluminium oxide; LTO: lithium titanate oxide; LFP: lithium iron phosphate; NMC: nickel manganese cobalt.

Source: Alternative Fuels Insight platform (DNV, n.d.).

Safety

The safety concept for the integration of batteries on board is largely based on fire safety. Battery fires have specific characteristics when compared to more conventional energy and power systems. The temperatures achieved in the fires are considerably higher, and toxic and explosive gases are produced. Specific considerations may be necessary regarding early fire and gas detection, fire extinguishing systems, battery-room ventilation systems, toxicity, off-gas detection and thermal runaway identification. The fire extinguishing systems must also coordinate with ventilation systems to mitigate the effects of gas accumulation during a fire.

Understanding how a battery system can fail is important in assessing the risk of fire and propagation. Below, the different failure modes are presented, together with specific battery technology considerations with an impact on safety. The operational safety risks of lithium-ion batteries are also listed.

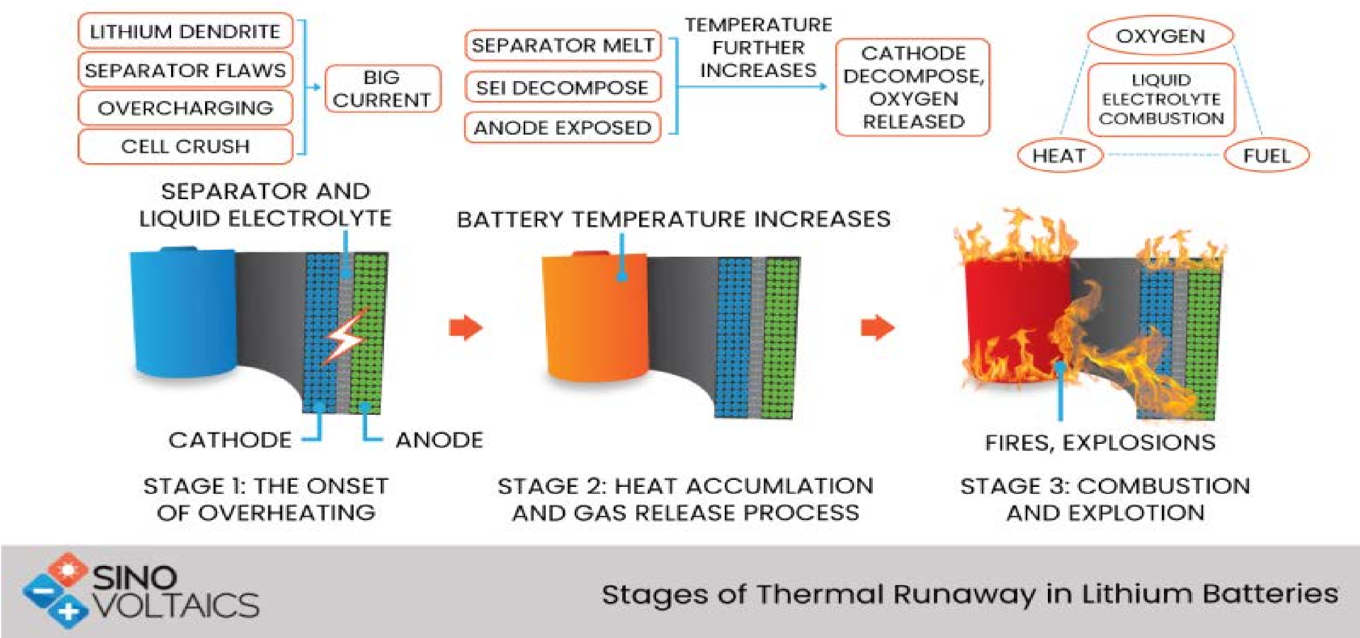
Failure modes

Safety concerns regarding lithium-ion batteries come from two sources: one is the presence of flammable, unstable electrolyte; the second is the presence of metal electrodes that can burn and often release oxygen. Ignition and the likelihood of a safety event are largely linked to the first of these, while the high temperature and difficult-to-extinguish nature of the fire are largely linked to the second. Based on these components, there are two primary failure modes or effects that can result from lithium-ion battery abuse: cascading thermal runaway and the release of toxic and flammable gases.

- **Thermal runaway and propagation.** Thermal runaway is the exothermic reaction that occurs when a lithium-ion battery starts to burn. The thermal event often starts from an abuse mechanism that causes an internal temperature rise sufficient to ignite the electrolyte within a given cell. This fire then poses a significant risk of igniting the metallic electrodes that are contained within the battery cell, thus producing a high-temperature metal (Class D) fire. Additionally, these metals may contain oxygen, which is thus released as it burns. Not all lithium-ion batteries contain oxygen within the electrodes, but all lithium-ion batteries on the market today contain electrolyte that can ignite and cause this kind of thermal runaway scenario.

  A maritime battery system is typically made up of thousands of cells. Thus, the failure and total heat release of a single cell is a relatively minor threat. The greater threat comes from a thermal event that produces sufficient heat to propagate to other cells, causing them to go into thermal runaway. As this cascades through the battery, the heat produced increases exponentially and there is a risk of a fire in which the entire battery is involved. Thus, battery modules and systems must be engineered to protect against propagation based on the cell that is used, and these cascading protections are the key feature regarding system design for safety.

Figure 161: Lithium-ion battery fire safety – the three stages of thermal runaway.



Source: Sinovoltaics[164]

164 https://sinovoltaics.com/energy-storage/battery-failures/stages-of-failure-in-lithium-ion-batteries/

- **Electrolyte off-gas.** The electrolyte that is contained within a given cell consists of an organic solvent, typically variants of ethyl carbonates. This means that they are flammable, and that the gases produced during a failure scenario are also flammable and can present an explosion risk. These gases also typically contain other components that are toxic and corrosive, such as hydrochloric acid and hydrofluoric acid.
- **Battery technology considerations.** In addition to the general safety aspects of lithium-ion batteries, there can also be significant differences between specific systems. These variations consist of the chemistry of the battery cells themselves, the design of the module (assembly of multiple battery cells) and the control system internal to the battery, known as the battery management system (BMS).

Table 53: Considerations regarding battery technology systems.

Battery Technology element	Description
BMS	The battery is only as strong as its weakest link (cell). All batteries within the system will degrade at slightly different rates. A BMS system should minimise such variations, keeping the batteries in balance. In addition, the BMS is responsible for calculating current limits, state of charge and state of health. The BMS is also vital in preventing the converter from overcharging the battery system. Such failures may cause more than one cell or module to fail simultaneously. Note that the most probable scenario for such failures is that any fire or off-gassing will start at the weakest cell or module, before spreading to the rest of the system.
Battery cell and chemistry considerations	A battery system is built up from tens of thousands of cells. In the case that one cells fails in some sort of thermal event, it should not propagate to other cells around it. Limiting the size of the cells limits the heat produced. A larger cell will contain a larger amount of energy and thus produce more heat when it burns. Larger cells have advantages regarding energy content and system density, but the potential heat released should be also considered. Chemistry is also an important factor. Most lithium-ion batteries in use are of a lithium cobalt oxide, nickel cobalt manganese or lithium manganese oxide type. These chemistries present similarities in terms of having layered metal oxides and thus producing oxygen during thermal runaway events. Thus, they will tend to burn more violently and with a greater amount of heat released. Lithium iron phosphate batteries, on the other hand, do not contain oxygen in the internal metal structures and thus do not produce as much heat in the case of a thermal failure. Additionally, lithium titanate oxide batteries will tend to produce less heat during a thermal failure scenario.
Module design	The module is the level at which key detections are made. Multiple sensors for voltage, temperature and current will be placed in the module. The higher the number of sensors is, the better the visibility the control system has into the battery, and thus the better the ability to detect an event as soon as possible. Many systems have voltage sensors on every cell, which is highly advantageous. Many will also have multiple temperature sensors placed strategically, along with current sensors. An increased amount of sensors will typically accompany increased system cost. Modules also contain the systems responsible for the thermal management of the battery. Batteries are typically either air cooled or liquid cooled. The cooling system will help ensure the more balanced operation and degradation of the cells.

Operational safety risks of lithium-ion batteries

Table 54 describes the main ways a lithium-ion battery can be misused, increasing the risk of a failure scenario. Many of these risks come from undesired electrical operation, and thus the control system (BMS) plays a key role. The electrical architecture and system protections are also very relevant. These factors are described from a cell perspective. However, they are also present at the module and rack levels, with potentially worse consequences for the ship (DNV GL et al., 2020).

Table 54: Operational safety risks of lithium-ion batteries.

Operational safety risk	Description
Overcharge	Overcharging a lithium-ion battery is one of the most likely scenarios, and one with the worst consequences. Overcharging a battery means charging it to a point where its voltage is greater than it is rated to be. When a battery is overcharged, the internal temperature rises, and the electrolyte is at significant risk of breaking down into gaseous constituents. Both circumstances lead to a risk of igniting the electrolyte in liquid or gaseous form. The overcharging can happen due to the incorrect communication of the state of charge from the BMS to the converter or the power management system, an imbalance between cells or a short circuit producing an excessive charge current.
Overdischarge	Overdischarge represents a scenario where the battery voltage has dropped below the manufacturer's recommended limits. This can lead to decomposition of the electrodes within the battery, which then poses a risk of short-circuiting, and thus of heating the electrolyte and causing a fire. As in the case of overcharge, the BMS has a prime role in protecting against overdischarge.
Overcurrent	Overcurrent comes from charging or discharging the battery at too high a rate. This can cause excessive temperature generation, leading to electrolyte ignition. In addition, it can lead to incorrect voltage management, and thus to accidental overcharging or overdischarging. The converter connected to the battery should be equipped with overcurrent protection with limits set by the BMS. In severe cases, the excessive current may be due to a fault or a short circuit, and thus out of control. Passive electrical protections such as fuses and breakers are key to preventing such a failure.
Overheating	Thermal management of a battery system is essential. Excessive temperatures will accelerate degradation and lead to an accident. If the ambient temperature is too high, the battery may increase its internal temperature beyond acceptable limits. Acceptable upper temperature limits are often around 45 °C.
Excessive cold	Operating a battery in temperatures below its rated range will increase internal resistance and decrease efficiency, and can also lead to an accident through lithium plating on the anode or the formation of dendrites, thus resulting in an internal short circuit and the rapid heating of the electrolyte. Lower temperature thresholds vary widely between different cell chemistries, and manufacturer recommendations should be followed closely, but it can generally be considered inadvisable to operate below 10 °C.
External short circuit	An external short circuit poses the same risk as many of the other failure modes described in this section. If the battery is rapidly charged or discharged, the electrolyte in a cell may heat to the point of ignition and pose a threat of thermal runaway and/or flammable or toxic off-gas release. As mentioned before, passive electrical protections such as fuses and breakers are key to preventing this failure.
Mechanical damage	If a cell is mechanically damaged, there is a risk of the electrodes coming into contact and short-circuiting. This short-circuiting thus produces the same failure mode as heating the electrolyte to the point of ignition.
External fire	An external fire threatens the battery system itself, and could thus lead to the direct overheating and combustion of all battery materials. An external fire may also heat up the battery space so the ambient temperature exceeds the acceptable limit for safe battery operation. Proper fire segregation of the battery room and a fire extinguishing system that removes the heat from the battery space are therefore important.

Operational safety risk	Description
Internal defect	An internal defect represents perhaps the largest threat to a lithium-ion battery system because it is something that cannot be detected by the BMS. Most other failures will result in indications from voltage or temperature sensors that will be detected and accounted for by the BMS. An internal defect may produce an internal short circuit without warning. This may be the result of poor quality control at the manufacturing stage. Although many cell producers maintain a high degree of quality control, the large number of cells required for an installation makes the detection of internal defects more difficult. Internal defects pose significant risks, and are the main reason off-gas and thermal runaway must be considered and protected against in even the most highly controlled and monitored systems.

Regulatory development

Rapid technological development requires the implementation of technologies in a safe and uniform way across the sector, based on well-understood, simple and solid safety guidance. At the same time, continuous technological development in the search for the most efficient energy storage solution or chemistry also makes it difficult to draw up requirements due to a fear that they would become obsolete in a short period of time – even before adoption.

There are still no international regulations or guidelines concerning risk management of battery storage and installations for electric propulsion. There is only a general reference (SOLAS II-1 Regulation 40.2):

> *The Administration shall take appropriate steps to ensure uniformity in the implementation and application of the provisions of this part in respect of electrical installations.**
>
> ** Refer to the recommendations published by the IEC and, in particular, publication IEC 60092 – Electrical installations in ships.*

Furthermore, Regulation 45 'Precautions against shock, fire and other hazards of electrical origin' states the following in relation to batteries:

> *9.1. Accumulator batteries shall be suitably housed, and compartments used primarily for their accommodation shall be properly constructed and efficiently ventilated.*

The important field of battery energy storage systems safety has been shaped by the requirements of classification societies, industry standards, and the relevant codes, with only limited involvement from flag states.

EMSA, with the support of the Commission, the Member States and the industry, has drawn up the first non-mandatory guidance for national administrations and the industry. This guidance aims at the uniform implementation of the essential safety requirements for battery energy storage systems on board ships, focusing on lithium-ion batteries, which are the most widespread technology for use in maritime applications. **EMSA guidance on the safety of battery energy storage systems on board ships has been available since November 2023** (165)**.**

IEC standards provide for the relevant standardisation of lithium-ion batteries and for general electrical safety aspects. The main standard addressing the safety of large marine batteries is under preparation: IEC standard 63462-1 – Maritime battery system – Part 1: Secondary lithium cells and batteries – Safety requirements.

Industry guidance has also been emerging to contribute to standardisation efforts, such as the 'Guideline towards standardisation of containerized maritime battery systems' (166) by the Maritime Battery Forum, or its 'Firefighting guideline for maritime battery systems' (167).

5.5.9.2 Shore-side electricity

The operation of electric-power-driven ships requires shore-side/port infrastructure not only for supplying shore power but also for charging secondary battery groups on board. Interconnectivity and interoperability are key challenges to address for shore-side electricity (SSE) connection. Another important challenge for port electrical capacity development relates to constraints from transmission and distribution grids due to the need to feed significant electrical power capacity into ports to address the power demand from ships at berth.

SSE is essential in supporting electrification efforts. Disconnecting on-board generators and receiving electrical power from the shore or charging on-board batteries from shore-side battery charging installations are some of the possible options that are available today. Some key aspects of the infrastructure, equipment and operational concepts

165 https://emsa.europa.eu/we-do/safety/ship-safety-standards/item/5061-battery-energy-storage-systems-bess.html.

166 https://www.maritimebatteryforum.com/news/guideline-towards-standardisation-of-containerized-maritime-battery-systems.

167 https://www.maritimebatteryforum.com/news/firefighting-guideline-for-maritime-battery-systems.

have an important role in the safety of SSE installations. Aspects such as interconnectivity and interoperability, electrical safety risk management, selectivity and electrical protections are among the relevant elements to consider.

The various SSE technical options include the following.

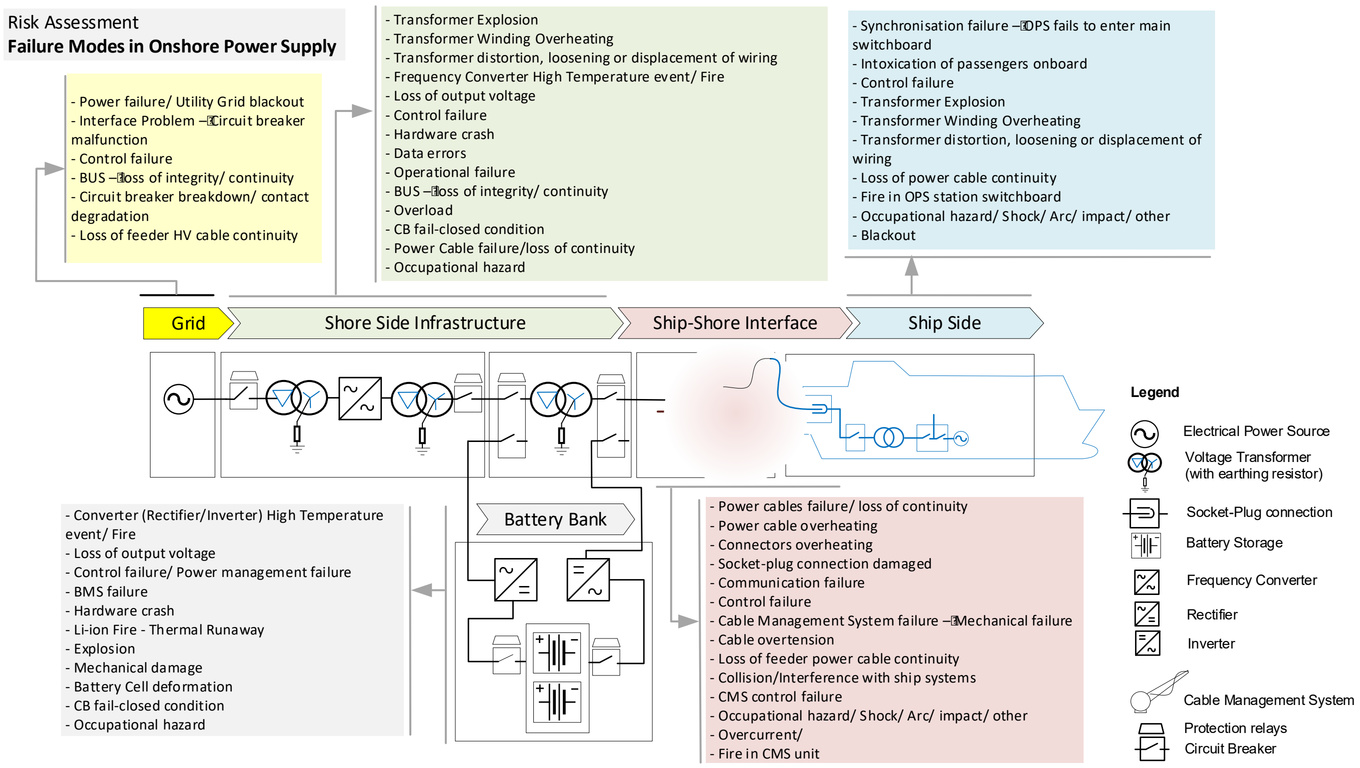
- **Onshore power supply (OPS).** Supply of electrical power across the ship-to-shore interface, in AC (alternating current) or DC (direct current), high voltage or low voltage, directly to the ship's main distribution switchboard, in replacement of on-board electrical power generation.
- **Shore-side battery charging (SBC).** Supply of electrical power across the ship-to-shore interface, in AC or DC, high voltage or low voltage, with the objective of charging EES units on board, involving power and battery management ship-to-shore interconnectivity.
- **Battery swapping.** Swapping of modular EES systems/ units between ship and shore, where a charged modular unit is embarked and connected on board in replacement of an identical/compatible unit to be charged at shoreside.
- **Shore-side power banking.** Use of EES / battery bank systems to provide energy for SSE services, when used as a main power source. Power banking can be either (1) from shore to ship, with EES ashore and otherwise standard OPS/SBC connection, or (2) via embarkation and on-board connection of modular EES.
- **Power generation.** The combination of distributed and microgeneration power solutions arranged in such a manner as to be used in the direct supply of electricity to SSE services.

In 2022, EMSA published guidance on SSE [168] intended to assist in the planning and development of SSE options, starting with project decision-making and the development of infrastructure elements, the definition of responsibility frameworks and the construction of control measures to assist in operation. This guidance was developed to assist port authorities, and covers not only the OPS but also the charging of batteries, battery swapping and any other electrical interaction between the port and the ship.

Safety Challenges

There are various safety challenges involved in SSE. The diagram in Figure 162 illustrates the different possible failure modes that can occur. Relevant safeguards to mitigate risk involve a mix of procedures, safety equipment, electrical protection strategies and devices, grounding, training, etc.

Figure 162: Possible failure modes in SSE arrangements.



Source: EMSA services.

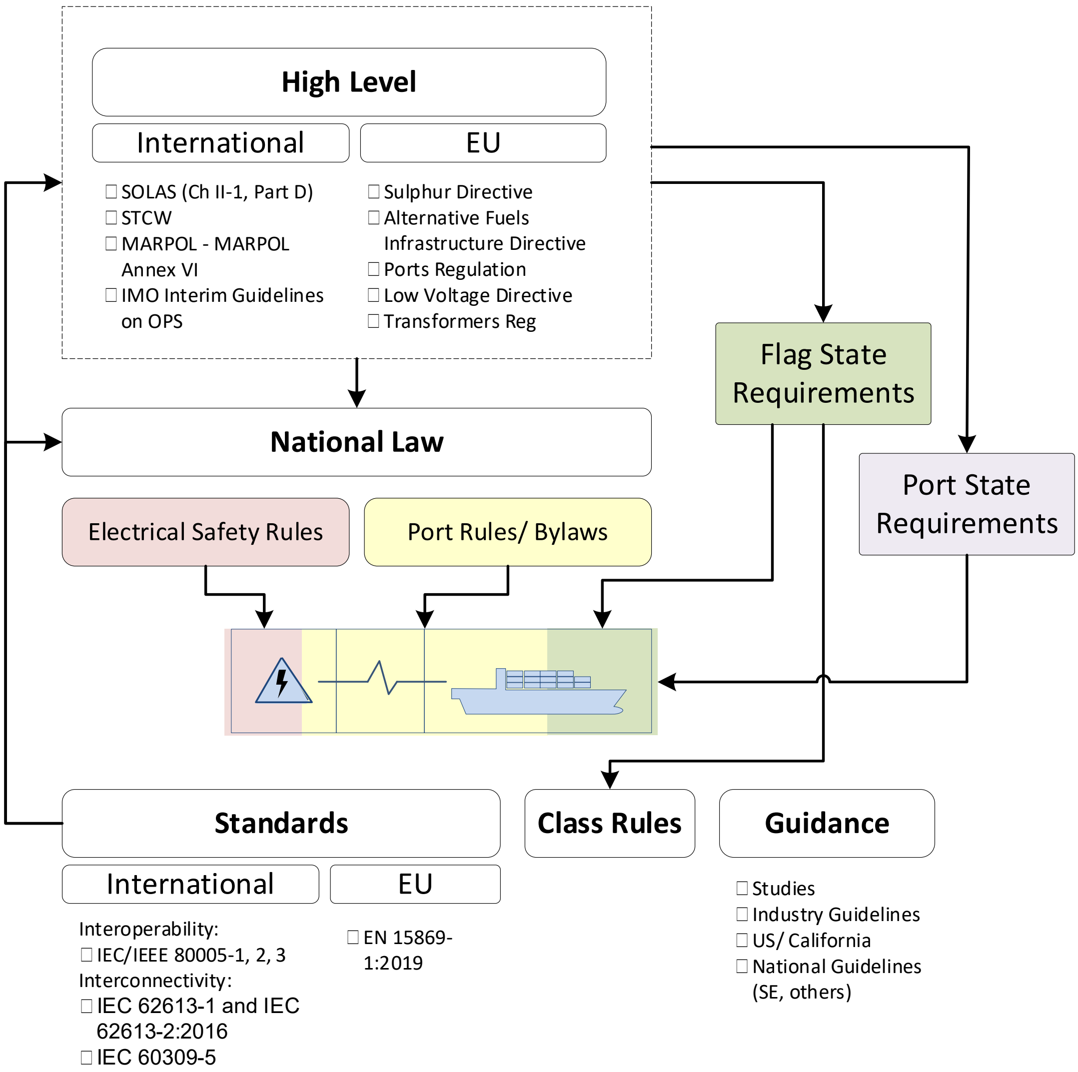
168 https://emsa.europa.eu/electrification/sse.html.

Regulatory Development

The regulatory framework for SSE is presented in Figure 163. Since both sides of the ship-to-shore interface are involved, the key challenge is to ensure interconnectivity and interoperability over the interface. This requires significant effort for the harmonisation and integration of international recognised standards with local/port/national frameworks.

Table 55 presents the level of completeness of the SSE regulatory framework.

Figure 163: SSE regulatory framework – different dimensions.



Source: EMSA services.

Table 55: SSE regulatory framework – identifying the gaps.

SSE mode		Interconnectivity	Interoperability
OPS	High-voltage shore connection	IEC 62613-2:2016	IEC/IEEE 80005-1
OPS	Low-voltage shore connection	IEC 60309-5	IEC/IEEE 80005-3 (under development/ finalisation)
OPS	Low-voltage shore connection – inland waterway	EN 15869-2:2019 (up to 125 A) EN 16840: 2017 (above 250 A)	
SBC	SBC-AC As OPS – ship-side charging	IEC 60309-5/ IEC 62613-2 AC connection	IEC/IEEE 80005 series As OPS – ship-side charging
SBC	SBC-DC	Not yet standardised	Not yet standardised

Source: EMSA services.

	Data Communication	Automation	International/EU Regulatory
OPS	IEC/IEEE 80005-1 (7.8) IEC/IEEE 80005-2 (normative requirements currently exist only for cruise ships)	Missing	IMO OPS guidelines EU AFID
OPS	IEC/IEEE 80005-2	Missing	Missing
OPS	Possible application of IEC/IEEE 80005-2	Missing	CCNR CESNI – ES-TRIN2019
SBC	Possibility for future development for IEC/IEEE 80005-2 or ISO15118	Missing	Missing
SBC		Missing	Missing

06 Looking ahead

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An analysis of the previous sections leads to the conclusion that the next few years will be eventful in the maritime safety field. There are challenges and opportunities in practically all the areas analysed that will have to be tackled effectively and in a cooperative manner by the maritime community as a whole.

6.1 The human element

- The EU has a centralised assessment system in which EMSA inspects the education systems of non-EU states so that the EU can recognise their certificates. Decision-makers should be aware of the need to maintain enough resources for conducting this assessment activity to ensure that there are enough seafarers with sufficient qualifications to crew EU Member State-flagged ships.

- The study of the implementation of the MLC 2006 in Association of Southeast Asian Nations countries will contribute to a common understanding of the status of seafarers' recruitment and placement at a global level, to identify obstacles to the effective implementation of labour-supplying responsibilities.

- The working environment of seafarers is not an easy one; the hardships go beyond the storms, the high waves and the bad weather conditions endured. The long days at sea, the intense activity in port, the limited social interaction and the fatigue are all factors that make life at sea highly demanding. Efforts to improve the working conditions of seafarers, such as the MLC Convention, are steps in the right direction. However, the figures from PSC inspections demonstrate that there is still a long way to go in improving the safety of the seafarers on board ships (see Section 5.1.5). Around 25 % of the deficiencies found relate to the human element, most of them within MLC Title 4, which deals with healthcare, safety protection and accident prevention for seafarers.

- Joint IMO, ILO and EU initiatives, complementing available research, are expected to strengthen protection against violence and harassment, including sexual harassment, bullying and sexual assault, to ensure seafarers' right to decent work and to increase the attractiveness of the industry across genders.

- Digitalisation and automation are increasing the demand for highly skilled crews. Reskilling and upskilling will be required, and can also bring opportunities for seafarers. The transfer to ROCs will improve working conditions by reducing the exposure to hazardous environments and to the long periods of time in partial social isolation. Training seafarers in new technologies will enable them to benefit from new opportunities that arise from technological developments. There will also be a need to reflect the demands of new technologies in an updated STCW Convention.

- The introduction of alternative fuels in the sector and the identification of the required skills and competencies resulting from research and growing experience need to be followed by guidelines for the development of training and assessment programmes for seafarers, along with new regulatory proposals. This is especially important in view of the ongoing comprehensive review of the STCW Convention.

- To support the transition of the EU maritime sector to a paperless environment, EMSA will continue working on the development of the EU Seafarers' Certification Platform. Among other functionalities, the platform will provide the means to issue e-certificates to seafarers and to facilitate the verification of the authenticity and validity of these documents. By doing so, the platform is expected not only to reduce the burden of PSC inspections relating to the verification of crew certificates, but also to increase protection against fraudulent documents while facilitating the provision of updated information on seafarers' numbers.

6.2 Ship safety

- The safety of passenger ships will remain a topic of the utmost importance, in particular due to the standing ageing trend of those ships flagged under a flag of an EU Member State. In general, safety standards are not applied retroactively and, accordingly, each ship fulfils the standards applicable at the date of construction. The analysis of the EU Member States' fleet of passenger ships shows that 38 % of ships in operation were built at the time when the applicable damage stability standards were those of SOLAS 60 and SOLAS 74 (see Section 1.3.1.3). This means that the fleet continues to have a heterogeneous safety level as far as damaged stability is concerned.

- The visits that EMSA is carrying out for passenger ship safety legislation show, on some occasions, a weak level of implementation of the safety requirements for domestic ships, which transport around 200 million passengers per year. In some cases, following the visits, safety certificates have been withdrawn. It is also noted in relation to these visits that the majority of Member States have delegated the surveying of these ships to ROs. Accordingly, it is to be considered whether the assessment of ROs should also include domestic passenger ships, as currently it only covers those operating internationally.

- The development cycle for new safety standards can take more than a decade from the moment the problem is officially recognised until the associated standards come into force. Then, from that point, more than a decade can pass until the new requirements have a real impact on the fleet, since they usually apply only to new ships. As illustrated in Section 5.2.2, the analysis of fire-related accidents supported by the outcomes of the Firesafe studies initiated by EMSA demonstrated the need to act and to amend SOLAS on fire safety matters back in 2016. Measures recommended and approved by the IMO in 2020, such as the minimum distance between permanent side openings of ro-ro spaces, will be applicable only from 2026.

- More research results are becoming available about electric vehicles' fire characteristics, which should assist regulators and the industry in applying appropriate measures when it comes to preventing or mitigating the consequences of vehicle fires on board ro-ro ships. The IMO will be working on the evaluation of the current requirements on the fire protection measures of ro-ro and vehicle spaces on board ships until 2027. In 2025, EMSA began the 'Study on alternative fuels vehicles (AFVs) fire safety on-board of ships' to complement real-scale testing of fires in enclosed spaces, the first deliverables of which will be available in 2026.

- The lack of harmonisation of fire protection standards for materials other than steel is another challenge. Whereas it is common to build large passenger ships from steel, small ones are built using aluminium, glass-reinforced plastic and wood. These ships are, in general, outside the scope of Directive 2009/45/EC, which only covers ships above 24 metres in length. However, in the domestic EU Member States' fleet, there are more than 1000 passenger ships made of wood and 600 made of glass-reinforced plastic already in operation with a length of less than 24 metres. The study launched by the Commission that, among other issues, includes this element could be the beginning of a harmonisation process to bring about further opportunities to enhance safety and the internal market.

- Increasing the installed offshore wind capacity in the EU is seen as a requirement for meeting the EU's targets for the use of renewable energy. This means that the demand for offshore support ships carrying industrial personnel is expected to increase. The international code for such ships operating on international voyages is already in force. However, the code does not include ships operating domestically, which is the case for most of these ships. This situation could pave the way for a misalignment of safety levels.

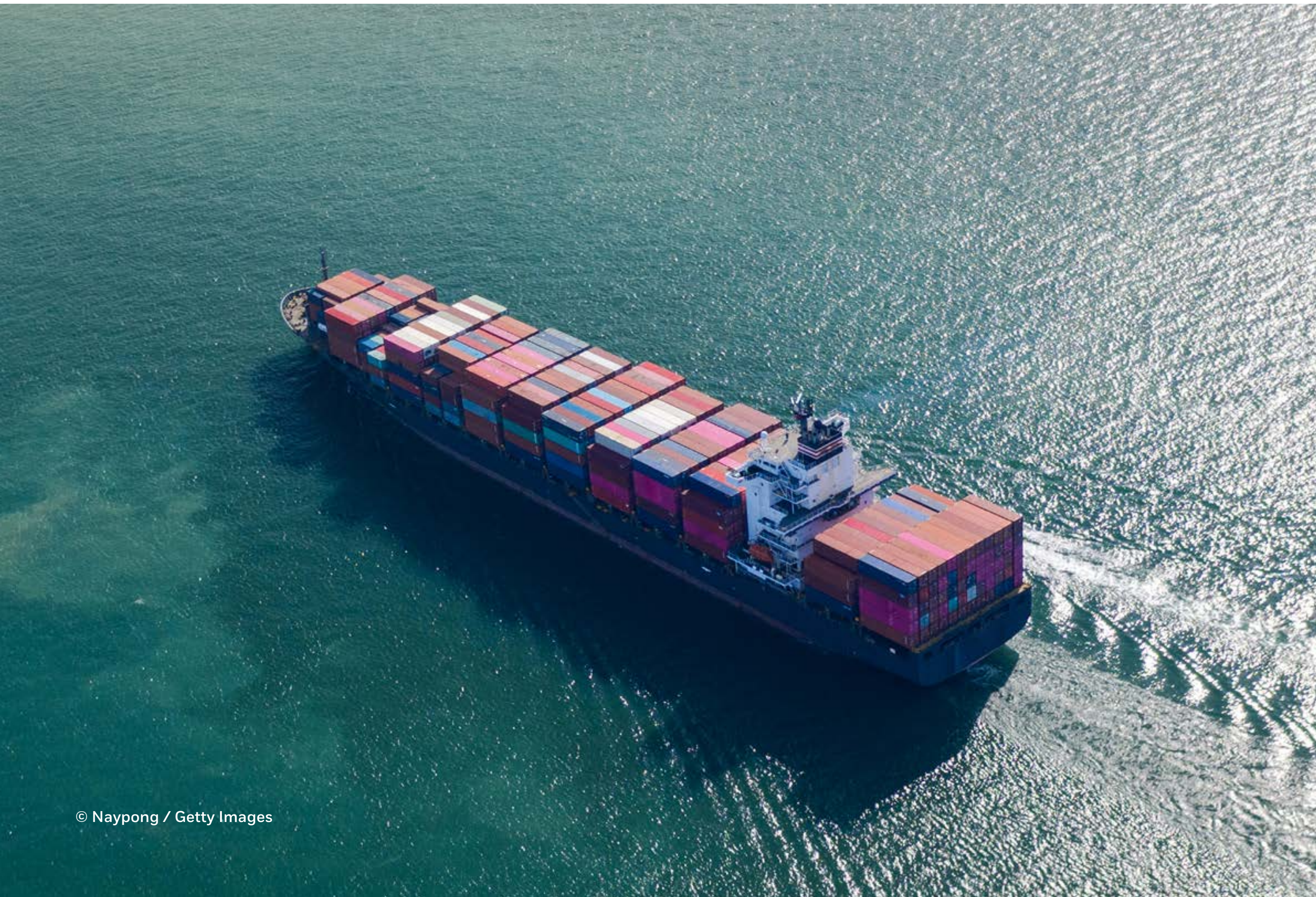
- The safety of fishing vessels is also a topic that should remain on our agenda in the coming years. Since 2020 there been no improvement in the safety level of these ships, judging by the number of accidents they have been involved in and their consequences. In addition, more than 65 % of the fleet of fishing vessels is more than 25 years old. The implementation of the AI Directive, which includes the mandatory reporting of accidents involving fishing vessels above 15 metres, and the new voluntary regime on PSC inspections in EU ports are expected to provide new insights into and impact on the safety of these ships in the long term. In addition, the Commission is in the process of evaluating the implementation of Council Directive 97/70/EC.

- The automation of ships will not happen immediately. It will follow a gradual approach. This means that, during the first years of operation, remotely controlled highly autonomous ships will sail on the same routes and call at the same ports as traditionally manned ships. This was also the case when steam-propelled ships operated simultaneously with sailing ships. Difficult-to-predict challenges may arise in terms of surveys, manoeuvres at sea and in port, qualifications, etc.

- EMSA is supporting the harmonisation of the safety level of the new technological solutions associated with autonomous ships based on the risk model developed in RBAT. Training sessions for EU maritime administrations and the industry, awareness campaigns and further enhancement of the pilot software tool are planned for the coming years.

- The cycle of visits to assess the implementation of the MED has produced important results and identified areas for improvement. The end-of-cycle workshop allowed all the stakeholders to take stock of the conclusions and learn about best practices. The mutual recognition agreement with the United States has allowed EU equipment manufacturers to access the US market, while at the same time ensuring harmonised safety with an important flag state. EMSA is working with the USCG on an interface between their respective product databases. The extension of this agreement to cover more items of equipment and the potential new agreements with other states may bring about new opportunities for the EU marine equipment industry.

- The new MED Portal mobile applications and the strengthening of the unique identification numbers for each product could improve the lack of enthusiasm shown until now in embracing the e-tag application for marine equipment. The possibility to scan e-tags with a simple mobile phone may lead to new opportunities for the industry and administrations, especially for market surveillance authorities. In addition, the e-tag will minimise the possibility of installing non-compliant equipment on board. Implementation is developing slowly, but is expected to gain traction in the coming years with the manufacturing of more items of MED e-tagged equipment. In addition, the possibility of including the marine sector in the concept for the implementation of the European digital product passport under the new Regulation (EU) 2024/1781 on ecodesign for sustainable products may bring about new opportunities for the further digitalisation of MED items.



6.3 Information exchange

- It is important to continue improving the quality of the information exchanged via SafeSeaNet in the effort to reduce the number of misdeclared hazmat cargoes. The risk of cargo-related accidents, such as cargo fires on container ships, could be reduced solely through correct declaration.

- Regulation (EU) 2019/1239 aims at the harmonised development of Member States' maritime NSWs and at facilitating the fulfilment of reporting obligations by ship operators in all EU ports through harmonised digital reporting interfaces. EMSA has developed common specifications and standards and is running a feasibility study to identify what information provided at the departure from a port in the EU must be made available upon arrival at the next port. This is expected to facilitate the application of the 'reporting once only' principle of the EMSWe Regulation. Depending on the study results, SafeSeaNet should be upgraded to address the necessary exchange of EMSWe information between the maritime NSWs of the Member States.

- New technologies and services are also being explored based on the exchange of notifications and position reports. The further optimisation of digital data communications through the use of VDES, and new sources of information such as satellite images, may complement existing land-based SAR services detecting, for example, emergency position-indicating radiobeacon or person-overboard alerts sent as AIS notifications that trigger alerts to maritime or SAR authorities.

- EMSA's IMS continue to support the Member States' authorities in their SAR activities. The number of enhanced SAR-SURPIC service requests recorded over the last several years shows that the Member States' use of the service is growing. This is positive in relation to information sharing for the facilitation of these operations, but also raises concerns about the growing number and types of distress situations that require the use of the service.

6.4 Implementation of legislation

- The inspection regimes – including those of the flag state, the port state and the special EU survey system for ro-pax and HSC engaged in regular voyages – will remain the cornerstone of the EU maritime safety policy. A continuous and remarkable effort is being made by all PSC inspectors, with the total number of inspections carried out rising to almost 14 500 in recent years. Sufficient resources and proper training programmes should be provided to ensure that the inspection effort is, at least, maintained.

- The main tool used to verify the implementation of EU maritime legislation is EMSA's visits. This exercise is far more than a mere 'control check'. It provides maritime administrations with the opportunity both to become more efficient by learning from the best practices already in place in other Member States and to improve their safety performance. The HA of a whole cycle of visits provides administrations with a safety benchmark against which they can compare their own operations. It also provides the EU legislator with first-hand feedback on the real issues experienced when implementing EU law.

- Flag states are delegating more and more competences to ROs, especially in the execution of statutory surveys. This means that part of the knowledge and experience of EU flag states is being lost. This tendency reinforces the importance of retaining centralised EU expertise to ensure the proper implementation of international regulations. Sufficient resources should be kept to undertake this important task. Similarly, the oversight of ROs by EU Member States is critical to ensuring that maritime safety is kept at an appropriate level. The IMSAS audits show that, with respect to the delegation of authority to ROs, the most recurrent findings relate to weaknesses in the administration's oversight programme. Accordingly, it should be considered whether this activity should be strengthened.

- Non-SOLAS ships brought under EU Member States' flags should be subject to the safety standards applicable to new ships and not to old ones corresponding to the keel-laying date. Throughout EMSA's inspections, it was noted that this has not always been the case and has led to low-standard ships, a situation that should be avoided.

- The Dynamic Overview of National Authorities tool, along with any developments it might undergo in the future, could potentially be used by the Member States to contribute to the self-assessment of their performance as flag states.

6.5 After the accident

- The latest Table-top Exercise on Places of Refuge again demonstrated the importance of having means of communication available for states and industry to cooperate when it is necessary to accommodate ships in need of assistance. More exercises of the kind (e.g. bilateral or regional) are necessary to spread awareness among neighbouring states about the existence of national procedures to deal with a place-of-refuge request and how the EU's operational guidelines on places of refuge can support decision-makers in such situations.

- SAR procedures, including exercises and evacuation methods, should be updated as necessary to ensure that suitable measures are in place to tackle a potential mass evacuation considering current and future passenger ship sizes. This is even more relevant in remote areas, such as the polar regions. EMSA recently launched a study looking at ways to enhance the effectiveness of evacuation on passenger ships.

- SARCPs are not mandatory for passenger ships on domestic voyages, though these ships can carry thousands of passengers. The possibility of exchanging best practices in this field should be considered.

- Aiming to support accident investigation, in 2023 EMSA started providing operational support for underwater surveys using ROVs. This service is also offered to national authorities in the context of coast guard functions, for instance for marine safety and counter-pollution, and could be expanded depending on users' needs.

- It is important that accident investigators be kept up to date with the impact of new technologies on safety. This will be necessary for the accident investigation process, particularly for incidents involving autonomous ships, alternative fuels transported as cargo or used as fuel, and ship electrification. EMSA will support associated training needs through the common core curriculum for marine safety investigators, launched in 2024.

6.6 Decarbonisation

- The understanding of the safety risks associated with the use of new fuels in shipping has grown at a fast pace since the last Emsafe report. However, the industry should be aware of the change in paradigm needed when dealing with fuels that are known to have severe consequences for the ship and for life on board in case of an accident. To be safe in the presence of the toxicity risks of ammonia and the explosion risks of hydrogen, both aggravated by the dispersion characteristics of these chemicals when compared with conventional fuels, robust risk mitigation measures are needed as part of inherently safer designs.

- The introduction of additional risk mitigation barriers in ship design ultimately leads to complexity and to somewhat different ships with specific operational needs, of which there is still little experience in the maritime industry. Risk assessment becomes crucial for the overall safety assessment and the verification of new designs, and should be looked at holistically considering hazards associated with physical layout, operation, control of risk mitigation actions and maintenance.

- With the lack of a current regulatory framework for addressing the safety of large batteries on board ships, EMSA was a pioneer in developing the non-mandatory guidance on battery safety, with the overwhelming support of the EU industry and administrations. Nevertheless, the battery market is constantly changing, and there is a need to adapt this document to emerging battery types, designs and further needs such as provisions for the verification of compliance. Also, if so decided by the EU Member States, there is a need to bring the discussion into an international setting at the IMO.

- The IMO's 'Interim guidelines for the safety of ships using fuel cell power installations' have been available since 2021. However, they do not include provisions regarding the fuel-reforming unit and process**.** In addition, hydrogen safety should be duly considered due to possible leaks from pipes, fixtures and the cell itself, along with other hazards linked with the properties of the primary fuel (other than hydrogen) during fuel supply and reforming. A future revision will consider the most recent technological developments and the experience built up during the application of the guidelines.

- The recent approval of the IMO's 'Interim guidelines for the safety of ammonia as fuel' established a baseline safety standard for the use of this fuel that is expected to support administrations in the coming years as its uptake increases. However, the high-level nature of these guidelines may, at this stage, give way to different methods of implementation among flag states, and therefore different safety levels. One example of a verification requirement that is left to the administration without specific guidance on how it should be done is the approval of the methodologies and conditions for gas leak dispersion analysis.

- In this regard, ports also play a central role in the EU's maritime green transition strategy. Ports are critical for the safe and efficient storage, handling and bunkering of alternative fuels such as ammonia and hydrogen, charging batteries using SSE and providing an onshore power supply. Ports ensure fuel safety, operational continuity and system resilience as the sector moves towards low-emission solutions.

- Investment in new skills is critical to ensuring that workers, both on board and onshore, are prepared and protected in the process of introducing new fuels and their handling procedures. Seafarers will need to have the right skills to handle new, complex, hybrid and zero-emission systems. Any gaps in this area could pose serious health and safety risks and hamper the energy transition.

ANNEX 1 EU legislation/ guidance and its focus

Directive/regulation	Policy objectives and targets	Domain
Regulation (EC) No 789/2004	Eliminating technical barriers to the transfer of cargo and passenger ships flying the flag of a Member State between the registers of the Member States while, at the same time, ensuring a high level of ship safety and environmental protection, in accordance with international conventions.	Flag state and ROs
Regulation (EC) No 336/2006	Implementing the ISM Code within the Community.	Flag state and ROs
Directive 2009/15/EC	Common rules and standards for ship inspection and survey organisations and for the relevant activities of maritime administrations.	Flag state and ROs
Directive 2009/21/EC	Flag State Directive.	Flag state and ROs
Regulation (EC) No 391/2009	Common rules and standards for ship inspection and survey organisations.	Flag state and ROs
Commission Regulation (EU) No 788/2014	Laying down detailed rules for the imposition of fines and periodic penalty payments and the withdrawal of recognition of ship inspection and survey organisations pursuant to Articles 6 and 7 of Regulation (EC) No 391/2009 of the European Parliament and of the Council.	Flag state and ROs
Regulation (EU) 2019/492	Amending Regulation (EC) No 391/2009 with regard to the withdrawal of the United Kingdom from the EU.	Flag state and ROs
Directive 2009/16/EC	Establishing the PSC regime at the EU level.	PSC
Directive 2002/59/EC	Establishing a vessel traffic monitoring and information system with a view to enhancing the safety and efficiency of maritime traffic, improving the response of authorities to incidents, accidents or potentially dangerous situations at sea, including SAR operations, and contributing to the better prevention and detection of pollution by ships.	Traffic monitoring and information systems
Directive 2010/65/EU	Simplifying and harmonising the administrative procedures applied to maritime transport by making the electronic transmission of information standard and by rationalising reporting formalities for ships arriving in and ships departing from ports situated in Member States.	Traffic monitoring and information systems
Directive (EU) 2019/883	Protecting the marine environment against the negative effects from discharges of waste from ships using ports located in the EU, while ensuring the smooth operation of maritime traffic, by improving the availability and use of adequate port reception facilities and the delivery of waste to those facilities.	Traffic monitoring and information systems
Regulation (EU) 2019/1239	Introducing an interoperable environment with harmonised interfaces, to simplify reporting obligations for ships arriving at, staying in and departing from EU ports. Also, aiming to improve the European maritime transport sector's competitiveness and efficiency by reducing the administrative burden, introducing a simplified digital information system to harmonise the existing national systems and reduce the need for paperwork.	Traffic monitoring and information systems
Directive 2009/20/EC	Laying down rules applicable to certain aspects of the obligations on shipowners as regards their insurance for maritime claims.	Places of refuge
Places of refuge: EU operational guidelines	Providing guidance for competent authorities and the main parties involved in managing a request for a place of refuge from a ship in need of assistance.	Places of refuge

Directive/regulation	Policy objectives and targets	Domain
Council Directive 98/41/EC	Provision of the number of people on board passenger ships and their personal information, facilitating the management of SAR operations.	SAR
Regulation (EU) No 656/2014	Establishing rules for surveillance of the external sea borders in the context of operational cooperation.	SAR
Commission Implementing Regulation (EU) 2021/581	Establishing communication obligations between the European Border and Coast Guard Agency, the national competent authorities for border control and the RCCs.	SAR
Council Directive 2009/13/EC	Implementing the Agreement concluded by the ECSA and the ETF on the MLC 2006, and amending Directive 1999/63/EC.	Human element
Directive 2013/54/EU	Concerning certain flag-state responsibilities for compliance and enforcement of the MLC 2006.	Human element
Directive (EU) 2022/993	Establishing the minimum level of training of seafarers.	Human element
Council Directive 93/103/EC	Establishing minimum safety and health requirements for work on board fishing vessels.	Ship safety standards
Council Directive 97/70/EC	Establishing a safety regime for fishing vessels of 24 metres in length and over.	Ship safety standards
Directive 2001/96/EC	Establishing requirements and procedures for the safe loading and unloading of bulk carriers.	Ship safety standards
Directive 2003/25/EC	Establishing specific stability requirements for ro-ro passenger ships.	Ship safety standards
Directive 2009/45/EC	Establishing safety rules and standards for passenger ships.	Ship safety standards
Regulation (EU) No 530/2012	Relating to the accelerated phasing-in of double-hull or equivalent design requirements for single-hull oil tankers.	Ship safety standards
Directive (EU) 2017/2110	Establishing a system of inspections for the safe operation of ro-ro passenger ships and passenger HSC in regular service.	Passenger ship safety
Directive 2014/90/EU	Marine Equipment Directive.	Marine equipment
Commission Delegated Regulation (EU) 2018/414	Identifying specific items of marine equipment that can benefit from electronic tagging.	Marine equipment
Commission Implementing Regulation (EU) 2018/608	Establishing technical criteria for electronic tags for marine equipment.	Marine equipment
Commission Implementing Regulation (EU) 2021/1158	Establishing design, construction, performance requirements and testing standards for marine equipment.	Marine equipment

Directive/regulation	Policy objectives and targets	Domain
Regulation (EU) 2024/1781	Establishing a framework for the setting of ecodesign requirements for sustainable products, amending Directive (EU) 2020/1828 and Regulation (EU) 2023/1542 and repealing Directive 2009/125/EC.	Marine equipment
Commission Implementing Regulation (EU) No 651/2011	Adopting the rules of procedure of the PCF established by Member States in cooperation with the Commission pursuant to Article 10 of Directive 2009/18/EC.	Accident investigation
Commission Regulation (EU) No 1286/2011	Adopting a common methodology for investigating marine casualties and incidents developed pursuant to Article 5(4) of Directive 2009/18/EC.	Accident investigation
Directive 2009/18/EC	Establishing fundamental principles governing the investigation of accidents in the maritime transport sector in EU.	Accident investigation
EU operational guidelines for safe, secure and sustainable trials of maritime autonomous surface ships (MASS)	Establishing methods for designating test areas or a ship safety zone when conducting trials of MASS-related systems and infrastructure.	MASS

ANNEX 2 EU Member State fleet by flag

Table A2.1: Number of ships by EU Member State flag, excluding fishing vessels – size of fleet in 2023 and evolution between 2019 and 2023.

Country	2023	2019–2023	
Belgium	188	209	188
Bulgaria	45	54	45
Denmark	766	739	766
Germany	521	651	521
Estonia	59	63	59
Ireland	93	97	93
Greece	1,109	1,219	1,109
Spain	492	520	492
France	530	533	530
Croatia	353	328	353
Italy	1,145	1,234	1,145
Cyprus	969	1,021	969
Latvia	85	61	85
Lithuania	48	51	48
Luxembourg	148	152	148
Malta	1,827	2,157	1,827
Netherlands	1,141	1,154	1,141
Poland	124	117	124
Portugal	1,005	676	1,005
Romania	92	81	92
Slovenia	6	7	6
Slovakia	1	1	1
Finland	262	267	262
Sweden	349	358	349
Iceland	35	34	34
Norway	1,616	1,549	1,616

Table A2.2: Total fleet GT by EU Member State flag, excluding fishing vessels – fleet of 2023 and evolution between 2019 and 2023.

Country	2023	2019–2023	
Belgium	4.77M	6.3M	4.77M
Bulgaria	100.72K	136.42K	100.71K
Denmark	22.35M	21.04M	22.35M
Germany	7.94M	9.97M	7.94M
Estonia	350.73K	387.57K	350.73K
Ireland	263.51K	266.02K	263.51K
Greece	33.93M	39.6M	33.93M
Spain	2.44M	2.57M	2.44M
France	9.66M	6.4M	9.66M
Croatia	935.95K	1.26M	935.95K
Italy	12.6M	14.41M	12.6M
Cyprus	21.12M	22.79M	21.12M
Latvia	249.25K	120.97K	249.25K
Lithuania	318.86K	360.1K	318.86K
Luxembourg	1.19M	1.01M	1.19M
Malta	78.75M	80.45M	78.75M
Netherlands	6.51M	6.85M	6.51M
Poland	71.75K	63.94K	71.75K
Portugal	22.39M	15.19M	22.39M
Romania	46.9K	41.18K	46.9K
Slovenia	2.38K	2.73K	2.38k
Slovakia	1.25K	1.25K	1,25K
Finland	1.91M	1.7M	1.91M
Sweden	2.21M	2.07M	2.21M
Iceland	27.2K	24.77K	27.2K
Norway	19.29M	18.62M	19.29M

Table A2.3: Total number of fishing vessels by size and EU Member State (excluding Iceland and Norway).

Country	No. of vessels	< 15 m	15 - 24 m	≥ 24 m
Belgium	60	0	26	34
Bulgaria	1,777	1,722	44	11
Denmark	1,779	1,568	162	49
Germany	1,141	937	163	41
Estonia	2,035	2,005	5	25
Ireland	2,039	1,859	71	108
Greece	11,464	10,976	320	168
Spain	8,548	6,926	950	672
France	5,994	5,396	421	177
Croatia	7,319	7,031	186	102
Italy	12,258	10,800	1,150	308
Cyprus	818	794	18	6
Latvia	662	613	11	38
Lithuania	117	99	2	16
Malta	832	784	40	8
Netherlands	769	377	191	201
Poland	824	699	78	47
Portugal	6,859	6,414	271	174
Romania	174	169	3	2
Slovenia	136	130	6	0
Finland	3,238	3,202	17	19
Sweden	960	870	57	24

Table A2.4: Total number of fishing vessels by age, by EU Member State (excluding Iceland and Norway).

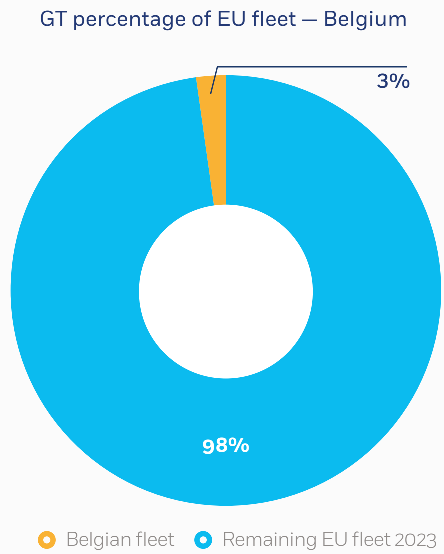
Country	< 5 years	5 - 14 years	15 - 24 years	≥ 25 years
Belgium	8	1	12	39
Bulgaria	63	267	547	900
Denmark	66	136	217	1,360
Germany	22	76	187	856
Estonia	129	366	480	1,060
Ireland	43	160	480	1,356
Greece	188	792	2,454	8,030
Spain	249	451	2,395	5,451
France	204	643	1,428	3,619
Croatia	85	303	948	5,975
Italy	160	947	1,693	9,458
Cyprus	0	0	0	818
Latvia	11	21	45	585
Lithuania	2	21	6	88
Malta	12	60	216	541
Netherlands	24	76	145	519
Poland	2	104	115	603
Portugal	150	456	1,845	4,407
Romania	6	59	41	68
Slovenia	0	0	0	136
Finland	105	426	551	2,156
Sweden	19	53	102	786

Detailed characteristics of the fleet of each EU Member State flag, excluding fishing vessels

BELGIUM

There are 188 ships registered with the flag of Belgium, corresponding to 1 % of the total EU Member State fleet. The sum of the Belgian ships' GT is 4 766 786, corresponding to 2 % of the EU Member States' fleet.

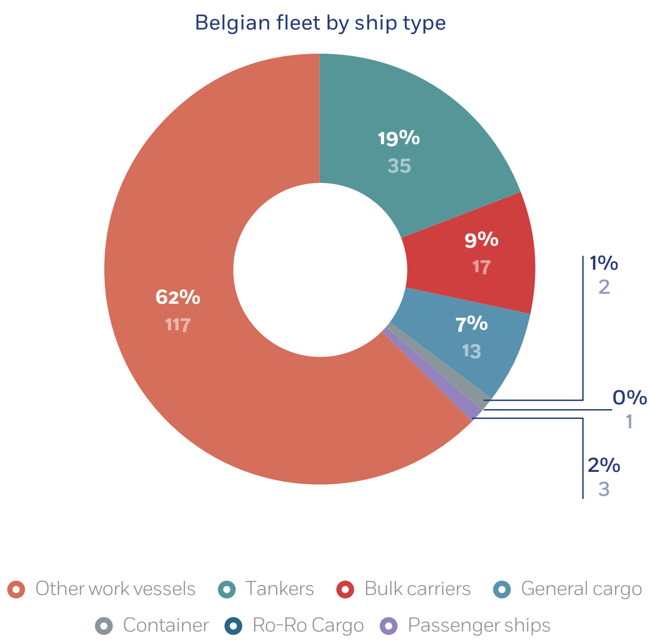
Figure A2.1: GT share of the flag of Belgium in the EU Member States' fleet.

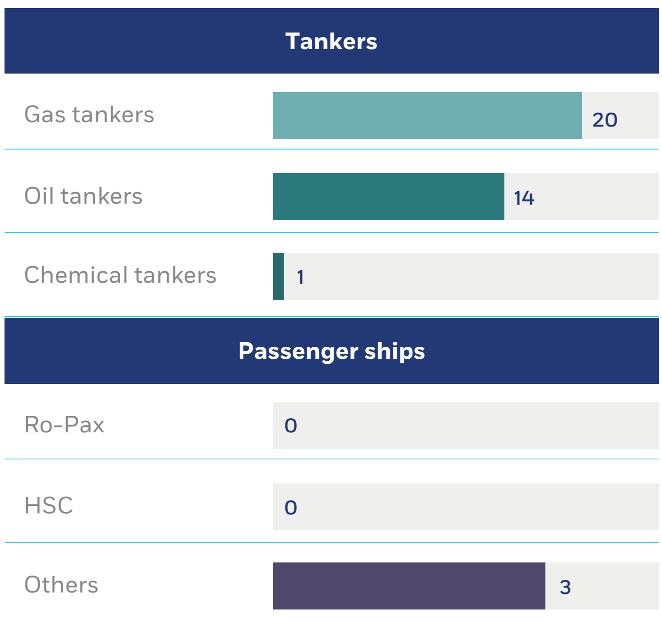


Their division by ship type is shown below. The largest category of ships flying the flag of Belgium is that of other work vessels, followed by tankers and bulk carriers.

Of the 35 tankers, the majority are either gas or oil tankers. There are no ro-pax or HSC in the Belgian fleet.

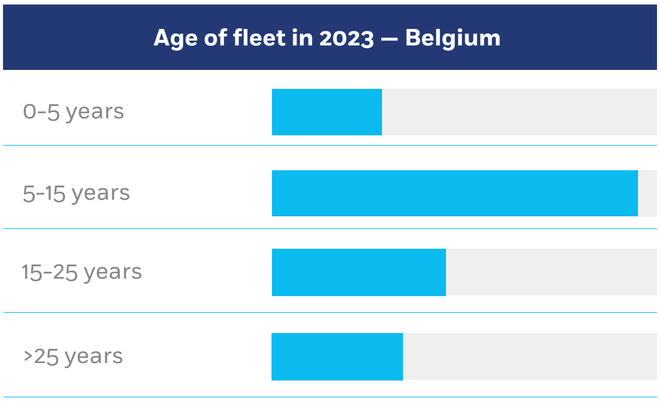
Figure A2.2: Belgian fleet by ship type, including number of tankers by subtype and number of ro-pax and HSC.

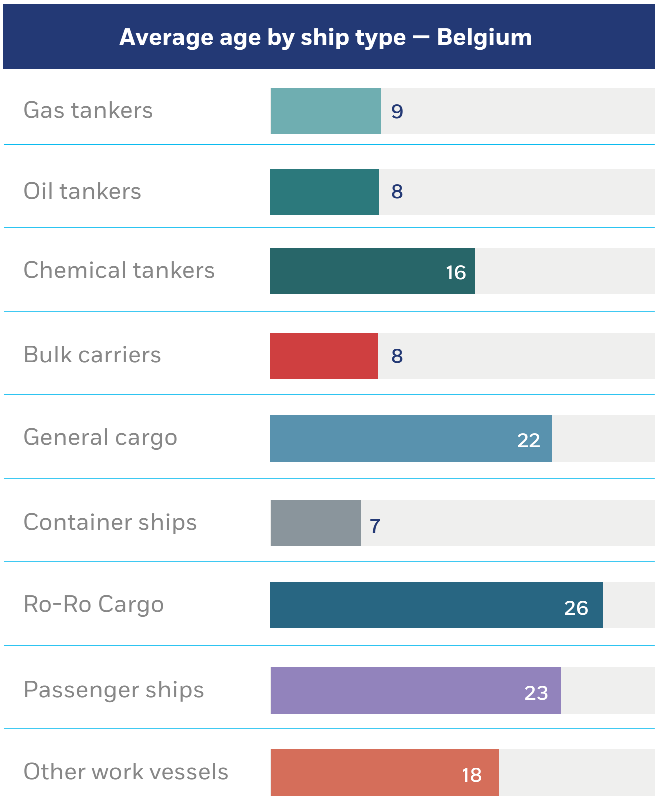




The overall fleet age categories and the average age by ship type of the ships flying the flag of Belgium are shown below.

Figure A2.3: Age of the fleet with the flag of Belgium – overall and average age by ship type.

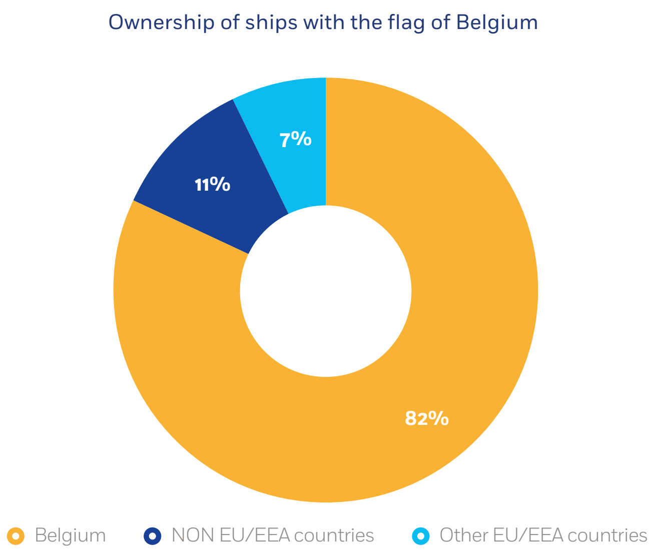


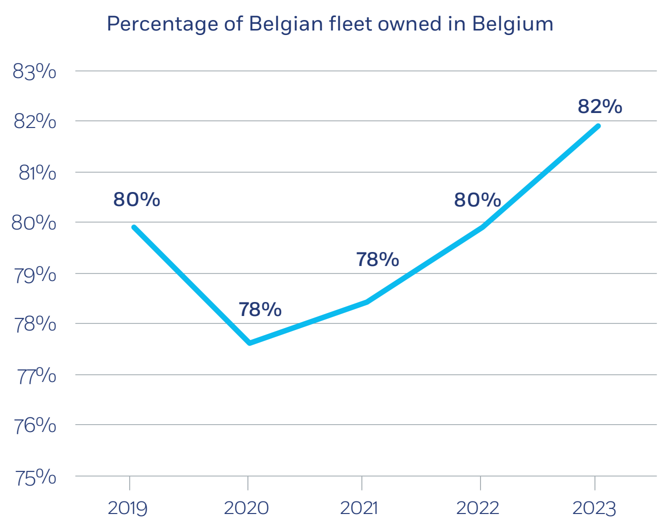


The percentage of ships, other than fishing vessels, with the flag of Belgium that belong to shipowners registered in the country is shown below.

This percentage has been increasing recently, after a drop in 2020.

Figure A2.4: Percentage of Belgian fleet owned by the shipowners of Belgium – evolution between 2019 and 2023.



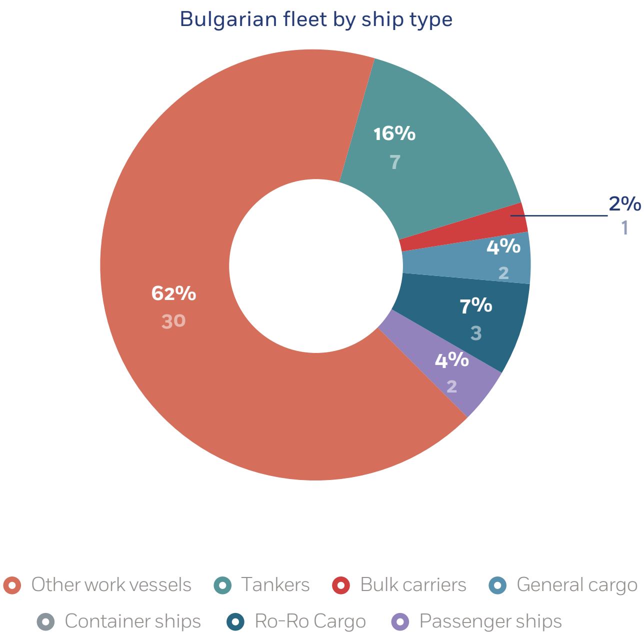


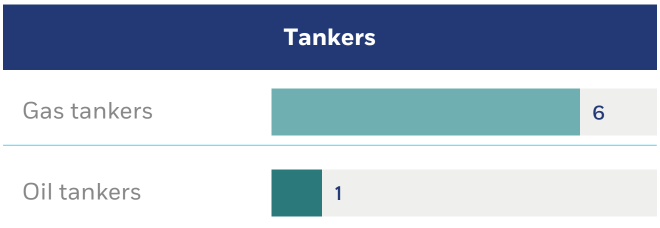
BULGARIA

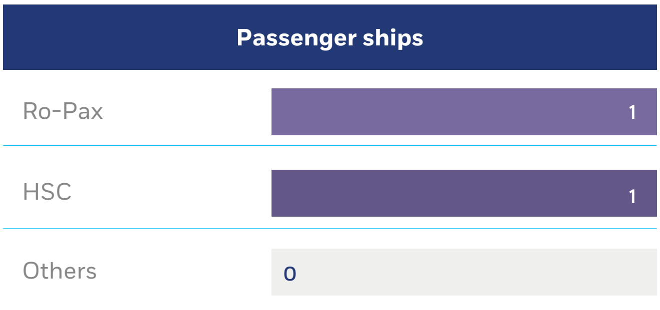
There are 45 ships registered with the flag of Bulgaria, with a total of 100 721 GT.

Their division by ship type is shown below. The largest category of ships flying the flag of Bulgaria is that of other work vessels. The fleet includes 7 tankers and 2 passenger ships (1 ro-pax and 1 HSC).

Figure A2.5: Bulgarian fleet by ship type, including number of tankers by subtype and number of ro-pax and HSC.

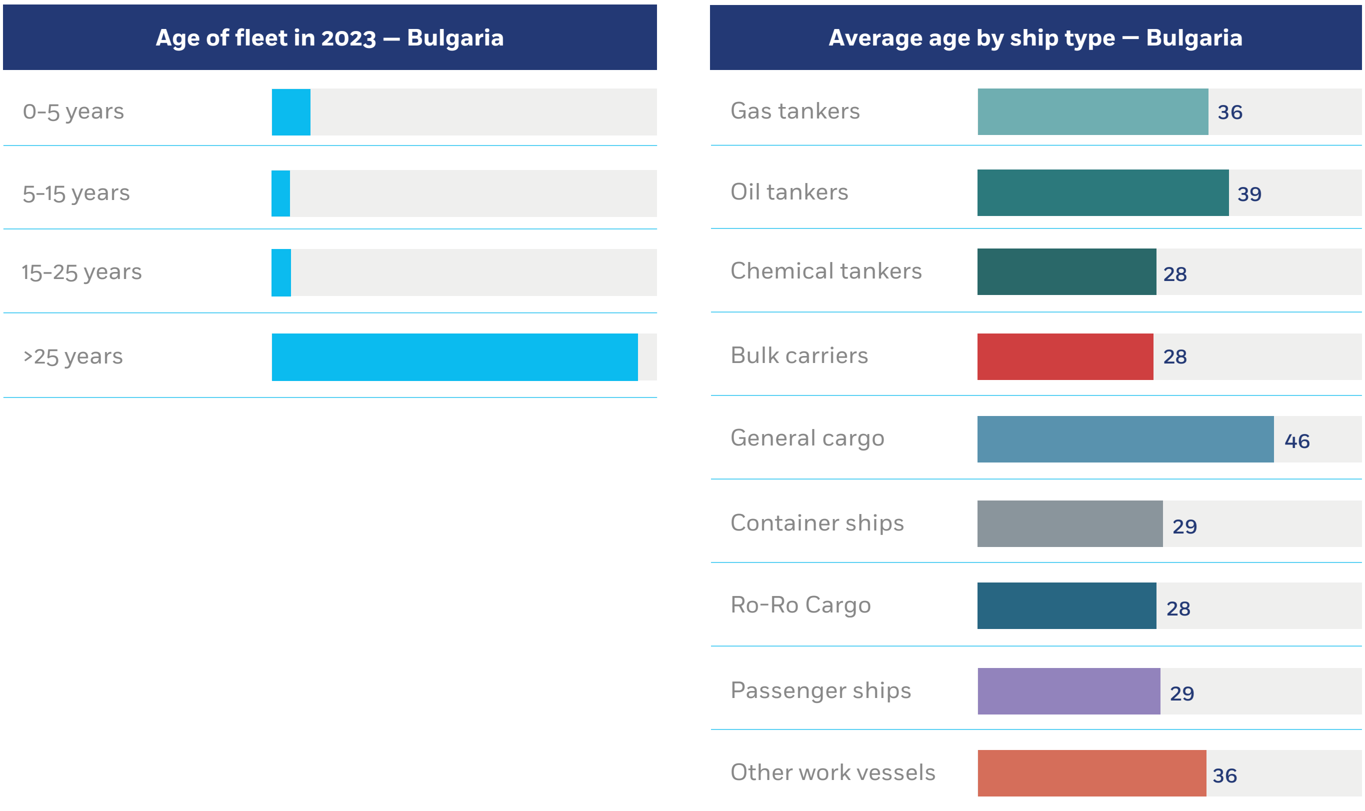






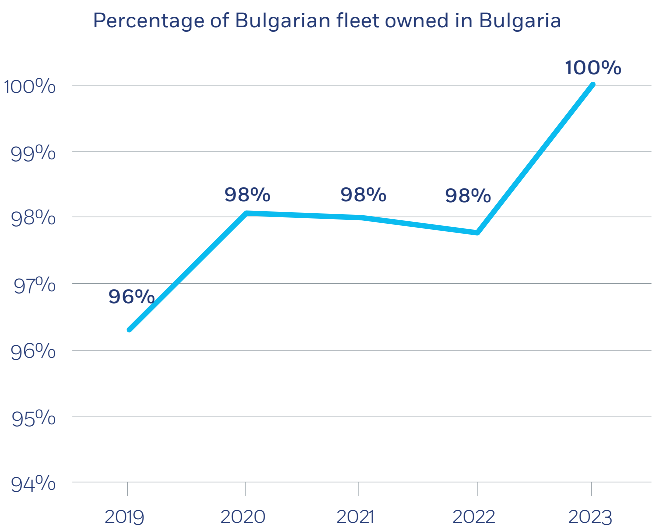
The overall fleet age categories and the average age by ship type of the ships flying the flag of Bulgaria are shown below.

Figure A2.6: Age of the fleet with the flag of Bulgaria – overall and average age by ship type.



All ships with the Bulgarian flag belong to shipowners based in Bulgaria. This percentage has been increasing since 2019, as shown in the figure below.

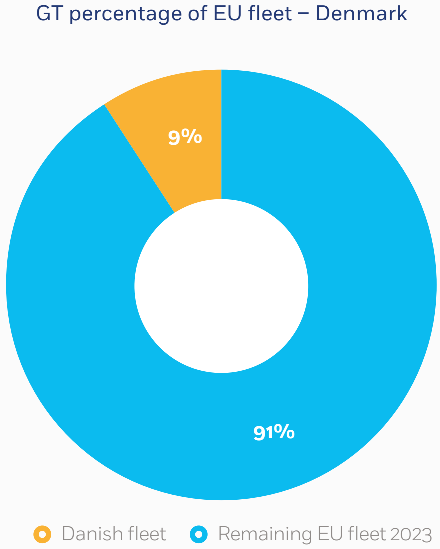
Figure A2.7: Percentage of Bulgarian fleet owned by the shipowners of Bulgaria – evolution between 2019 and 2023.



DENMARK

There are 766 ships registered with the flag of Denmark, corresponding to 6 % of the total EU Member State fleet. The sum of the Danish ships' GT is 22 348 102, corresponding to 9 % of the EU Member States' fleet.

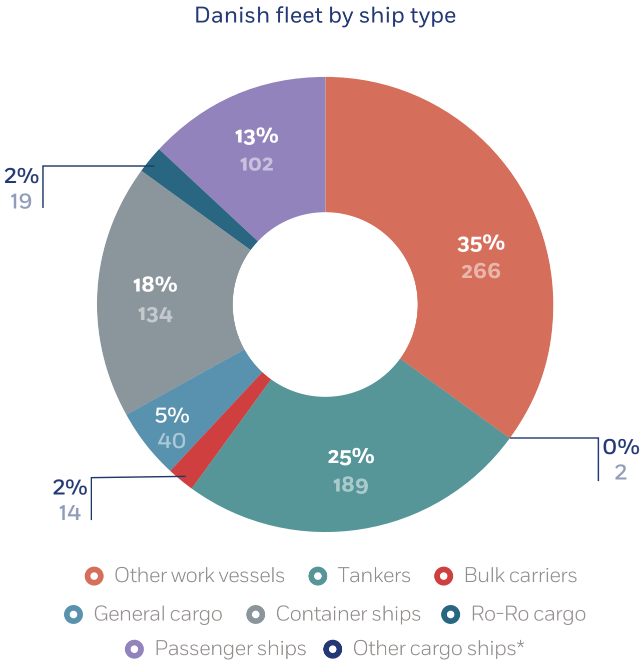
Figure A2.8: GT share of the flag of Denmark in the EU Member States' fleet.

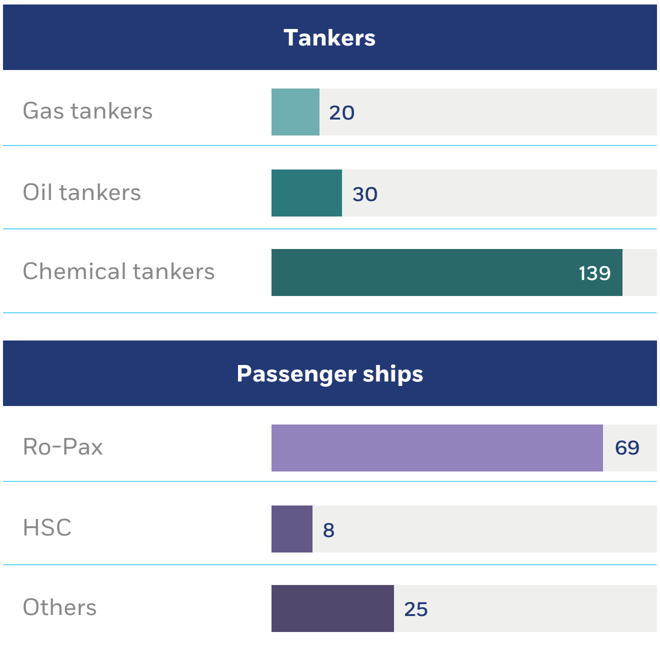


Their division by ship type is shown below. The largest category of ships flying the flag of Belgium is that of other work vessels, followed by tankers and bulk carriers.

Of the 35 tankers, the majority are either gas or oil tankers. There are no ro-pax or HSC in the Belgian fleet.

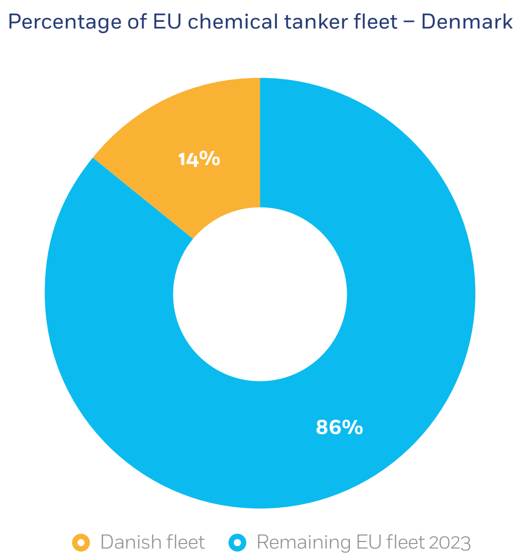
Figure A2.9: Danish fleet by ship type, including number of tankers by subtype and number of ro-pax and HSC.HSC.

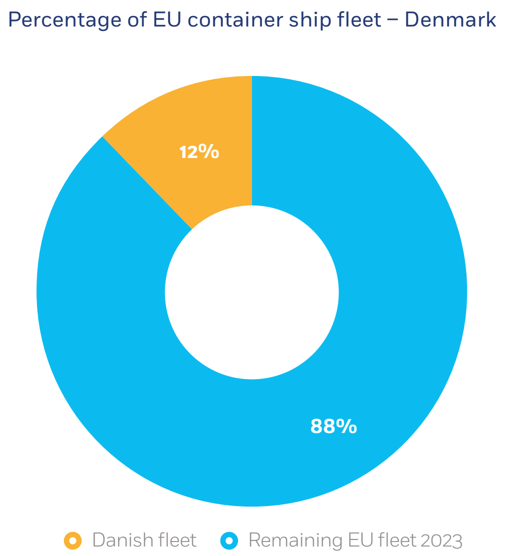




The chemical tankers and container ships of Denmark correspond to 14 % and 12 %, respectively, of the total EU Member State fleets of those ship types in terms of the number of ships.

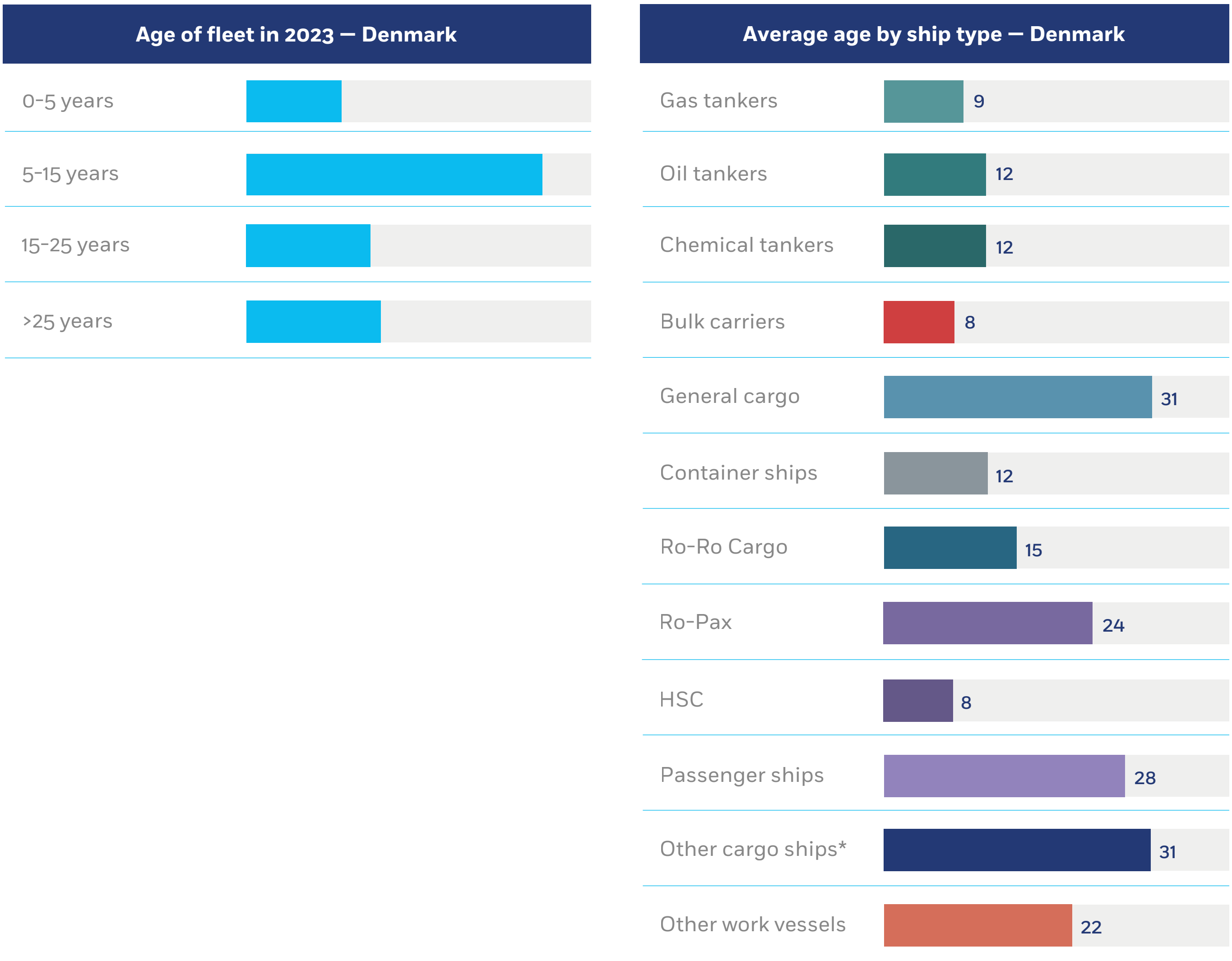
Figure A2.10: Share of the flag of Denmark in the EU Member States' chemical tanker and container ship fleets.





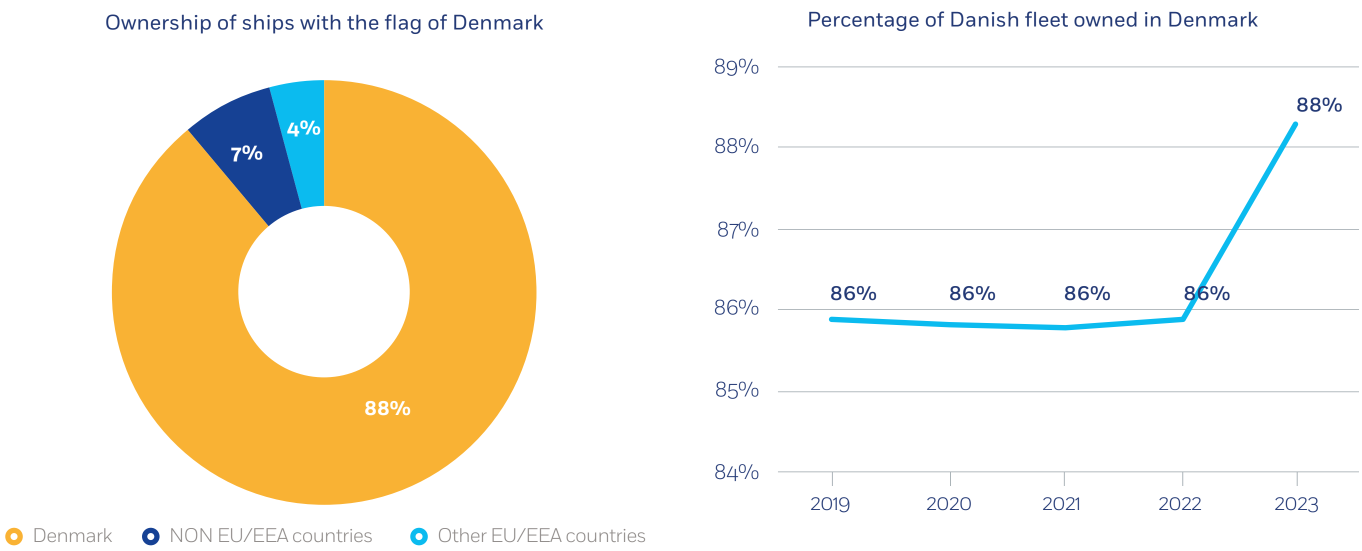
The overall fleet age categories and the average age by ship type of the ships flying the flag of Denmark are shown below.

Figure A2.11: Age of the fleet with the flag of Denmark – overall and average age by ship type.



The percentage of ships with the flag of Denmark that belong to shipowners registered in the country is shown below.

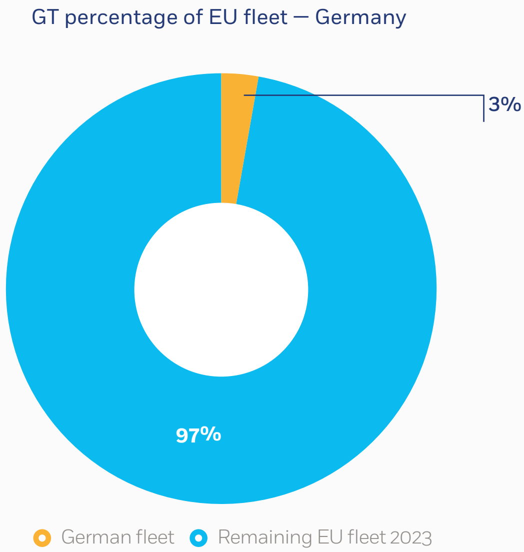
Figure A2.12: Percentage of Danish fleet owned by the shipowners of Denmark – evolution between 2019 and 2023.



GERMANY

There are 521 ships registered with the flag of Germany, corresponding to 4 % of the total EU Member State fleet. The sum of the German ships' GT is 7 938 832, corresponding to 3 % of the EU Member States' fleet.

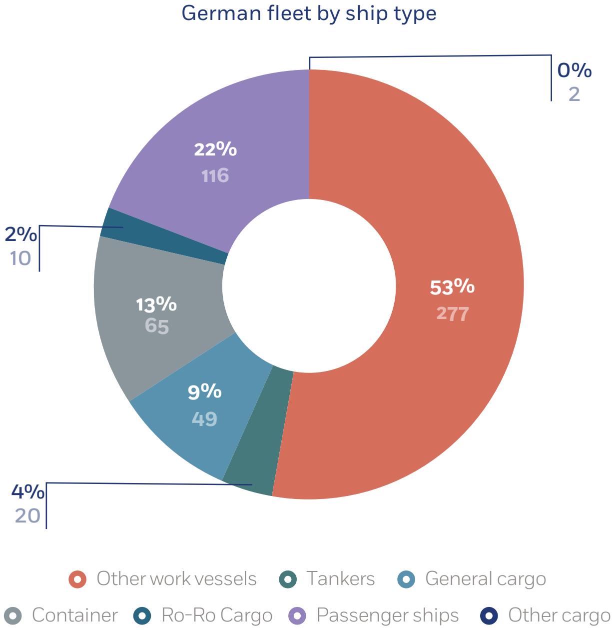
Figure A2.13: GT share of the flag of Germany in the EU Member States' fleet.

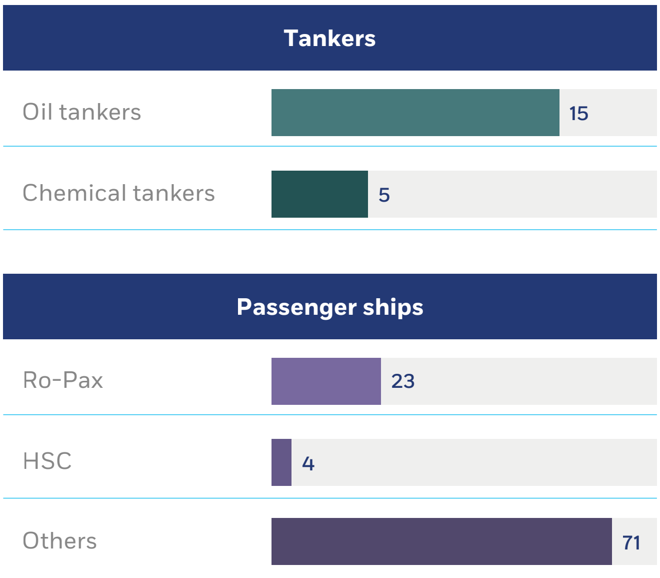


Their division by ship type is shown below. The largest category of ships flying the flag of Germany is that of other work vessels (53 %), followed by passenger ships (19 %) and container ships (13 %).

There are 98 passenger ships, including 23 ro-pax and 4 HSC, in the German fleet.

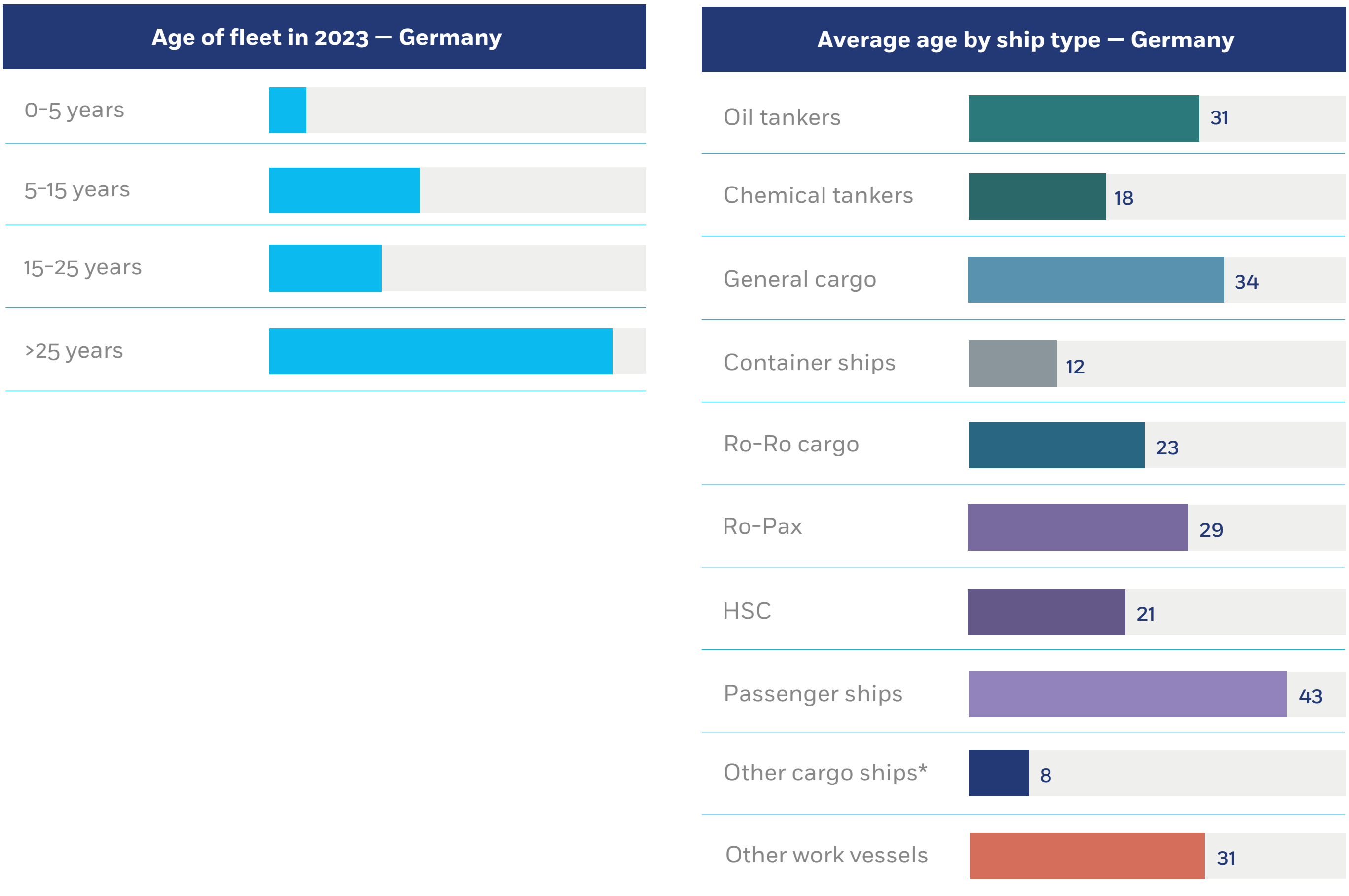
Figure A2.14: German fleet by ship type, including number of tankers by subtype and number of ro-pax and HSC.





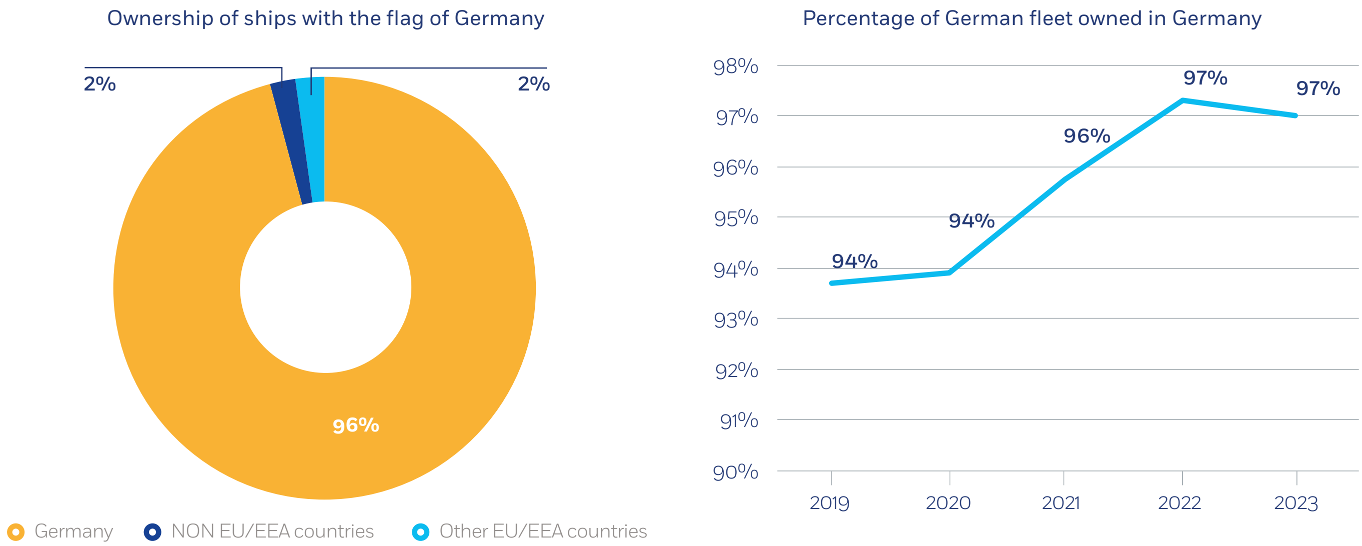
The overall fleet age categories and the average age by ship type of the ships flying the flag of Germany are shown below.

Figure A2.15: Age of the fleet with the flag of Germany – overall and average age by ship type.



The percentage of ships with the flag of Germany that belong to shipowners registered in the country is shown below.

Figure A2.16: Percentage of German fleet owned by the shipowners of Germany – evolution between 2019 and 2023.

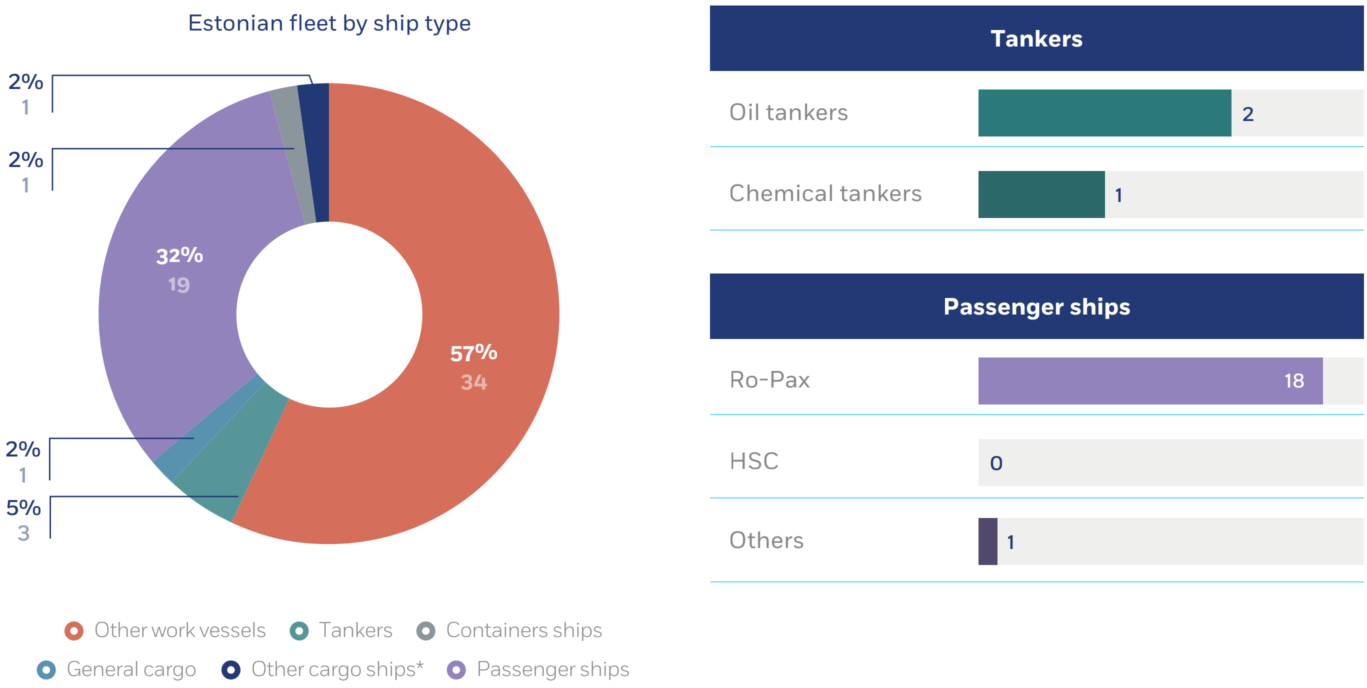


ESTONIA

There are 59 ships registered with the flag of Estonia, with a total of 350 729 GT.

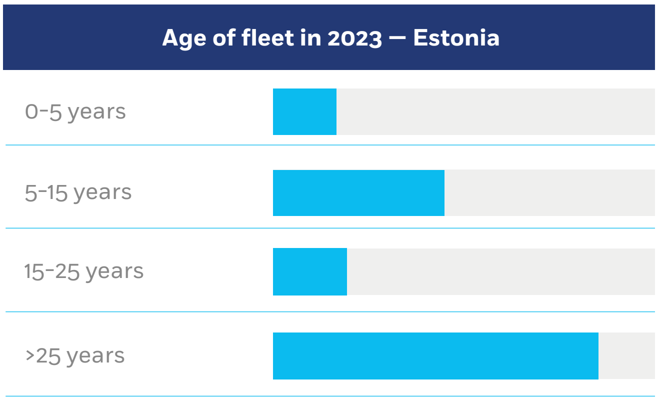
Their division by ship type is shown below. The largest category of ships flying the flag of Estonia is other work vessels (57 %), followed by passenger ships (32 %). There are 19 passenger ships, including 18 ro-pax, in the Estonian fleet.

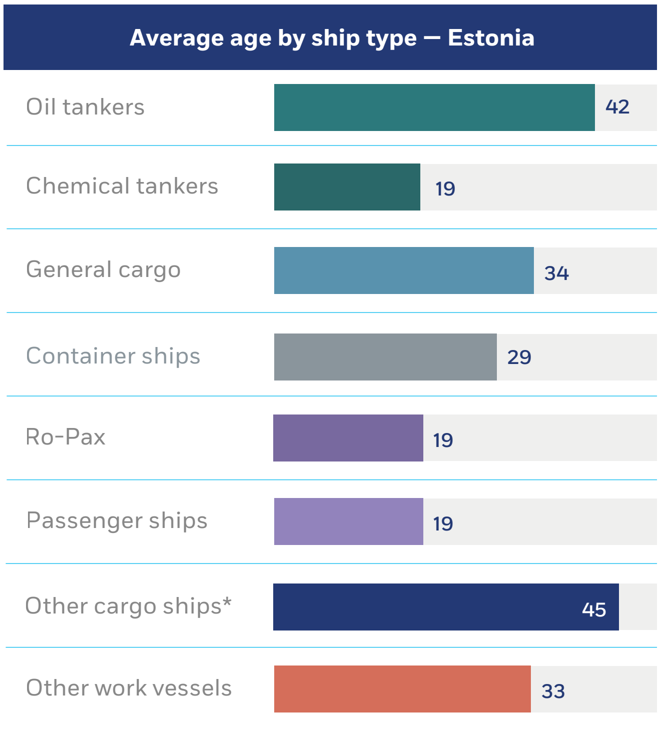
Figure A2.17: Estonian fleet by ship type, including number of tankers by subtype and number of ro-pax and HSC.



The overall fleet age categories and the average age by ship type of the ships flying the flag of Estonia are shown below.

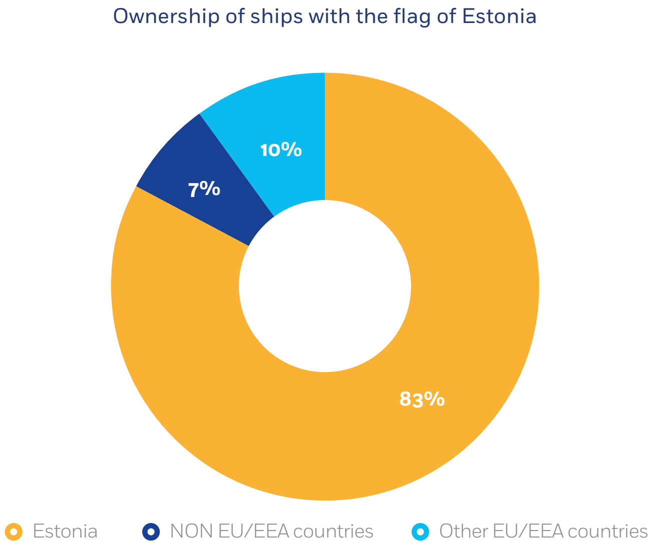
Figure A2.18: Age of the fleet with the flag of Estonia – overall and average age by ship type.

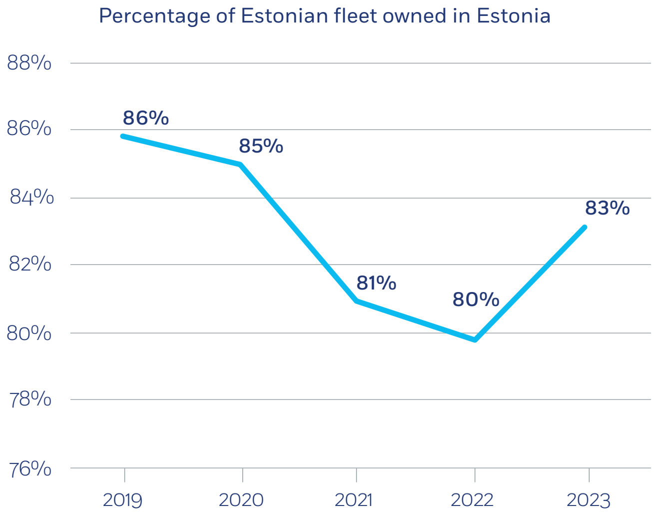




The percentage of ships with the flag of Estonia that belong to shipowners registered in the country is shown below.

Figure A2.19: Percentage of Estonian fleet owned by the shipowners of Estonia – evolution between 2019 and 2023.



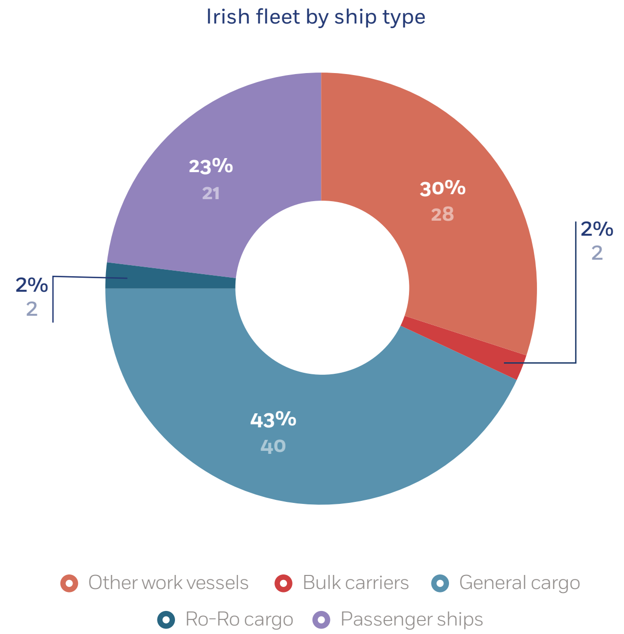


IRELAND

There are 93 ships registered with the flag of Ireland, corresponding to 1 % of the EU Member States' fleet, with a total of 263 507 GT.

Their division by ship type is shown below. The largest category of ships flying the flag of Ireland is general cargo vessels (43 %), followed by other work vessels (30 %) and passenger ships (23 %). There are 21 passenger ships, including 3 ro-pax.

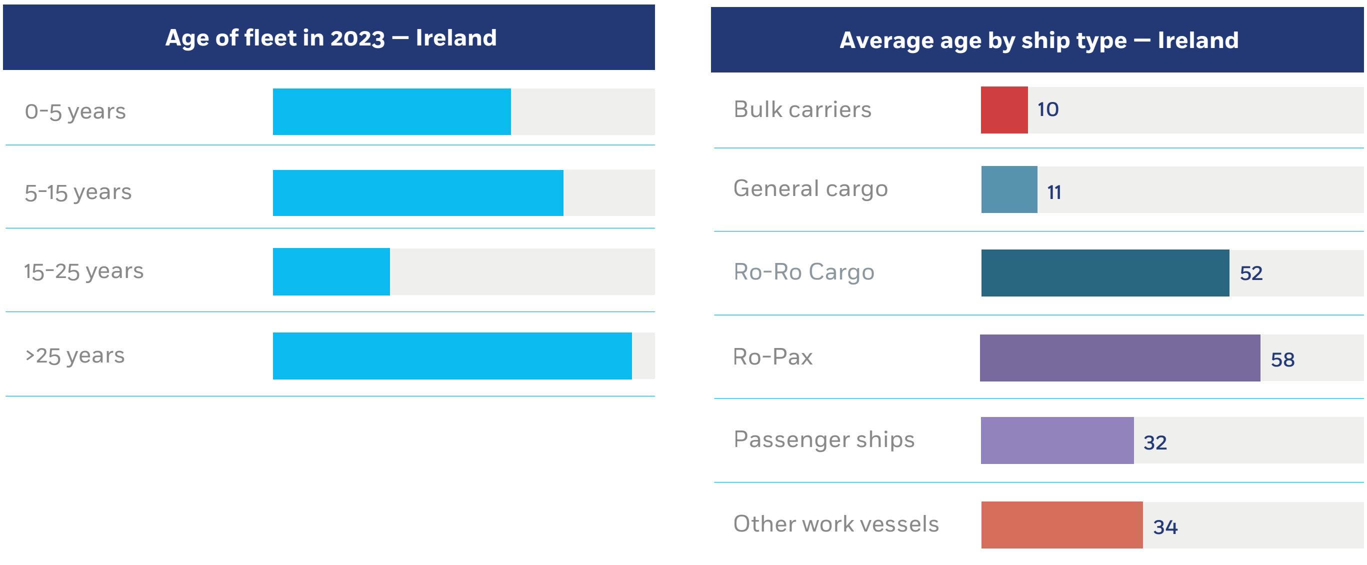
Figure A2.20: Irish fleet by ship type, including number of ro-pax and HSC.



Passenger ships	
Ro-Pax	3
HSC	0
Others	18

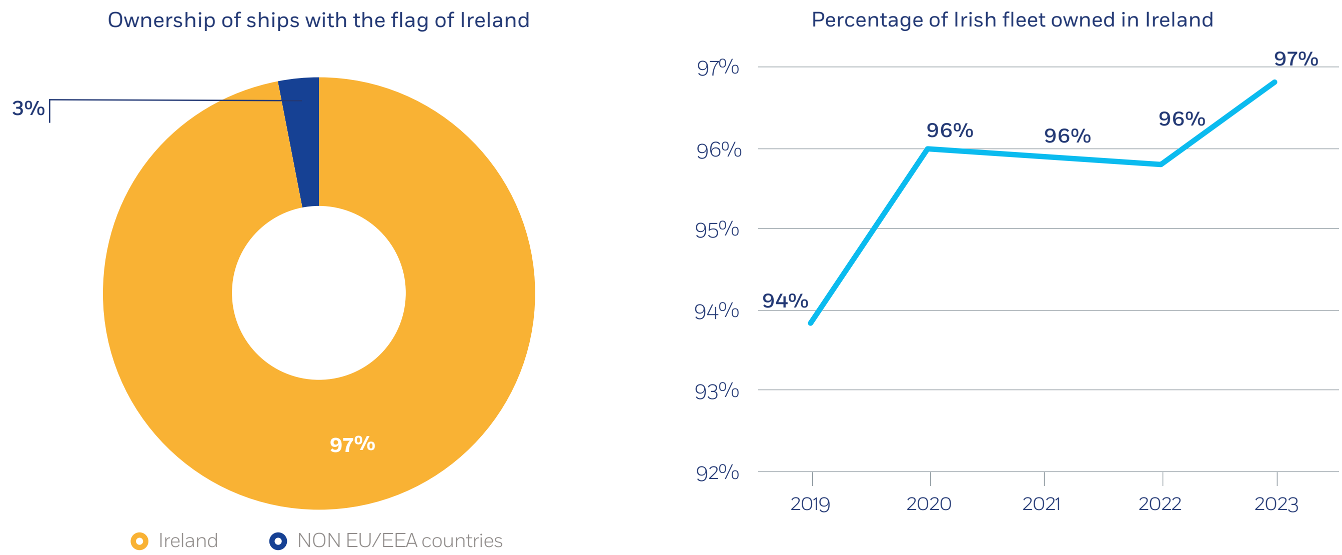
The overall fleet age categories and the average age by ship type of the ships flying the flag of Ireland are shown below.

Figure A2.21: Age of the fleet with the flag of Ireland – overall and average age by ship type.



The percentage of ships with the flag of Ireland that belong to shipowners registered in the country is shown below.

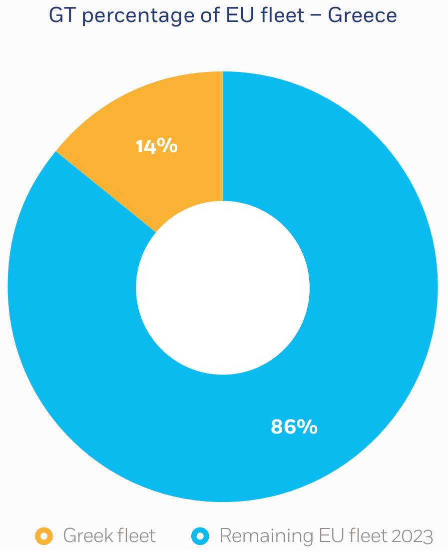
Figure A2.22:zPercentage of Irish fleet owned by the shipowners of Ireland – evolution between 2019 and 2023.



GREECE

There are 1 109 ships registered with the flag of Greece, corresponding to 9 % of the total EU Member State fleet. The sum of the Greek ships' GT is 33 926 885, corresponding to 14 % of the EU Member States' fleet.

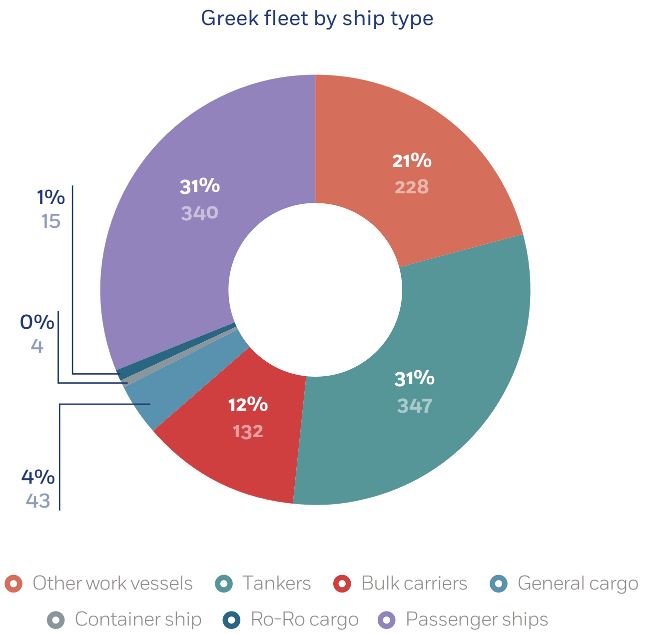
Figure A2.23: GT share of the flag of Greece in the EU Member States' fleet.



Their division by ship type is shown below. The largest categories of ships flying the flag of Greece are those of tankers and passenger ships (31 %), followed by other work vessels (21 %) and bulk carriers (12 %).

There are 340 passenger ships, including 184 ro-pax and 30 HSC, in the Greek fleet.

Figure A2.24: Greek fleet by ship type, including number of tankers by subtype and number of ro-pax and HSC.



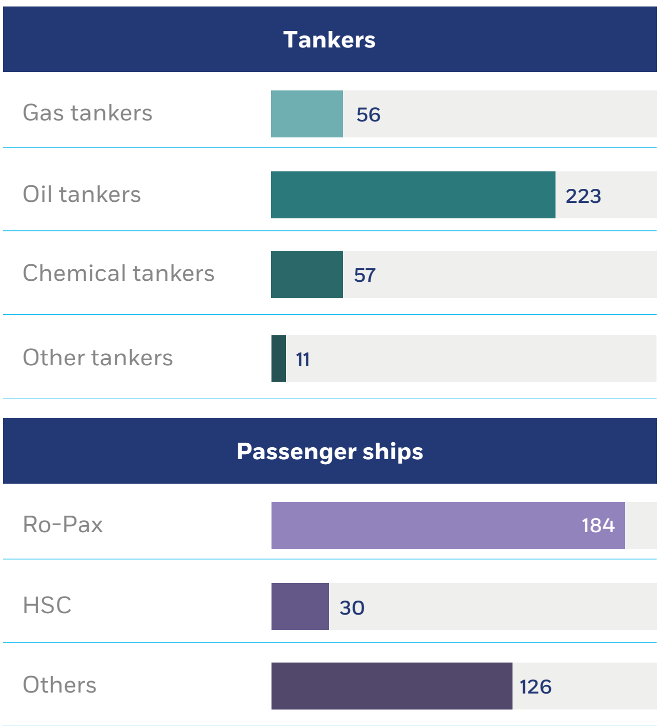
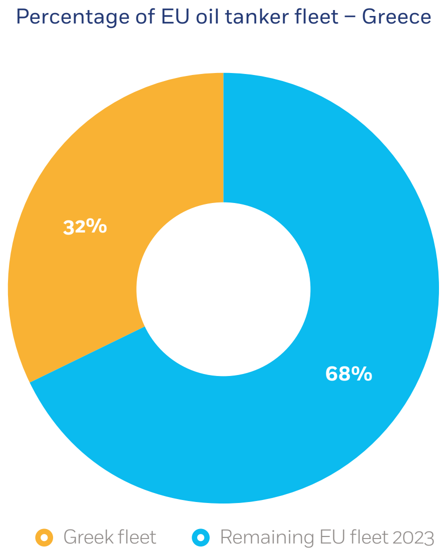
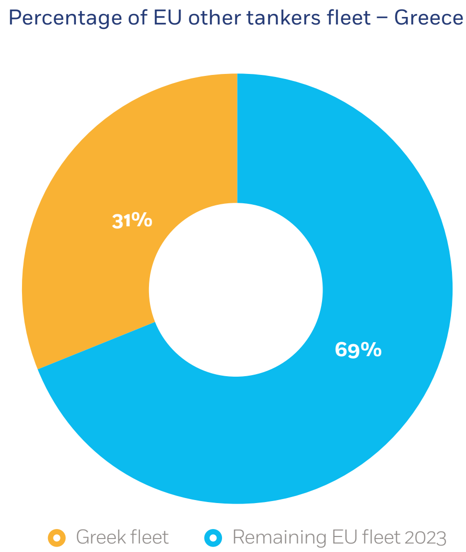
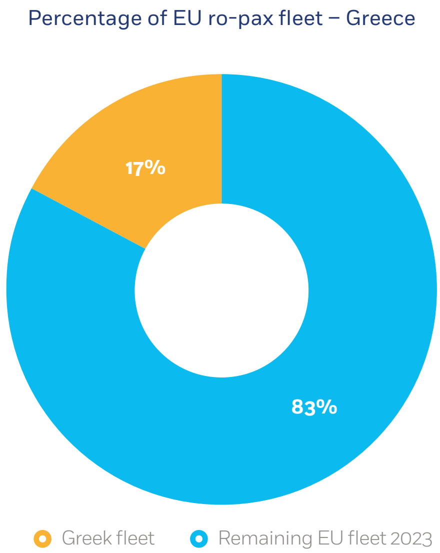


Figure A2.38: Greek fleet by ship type, including number of tankers by subtype and number of ro-pax and HSC.

Figure A2.25: Share of the flag of Greece in the EU Member States' oil, other tankers and ro-pax fleets.

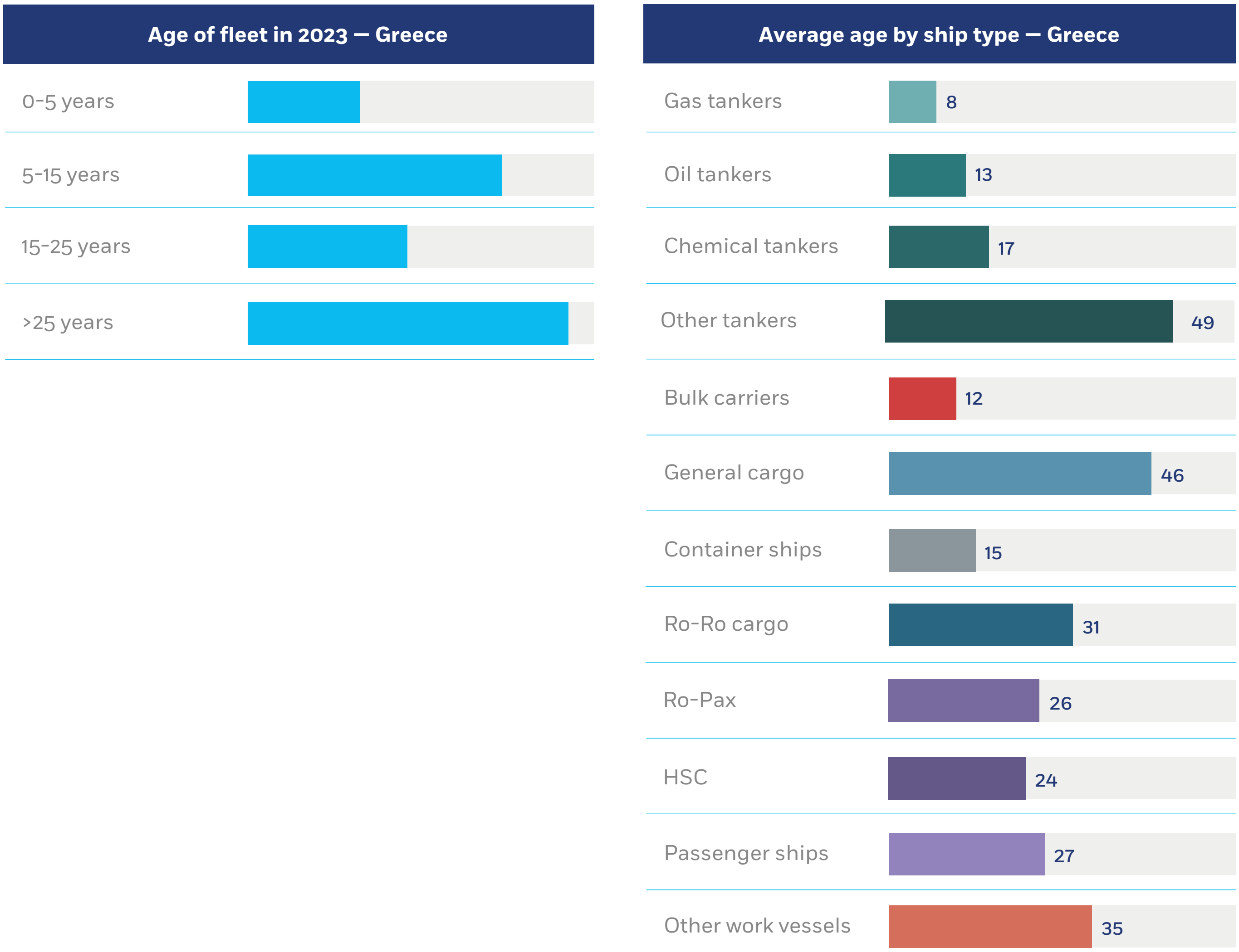






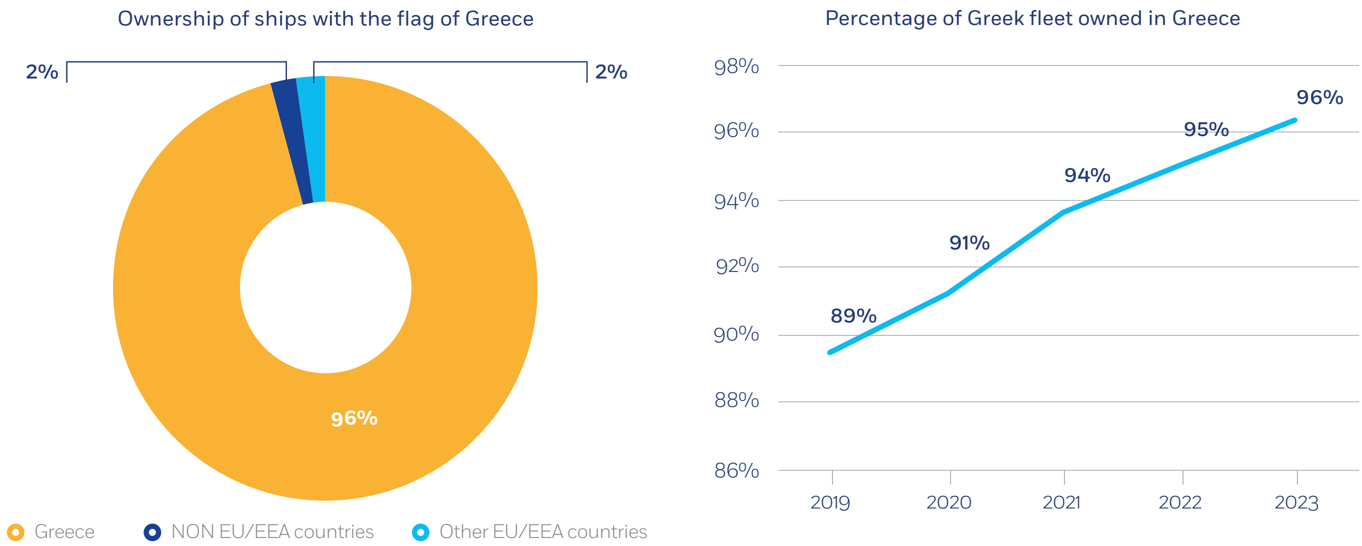
The overall fleet age categories and the average age by ship type of the ships flying the flag of Greece are shown below.

Figure A2.26: Age of the fleet with the flag of Greece – overall and average age by ship type.



The percentage of ships with the flag of Greece that belong to shipowners registered in the country is shown below. This percentage has been increasing since 2019.

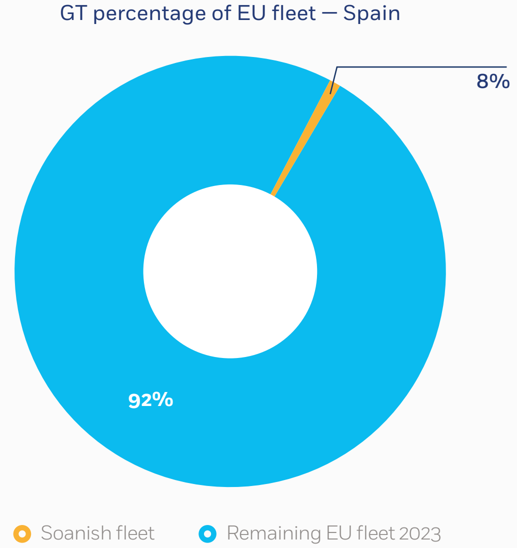
Figure A2.27: Percentage of Greek fleet owned by the shipowners of Greece – evolution between 2019 and 2023.



SPAIN

There are 492 ships registered with the flag of Spain, corresponding to 4 % of the total EU Member State fleet. The sum of the Spanish ships' GT is 2 437 035, corresponding to 1 % of the EU Member States' fleet.

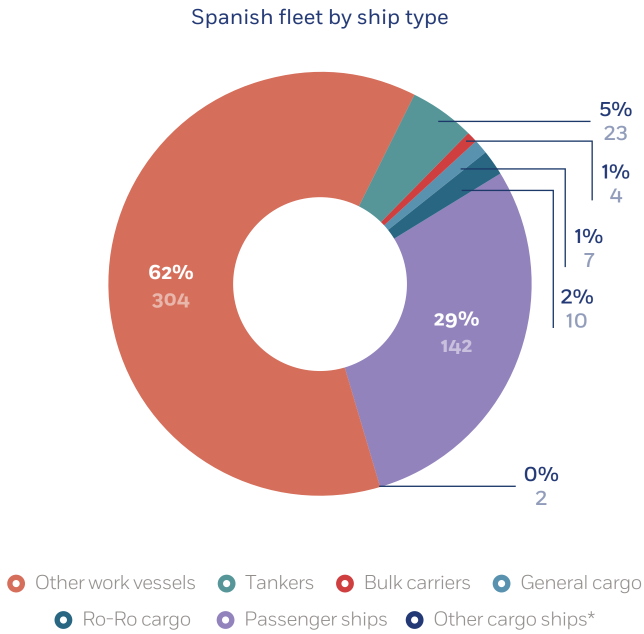
Figure A2.28: GT share of the flag of Spain in the EU Member States' fleet.

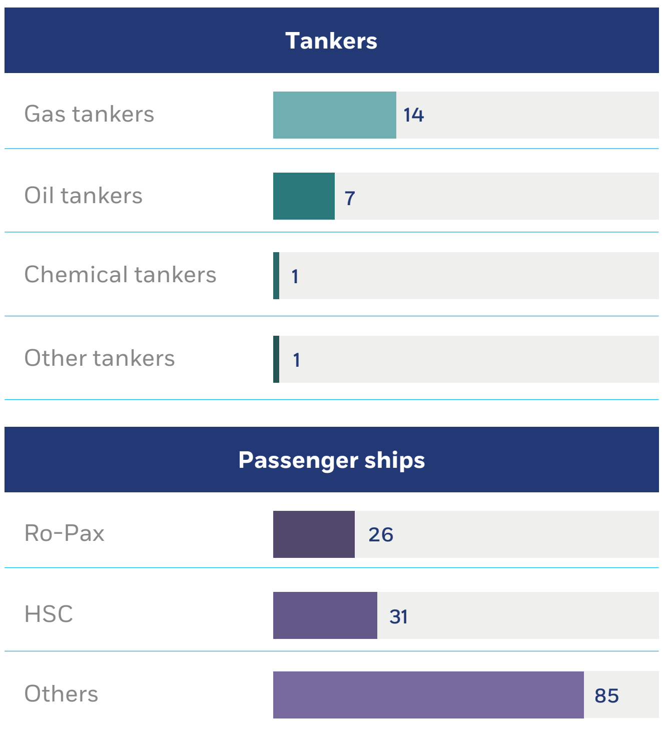


Their division by ship type is shown below. The largest category of ships flying the flag of Spain is that of other work vessels (62 %), followed by passenger ships (29 %).

There are 142 passenger ships, including 26 ro-pax and 31 HSC, in the Spanish fleet.

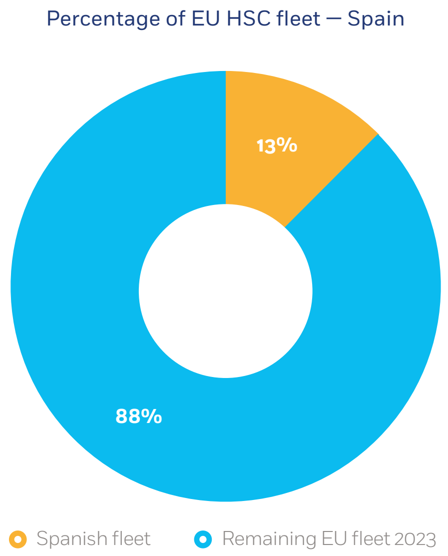
Figure A2.29: Spanish fleet by ship type, including number of tankers by subtype and number of ro-pax and HSC.





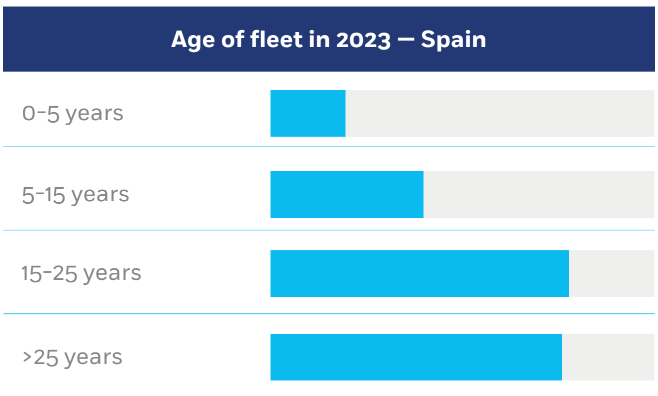
The HSC of Spain correspond to 13 % of the total EU Member State fleet of that ship type in terms of the number of ships.

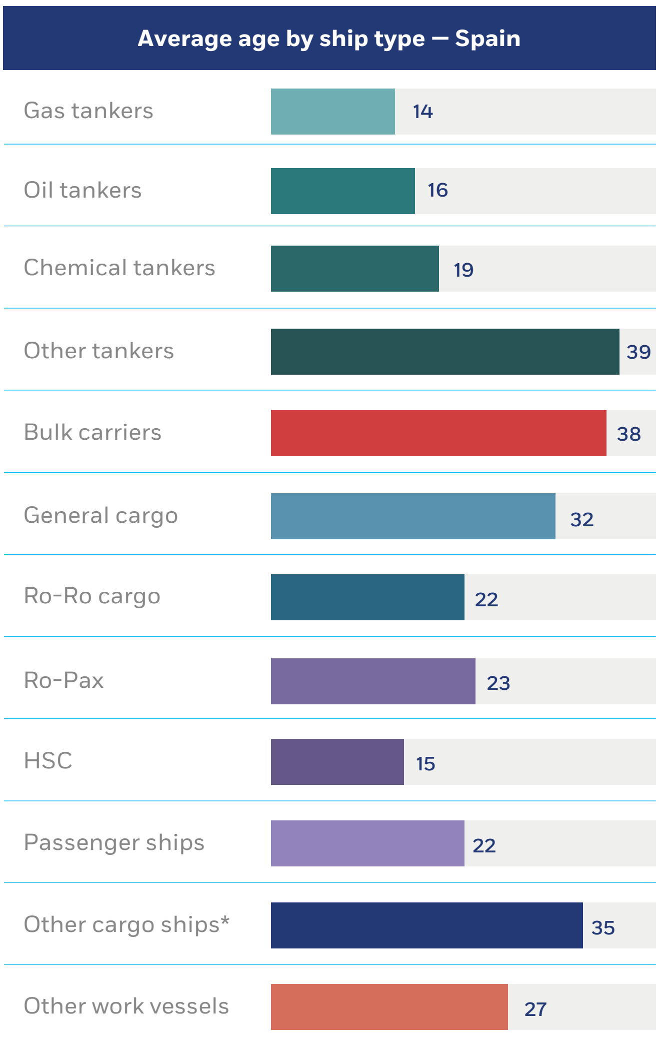
Figure A2.30: Share of the flag of Spain in the EU Member States' HSC fleet.



The overall fleet age categories and the average age by ship type of the ships flying the flag of Spain are shown below.

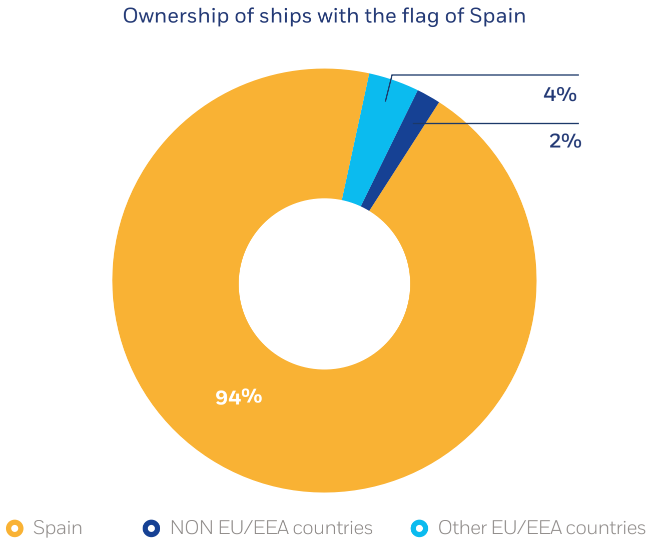
Figure A2.31: Age of the fleet with the flag of Spain – overall and average age by ship type.

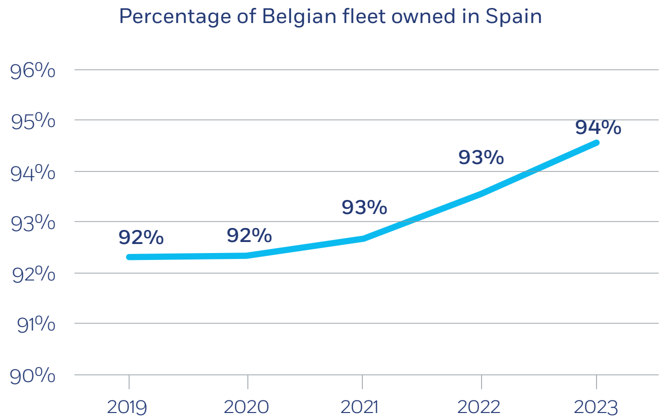




The percentage of ships with the flag of Spain that belong to shipowners registered in the country is shown below.

Figure A2.32: Percentage of Spanish fleet owned by the shipowners of Spain – evolution between 2019 and 2023.

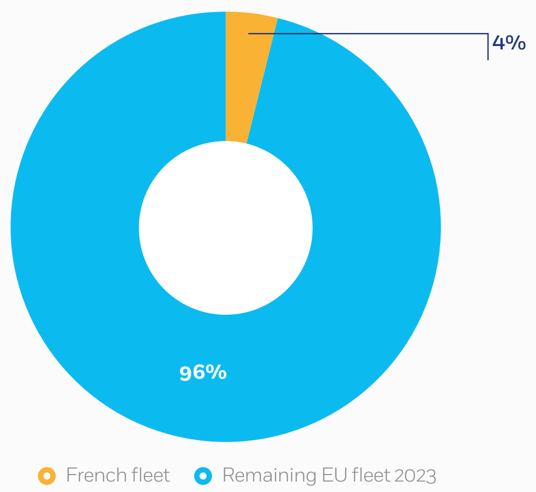




FRANCE

There are 530 ships registered with the flag of France, corresponding to 4 % of the total EU Member State fleet. The sum of the French ships' GT is 9 660 997, corresponding to 4 % of the EU Member States' fleet.

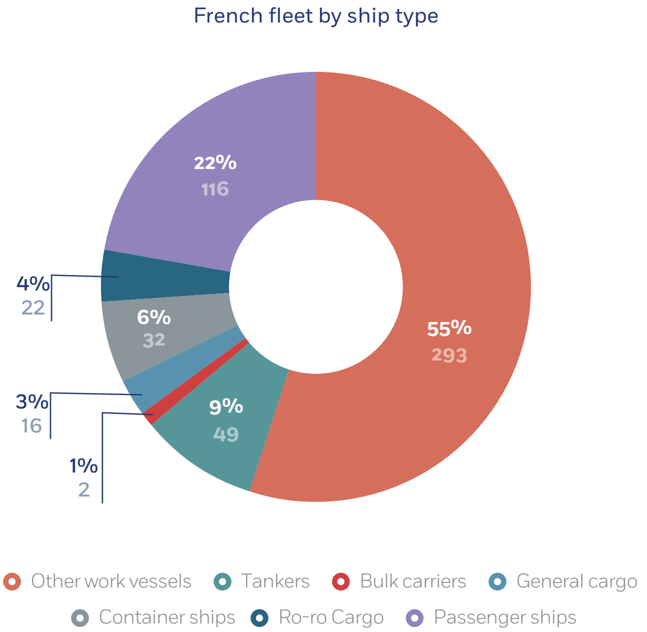
Figure A2.33: GT share of the flag of France in the EU Member States' fleet.

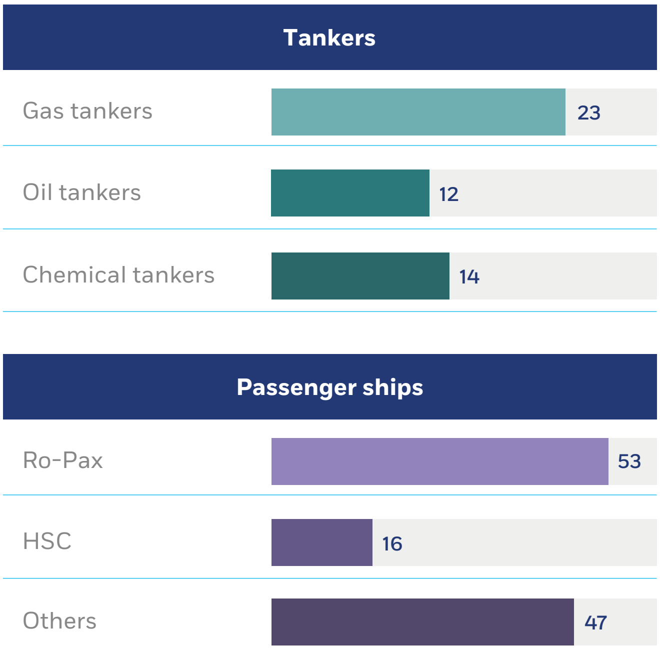


Their division by ship type is shown below. The largest category of ships flying the flag of France is that of other work vessels (55 %), followed by passenger ships (23 %).

There are 116 passenger ships, including 53 ro-pax and 16 HSC, in the French fleet.

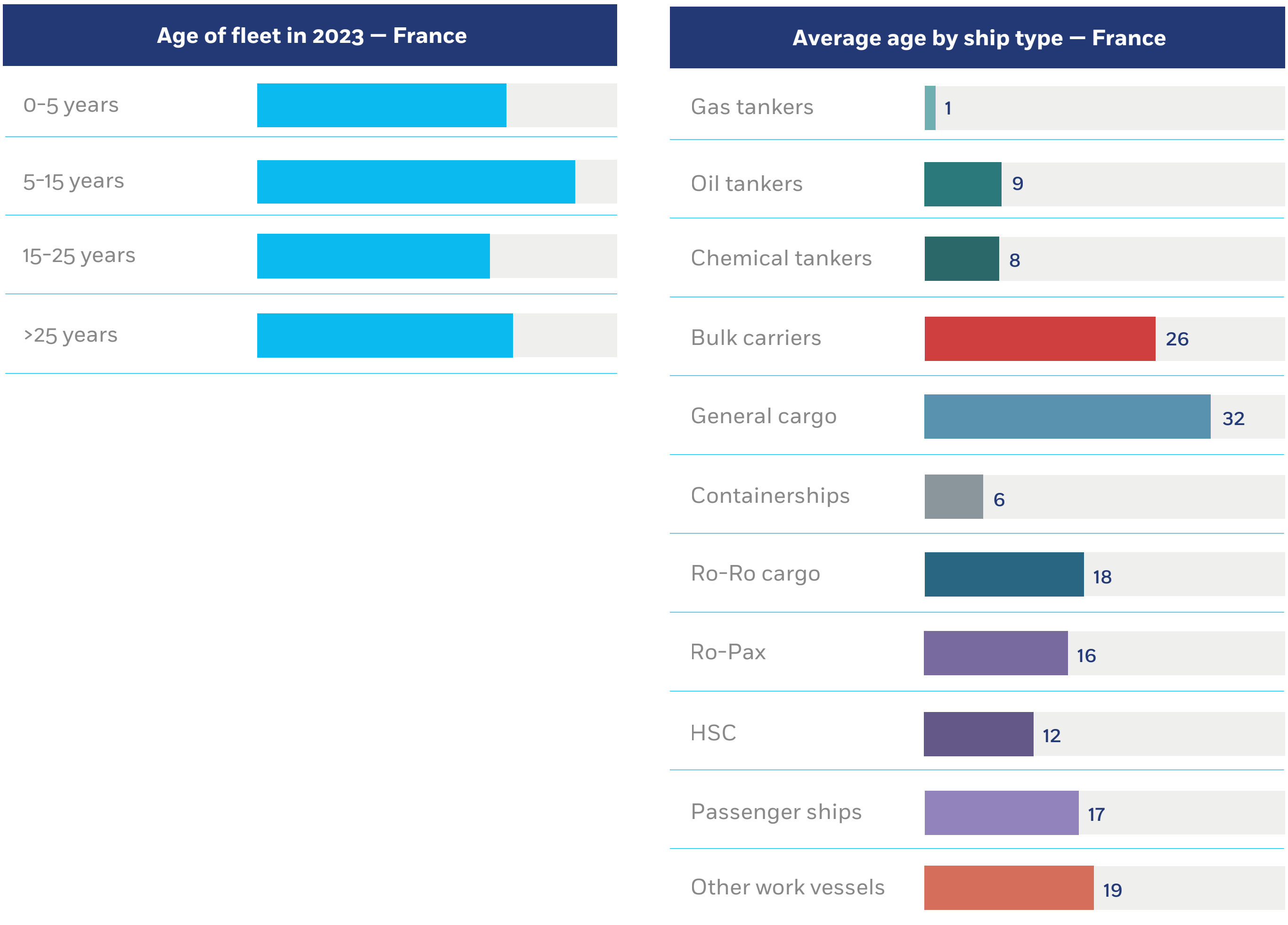
Figure A2.34: French fleet by ship type, including number of tankers by subtype and number of ro-pax and HSC.





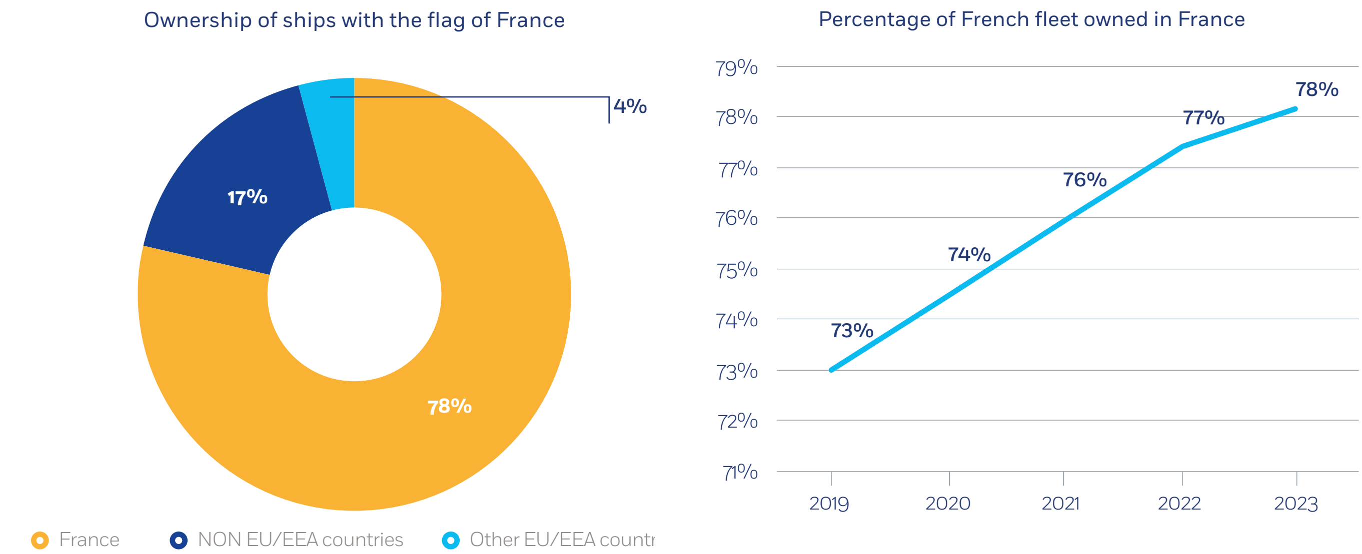
The overall fleet age categories and the average age by ship type of the ships flying the flag of France are shown below.

Figure A2.35: Age of the fleet with the flag of France – overall and average age by ship type.



The percentage of ships with the flag of France that belong to shipowners registered in the country is shown below.

Figure A2.36: Percentage of French fleet owned by the shipowners of France – evolution between 2019 and 2023.



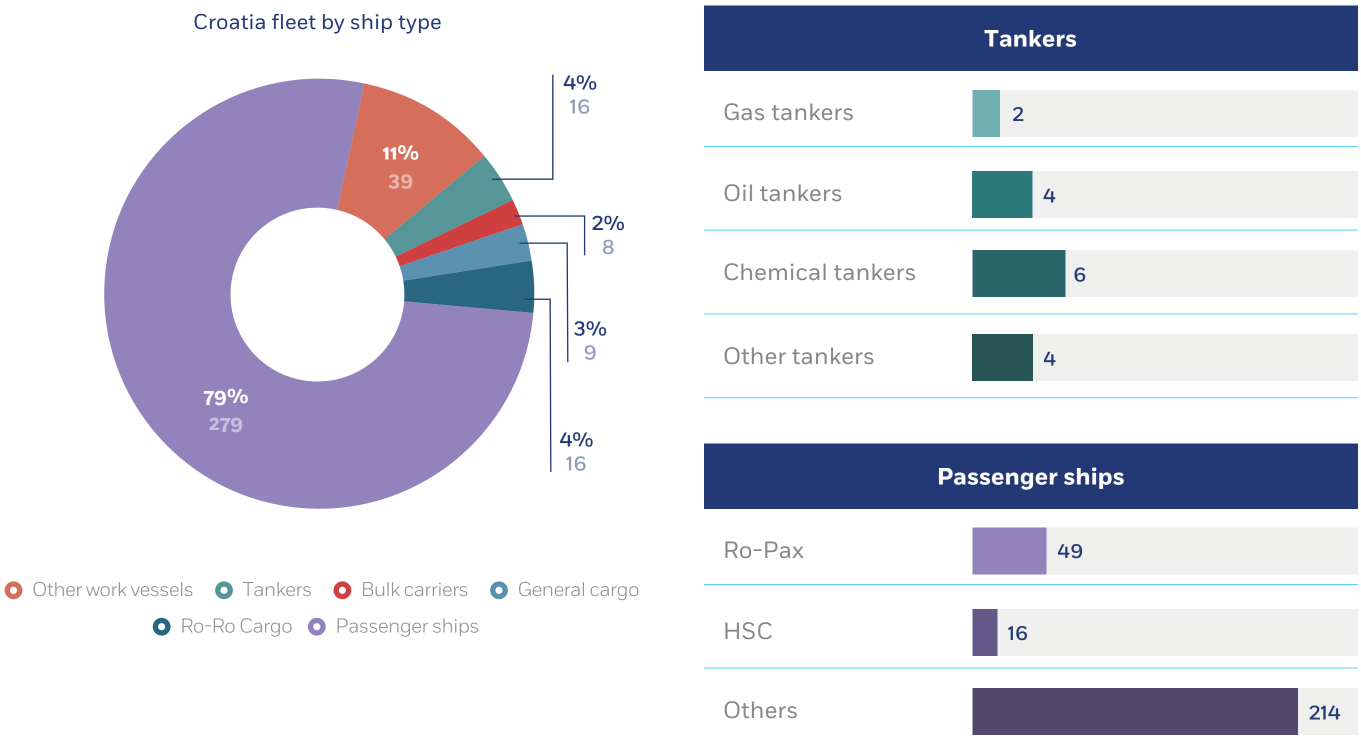
CROATIA

There are 353 ships registered with the flag of Croatia, corresponding to 3 % of the total EU Member State fleet. The sum of the Croatian ships' GT is 935 945, corresponding to 0.4 % of the EU Member States' fleet.

Their division by ship type is shown below. The largest category of ships flying the flag of Croatia is that of passenger ships, followed by other work vessels and tankers, the majority of which are chemical tankers.

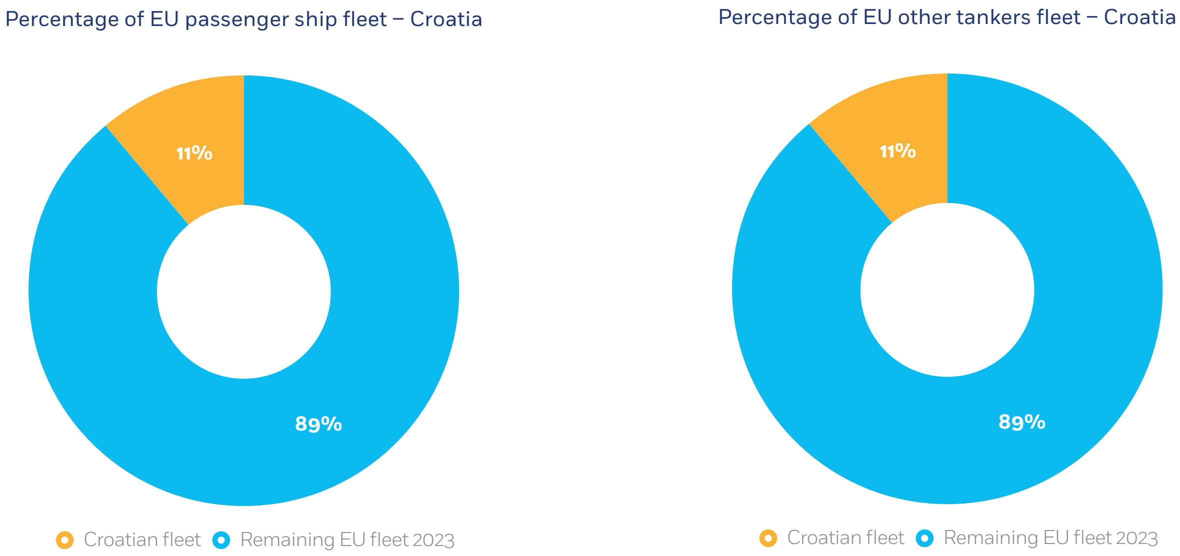
There are 49 ro-pax and 16 HSC in the Croatian fleet.

Figure A2.37: Croatian fleet by ship type, including number of tankers by subtype and number of ro-pax and HSC.



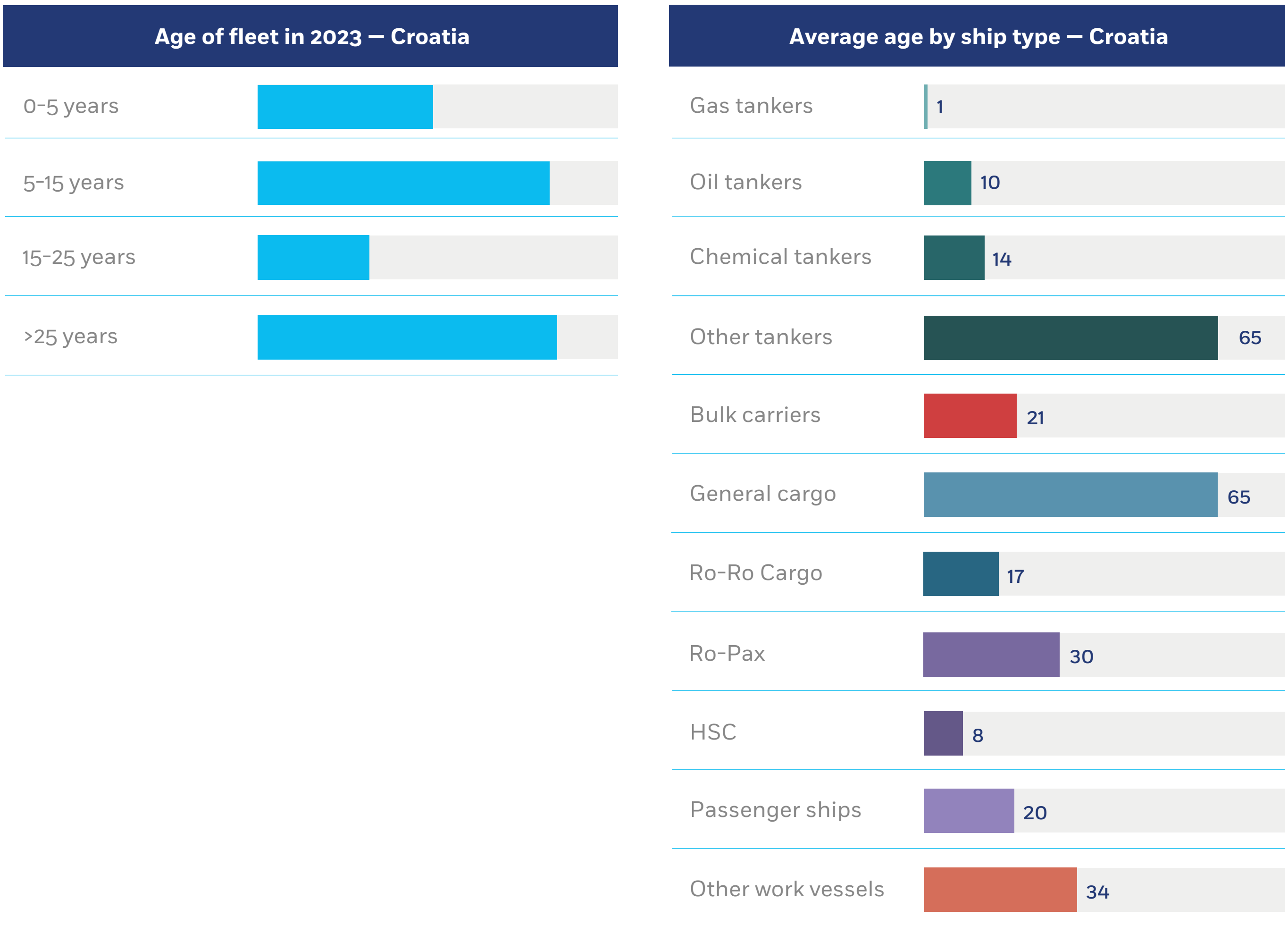
The passenger ships and other tankers of the Croatian fleet each correspond to 11 % of the total EU Member State fleets of those ship types in terms of the number of ships.

Figure A2.38: Share of the flag of Croatia in the EU Member States' passenger ship and other tankers fleets.



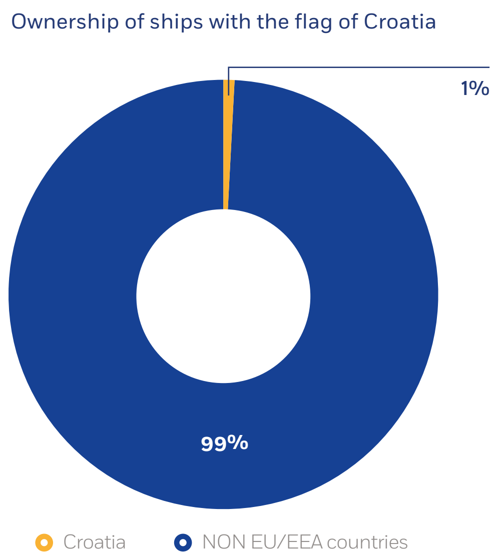
The overall fleet age categories and the average age by ship type of the ships flying the flag of Croatia are shown below.

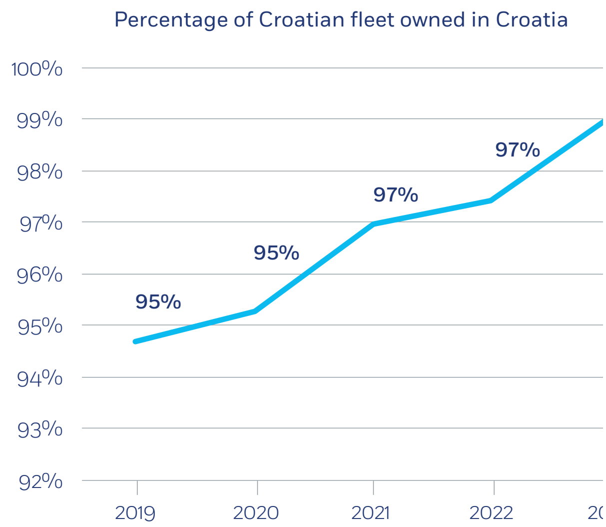
Figure A2.39: Age of the fleet with the flag of Croatia – overall and average age by ship type.



The percentage of ships with the flag of Croatia that belong to shipowners registered in the country is shown below. This percentage has been increasing since 2019.

Figure A2.40: Percentage of Croatian fleet owned by the shipowners of Croatia – evolution between 2019 and 2023.

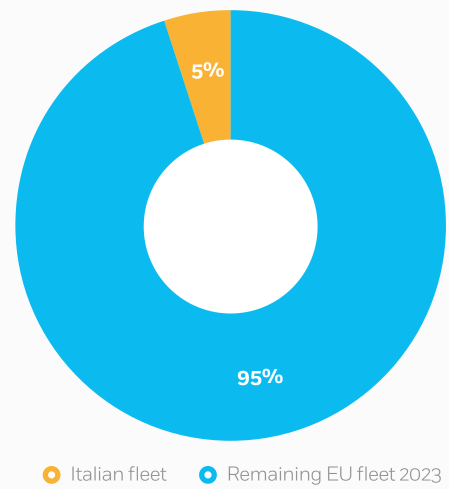




ITALY

There are 1 145 ships registered with the flag of Italy, corresponding to 9 % of the total EU Member State fleet. The sum of the Italian ships' GT is 12 602 716, corresponding to 5 % of the EU Member States' fleet.

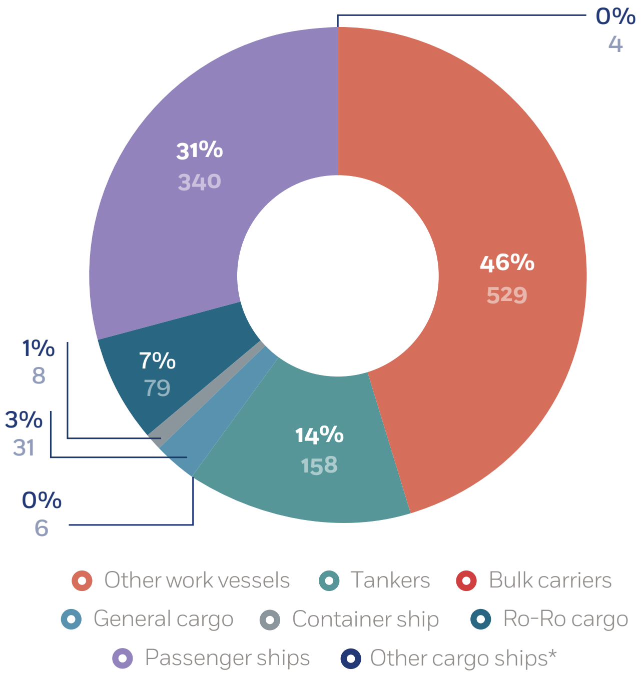
Figure A2.41: GT share of the flag of Italy in the EU Member States' fleet.

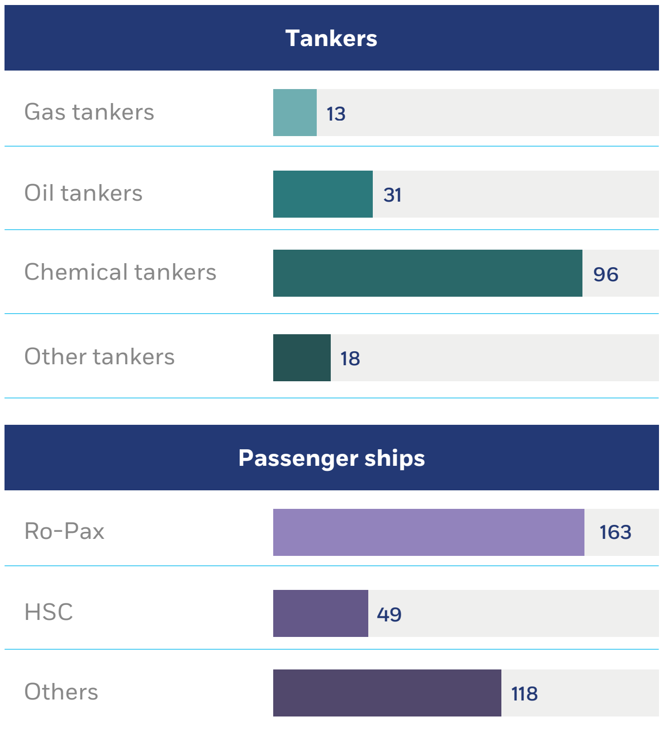


Their division by ship type is shown below. The largest category of ships flying the flag of Italy is that of other work vessels (46 %), followed by passenger ships (29 %) and tankers (14 %).

There are 330 passenger ships, including 163 ro-pax and 49 HSC, in the Italian fleet.

Figure A2.42: Italian fleet by ship type, including number of tankers by subtype and number of ro-pax and HSC.

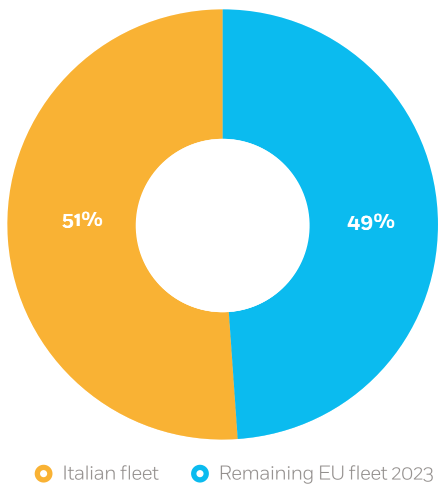




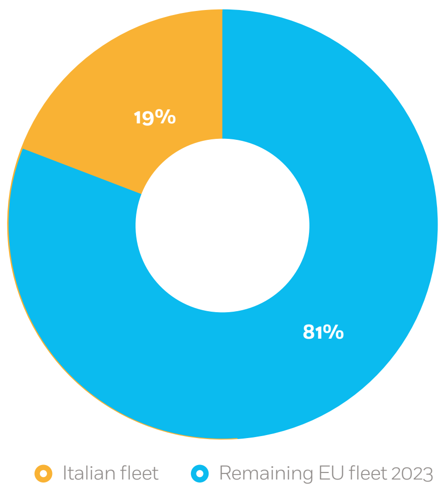
The other tankers, ro-ro cargo vessels and HSC of Italy correspond to 51 %, 19 % and 20 %, respectively, of the total EU Member State fleets of those ship types in terms of the number of ships.

Figure A2.43: Share of the flag of Italy in the EU Member States' other tankers, ro-ro cargo and HSC fleets.

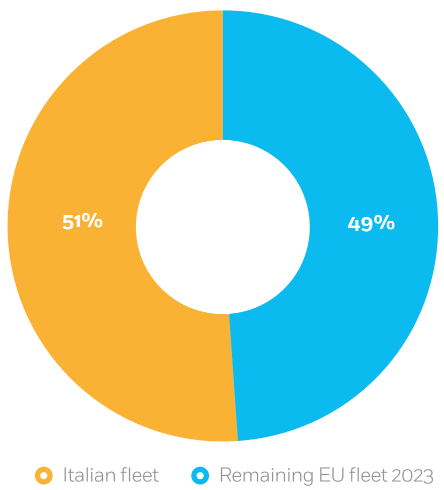
Percentage of EU other tankers fleet – Italy



Percentage of EU ro-ro fleet – Italy

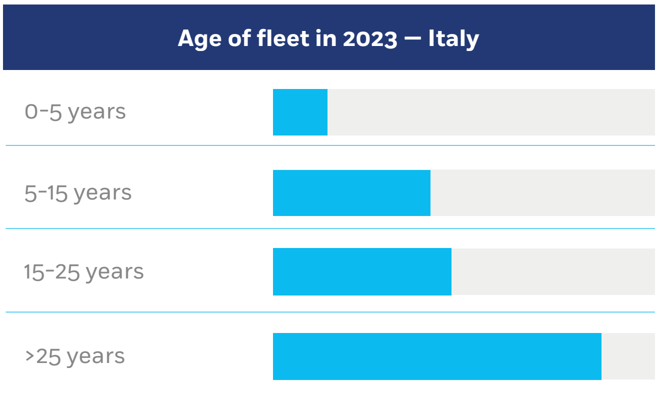


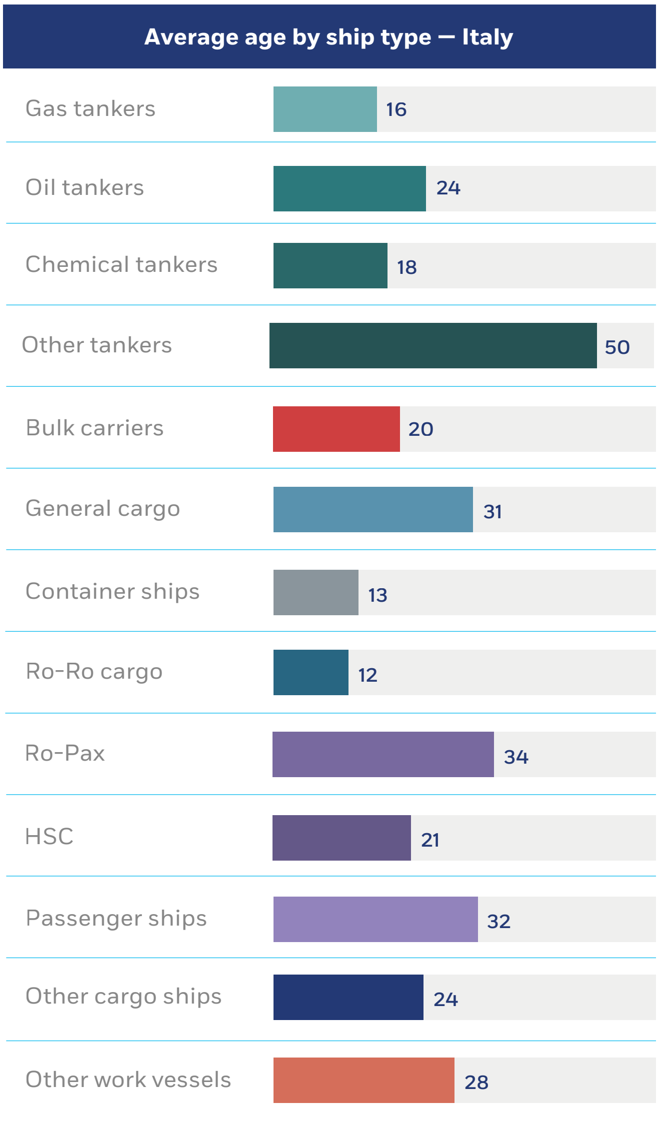
Percentage of EU other tankers fleet – Italy



The overall fleet age categories and the average age by ship type of the ships flying the flag of Italy are shown below.

Figure A2.44: Age of the fleet with the flag of Spain – overall and average age by ship type.

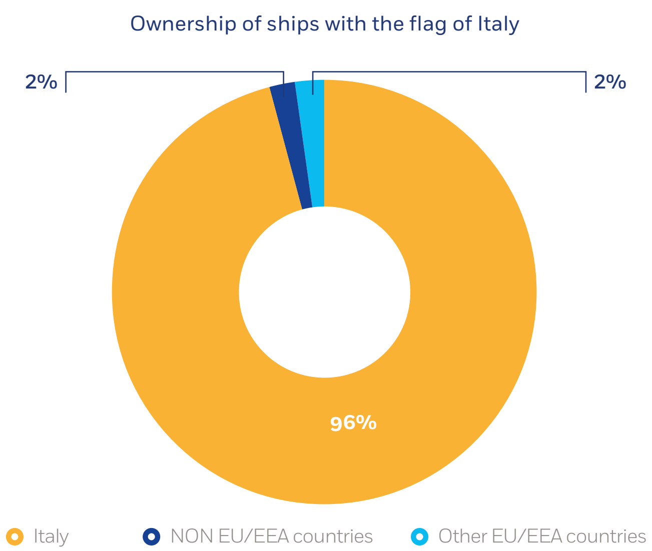


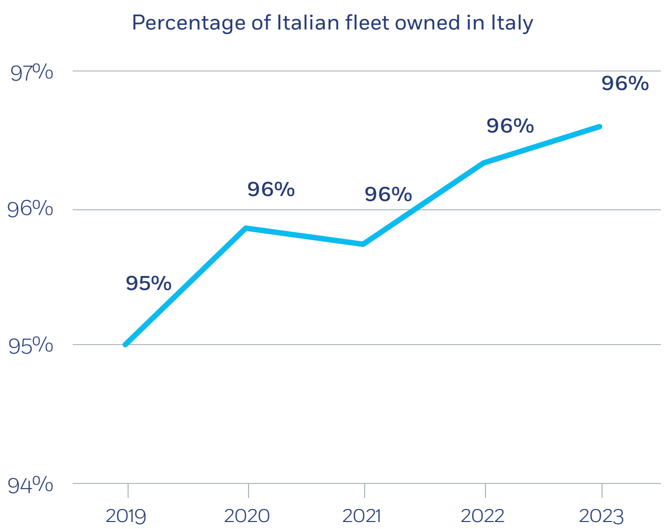


The percentage of ships with the flag of Italy that belong to shipowners registered in the country is shown below.

This percentage has been increasing since 2019.

Figure A2.45: Percentage of Italian fleet owned by the shipowners of Italy – evolution between 2019 and 2023.

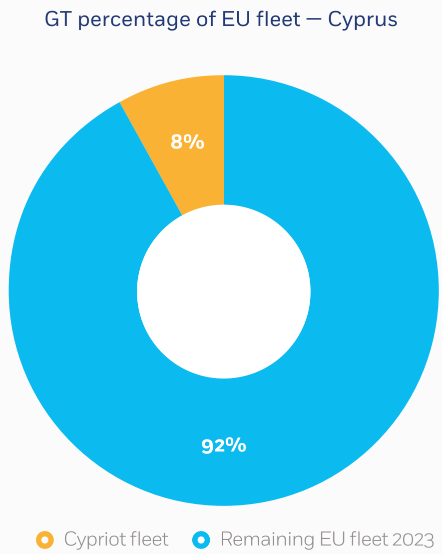




CYPRUS

There are 969 ships registered with the flag of Cyprus, corresponding to 7 % of the total EU Member State fleet. The sum of the Cypriot ships' GT is 21 118 545, corresponding to 8 % of the EU Member States' fleet.

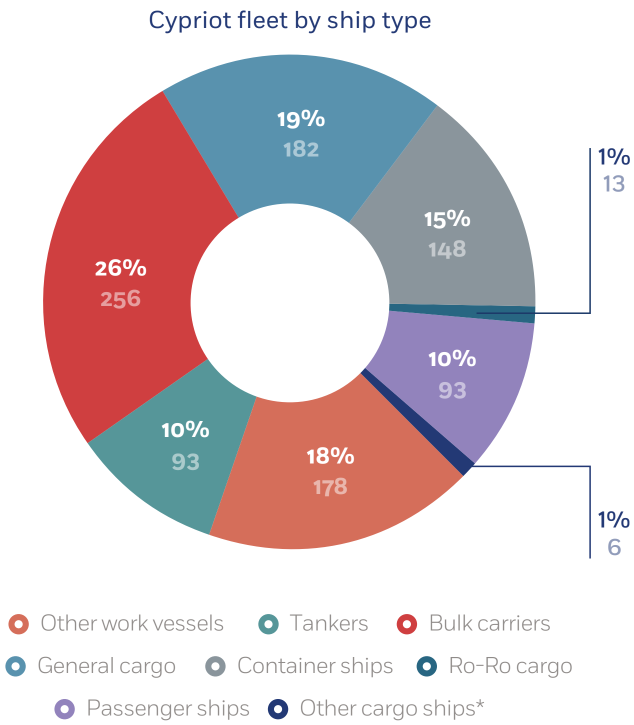
Figure A2.46: GT share of the flag of Cyprus in the EU Member States' fleet.

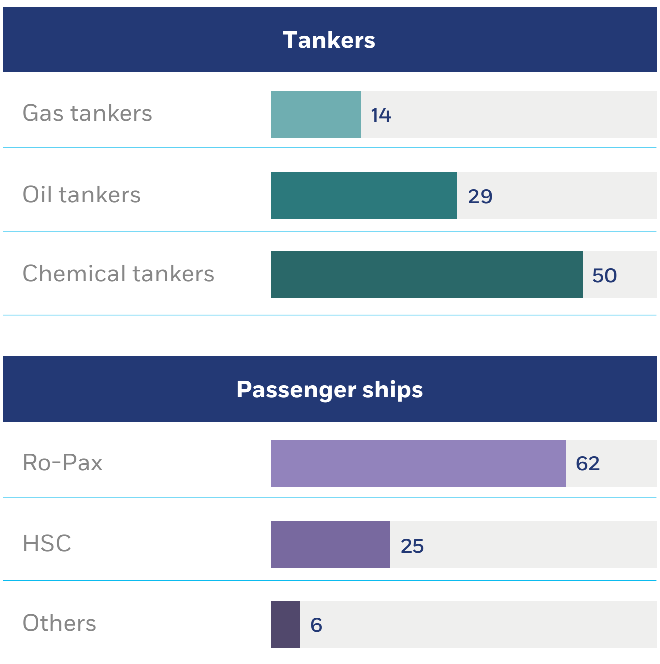


Their division by ship type is shown below. The largest category of ships flying the flag of Cyprus is that of bulk carriers (26 %), followed by general cargo vessels (19 %), other work vessels (18 %) and container ships (15 %).

There are 93 passenger ships, including 62 ro-pax and 25 HSC, in the Cypriot fleet.

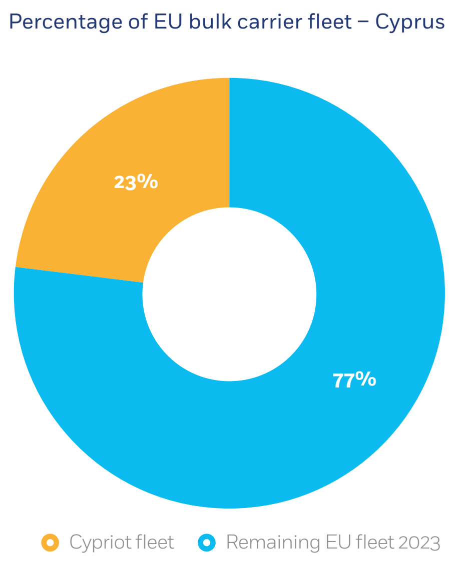
Figure A2.47: Cypriot fleet by ship type, including number of tankers by subtype and number of ro-pax and HSC.

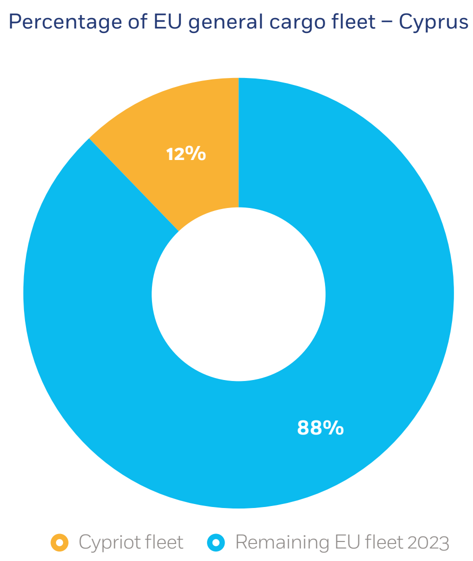


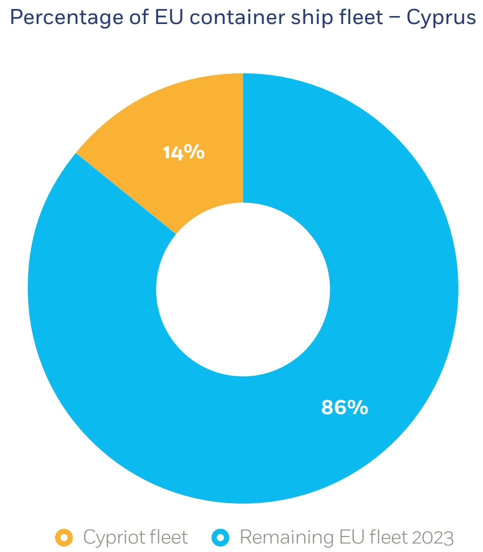


The other tankers, ro-ro cargo vessels and HSC of Italy correspond to 51 %, 19 % and 20 %, respectively, of the total EU Member State fleets of those ship types in terms of the number of ships.

Figure A2.48: Share of the flag of Cyprus in the EU Member States' bulk carrier, general cargo vessel and container ship fleets.

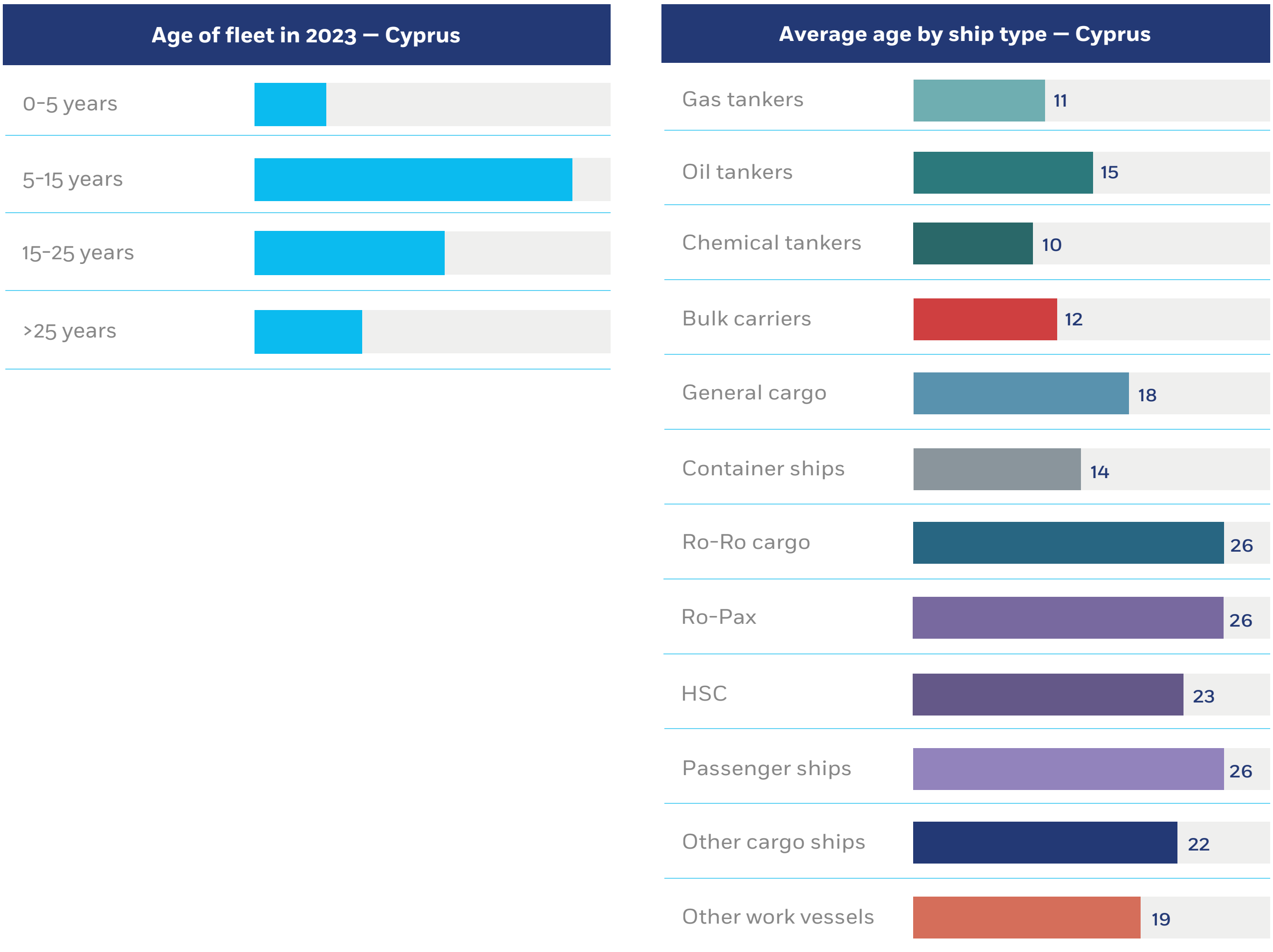






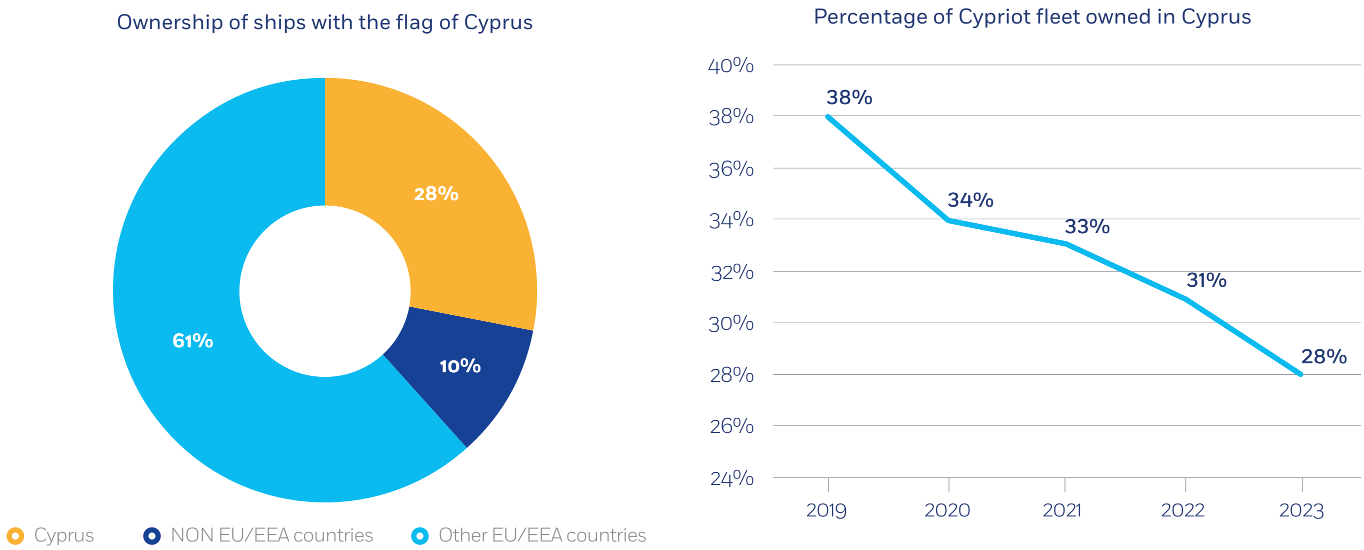
The overall fleet age categories and the average age by ship type of the ships flying the flag of Cyprus are shown below.

Figure A2.49: Age of the fleet with the flag of Cyprus – overall and average age by ship type.



The percentage of ships with the flag of Cyprus that belong to shipowners registered in the country is shown below. This percentage has been decreasing since 2019. In addition, 10 % of the ships flying the flag of Cyprus belong to shipowners outside the EU.

Figure A2.50: Percentage of Cypriot fleet owned by the shipowners of Cyprus – evolution between 2019 and 2023.

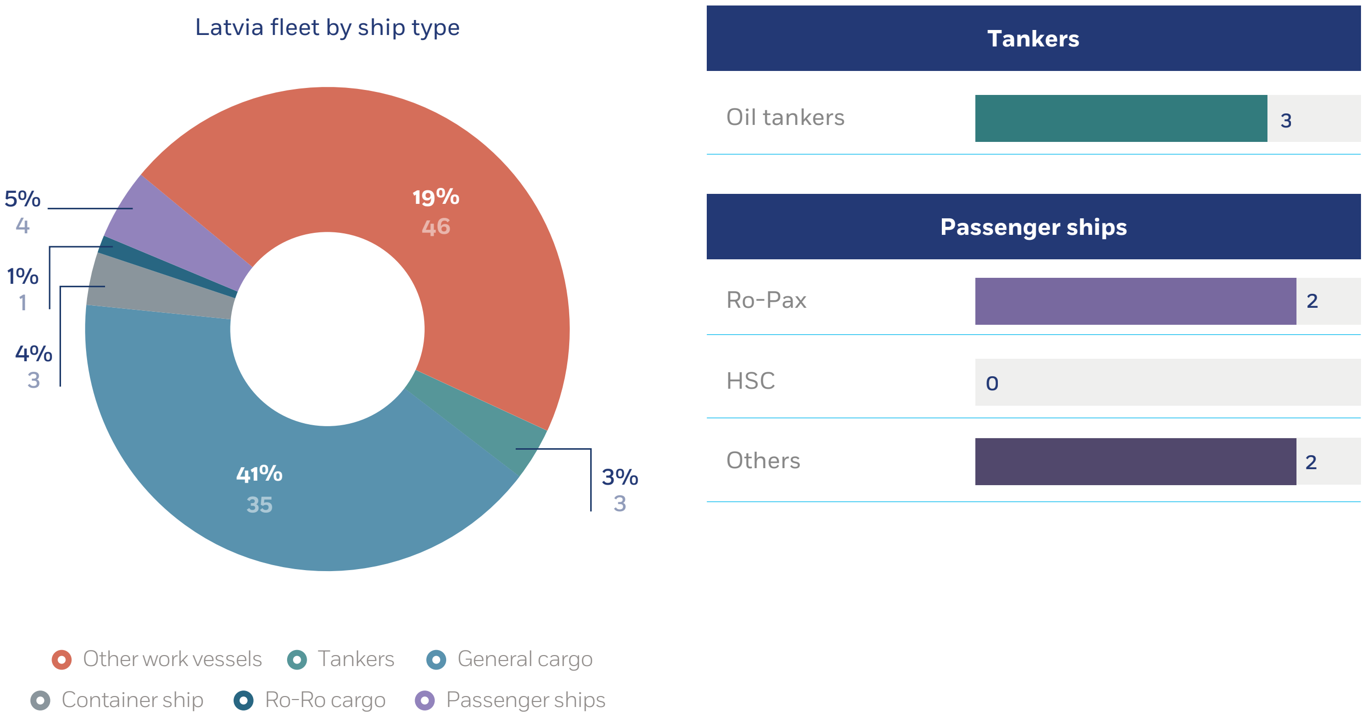


LATVIA

There are 85 ships registered with the flag of Latvia, corresponding to 1 % of the EU Member States' fleet, with a total of 249 247 GT.

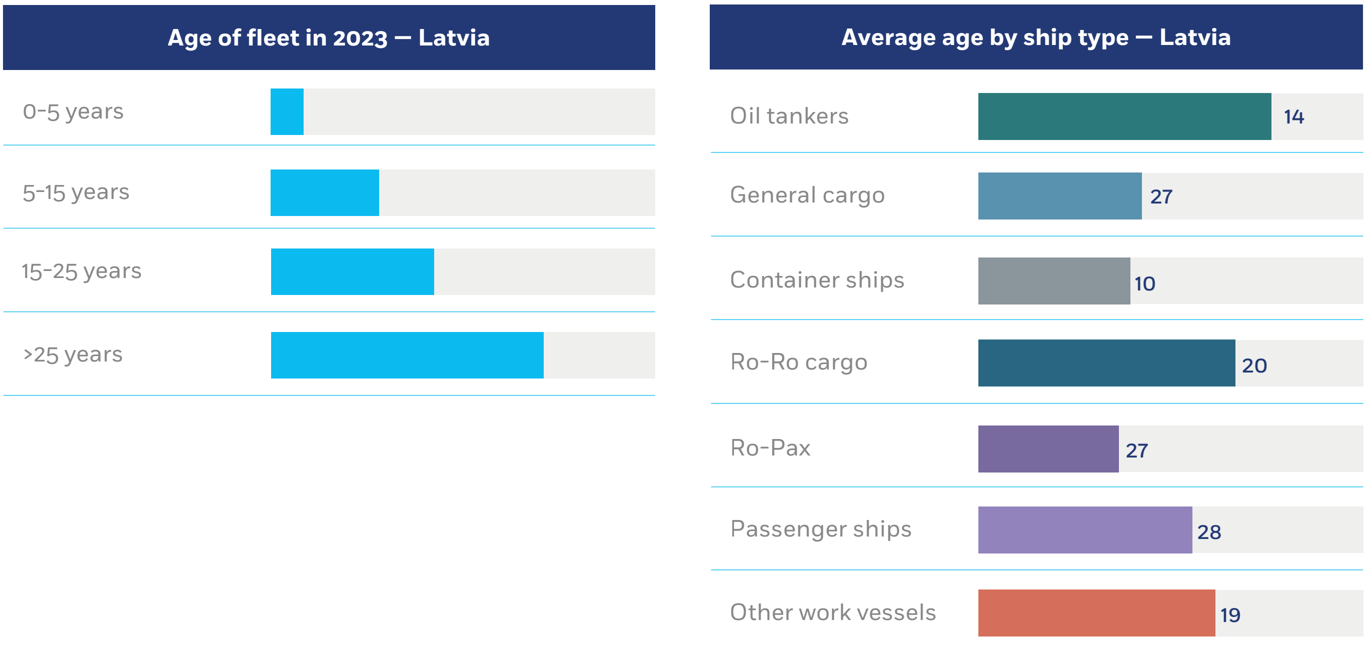
Their division by ship type is shown below. The largest category of ships flying the flag of Latvia is other work vessels (46 %), followed by general cargo ships (41 %). There are 4 passenger ships, including 2 ro-pax.

Figure A2.51: Latvian fleet by ship type, including number of tankers by subtype and number of ro-pax and HSC.



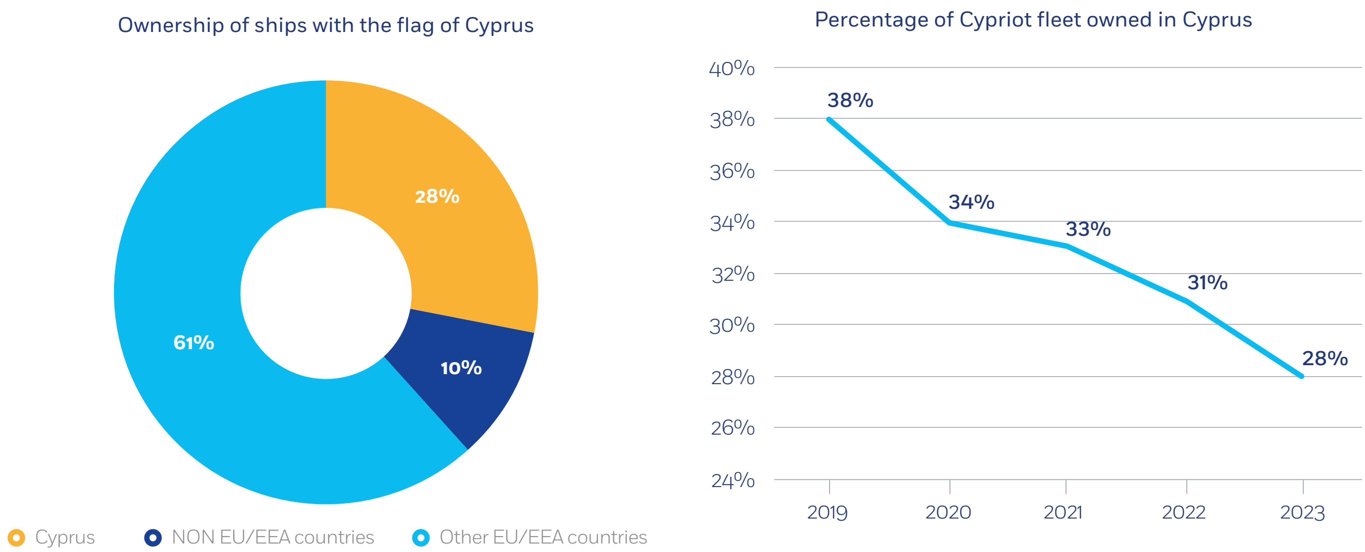
The overall fleet age categories and the average age by ship type of the ships flying the flag of Latvia are shown below.

Figure A2.52: Age of the fleet with the flag of Latvia – overall and average age by ship type.



The percentage of ships with the flag of Latvia that belong to shipowners registered in the country is shown below. This percentage decreased between 2019 and 2023.

Figure A2.53: Percentage of Latvian fleet owned by the shipowners of Latvia – evolution between 2019 and 2023.

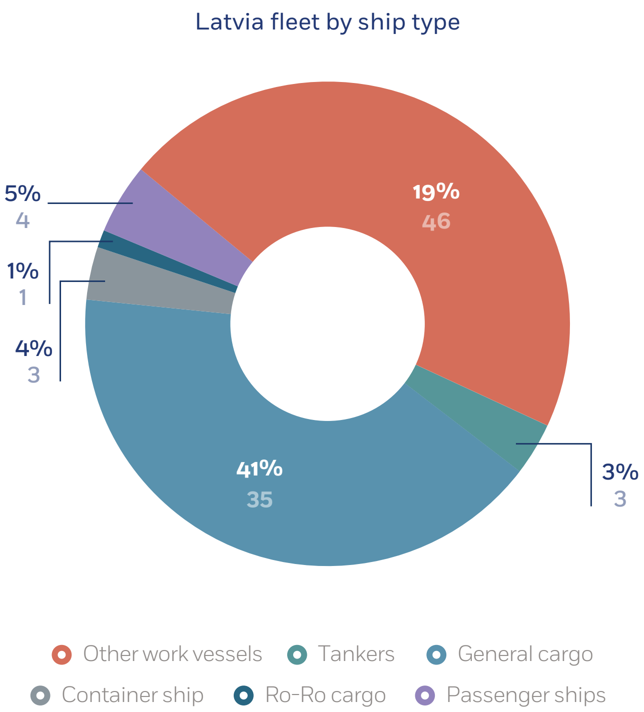


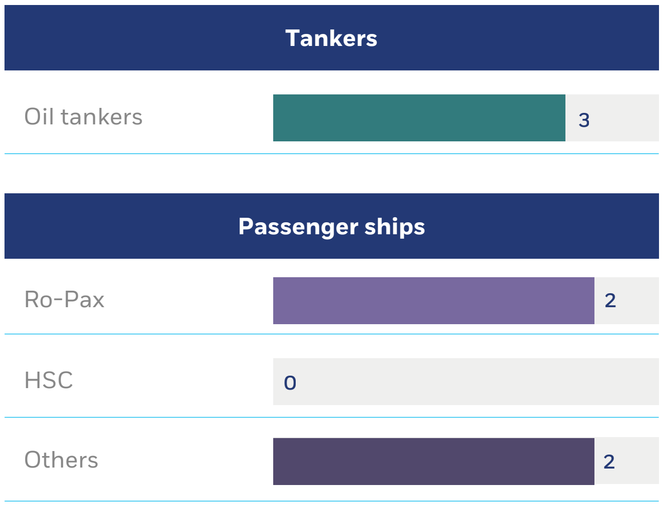
LITHUANIA

There are 48 ships registered with the flag of Lithuania, with a total of 318 857 GT.

Their division by ship type is shown below. The largest category of ships flying the flag of Lithuania is other work vessels (40 %), followed by general cargo ships (19 %). There are 8 ro-pax ships in the Lithuanian fleet.

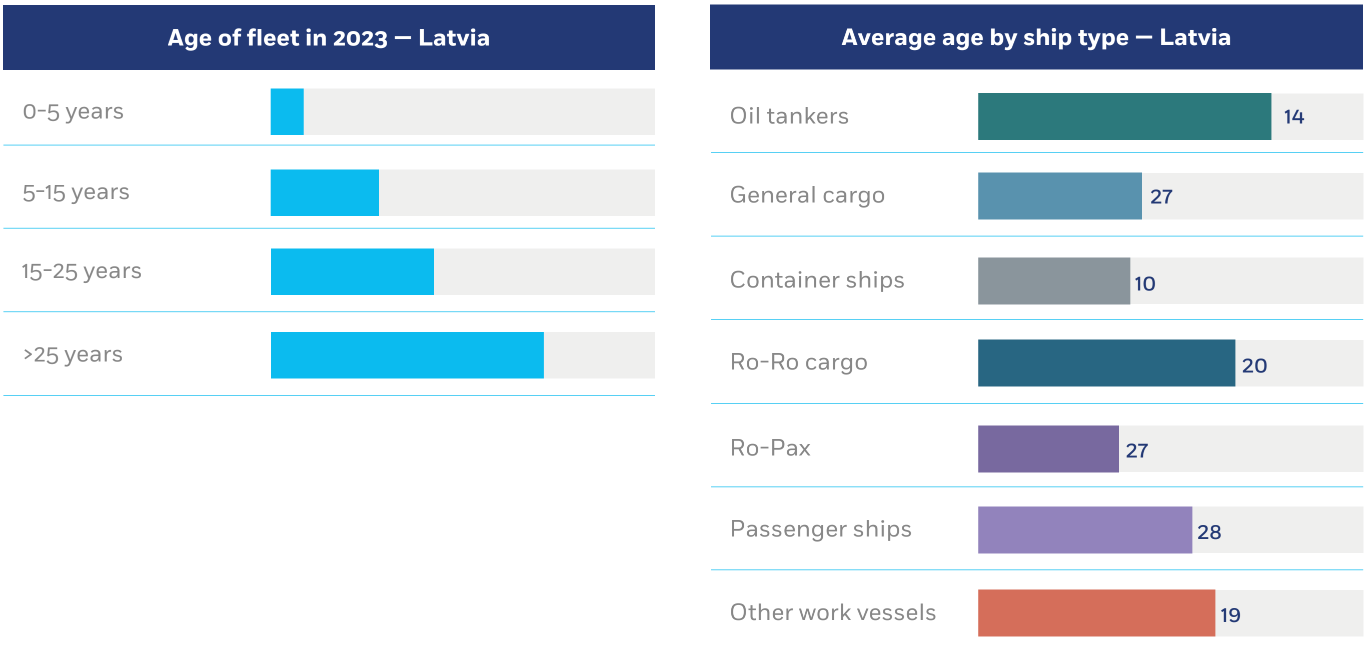
Figure A2.54: Lithuanian fleet by ship type, including number of tankers by subtype and number of ro-pax and HSC.





The overall fleet age categories and the average age by ship type of the ships flying the flag of Lithuania are shown below.

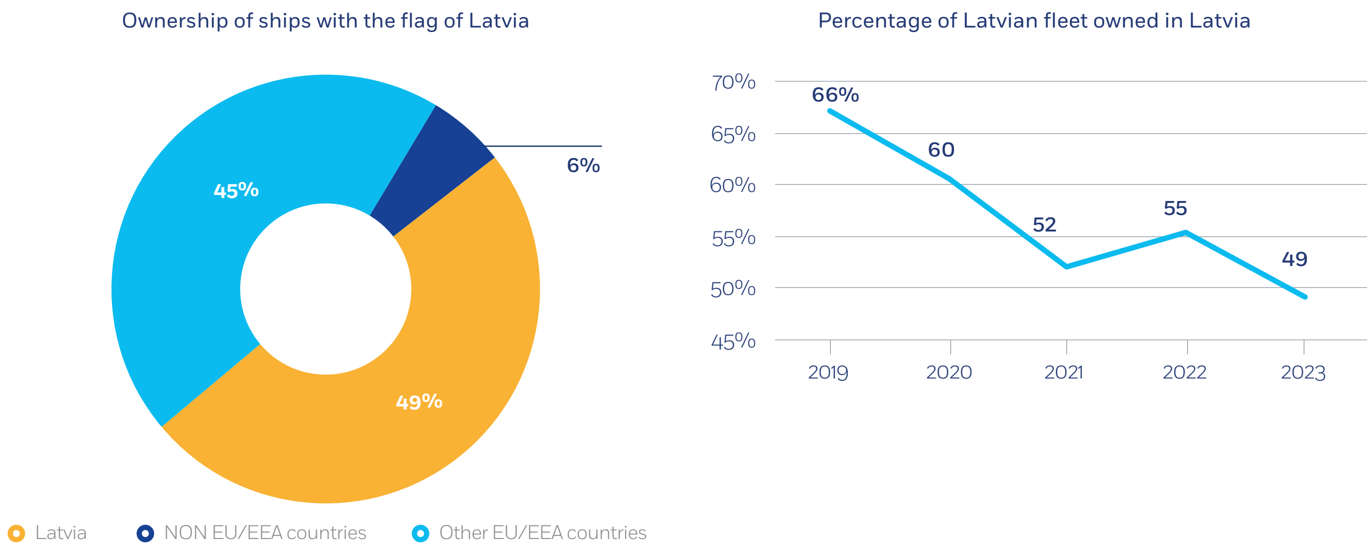
Figure A2.55: Age of the fleet with the flag of Lithuania – overall and average age by ship type.



The percentage of ships with the flag of Lithuania that belong to shipowners registered in the country is shown below.

This percentage increased between 2019 and 2023.

Figure A2.56: Percentage of Lithuanian fleet owned by the shipowners of Lithuania – evolution between 2019 and 2023.

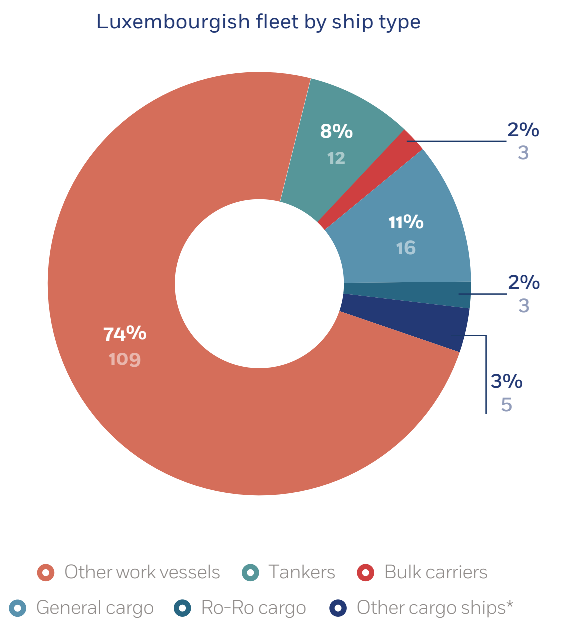


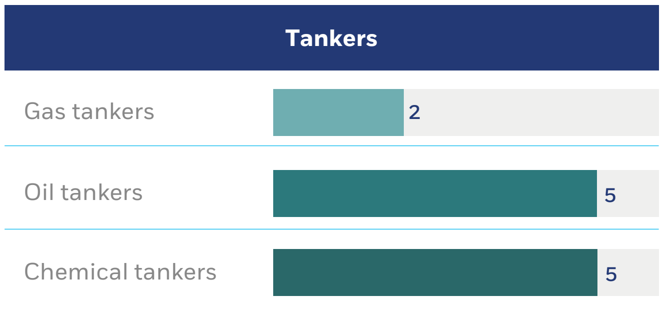
LUXEMBOURG

There are 148 ships registered with the flag of Luxembourg, corresponding to 1 % of the total EU Member State fleet, with a total of 1 189 852 GT.

Their division by ship type is shown below. The largest category of ships flying the flag of Luxembourg is other work vessels (74 %). There are no passenger ships in the Luxembourgish fleet.

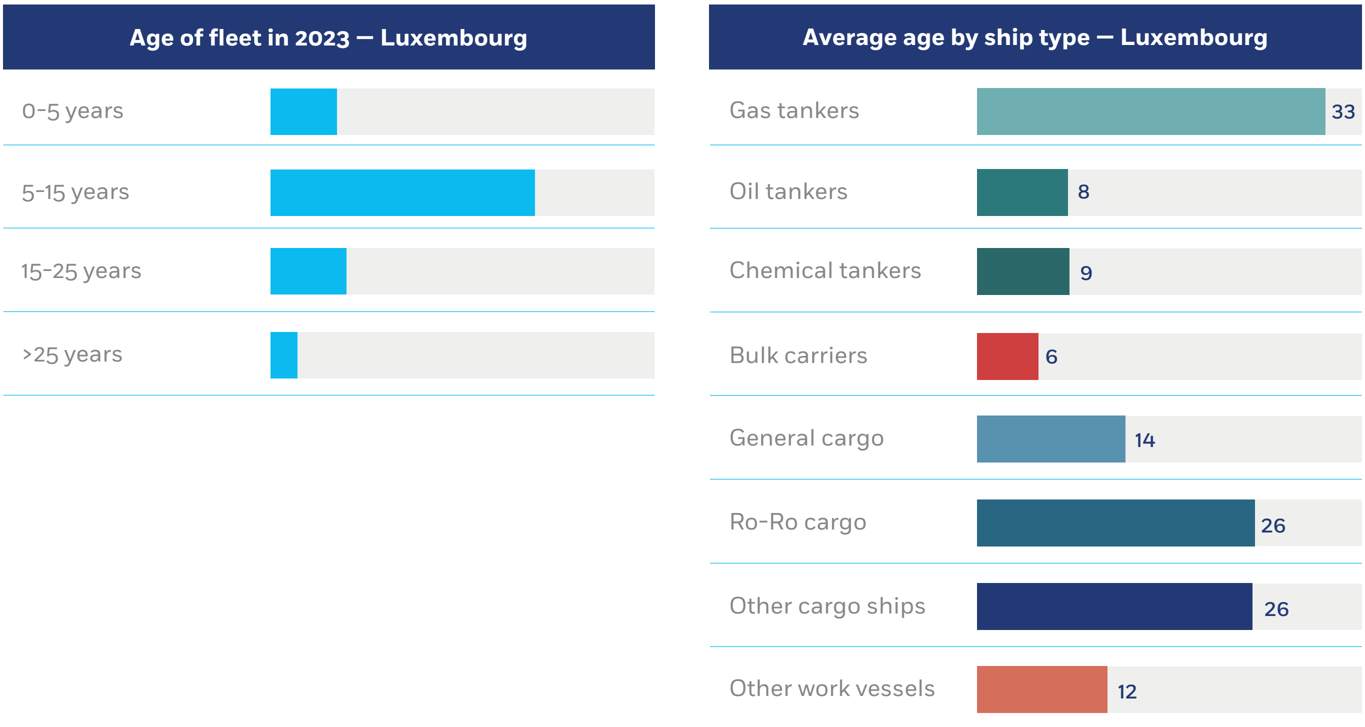
Figure A2.57: Luxembourgish fleet by ship type, including number of tankers by subtype.





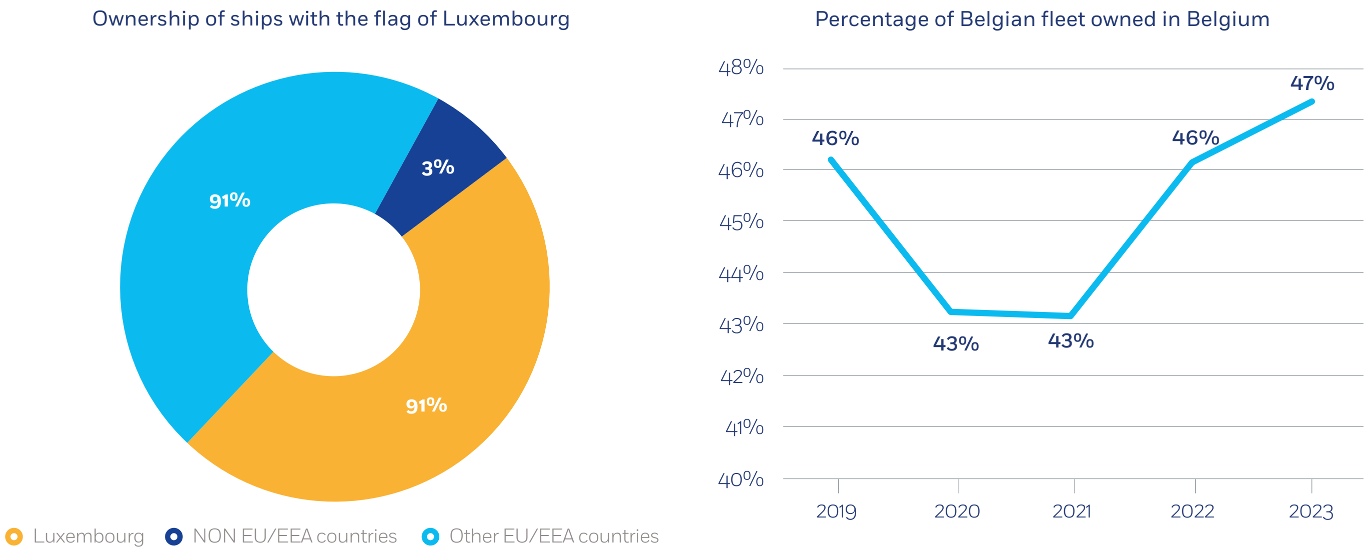
The overall fleet age categories and the average age by ship type of the ships flying the flag of Luxembourg are shown below.

Figure A2.58: Age of the fleet with the flag of Luxembourg – overall and average age by ship type.



The percentage of ships with the flag of Luxembourg that belong to shipowners registered in the country is shown below.

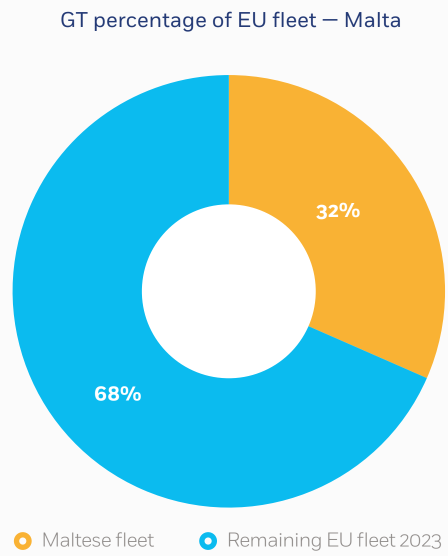
Figure A2.59: Percentage of Luxembourgish fleet owned by the shipowners of Luxembourg – evolution between 2019 and 2023.



MALTA

There are 1 827 ships registered with the flag of Malta, corresponding to 14 % of the total EU Member State fleet. The sum of the Maltese ships' GT is 78 750 805, corresponding to 32 % of the EU Member States' fleet.

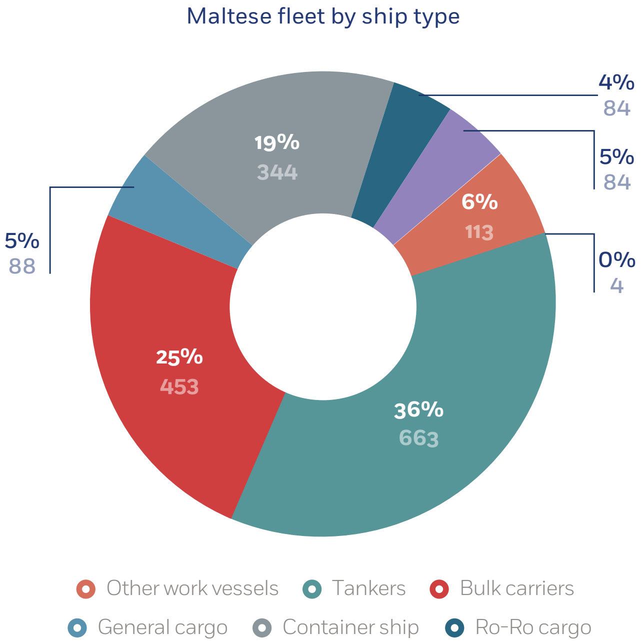
Figure A2.60: GT share of the flag of Malta in the EU Member States' fleet.

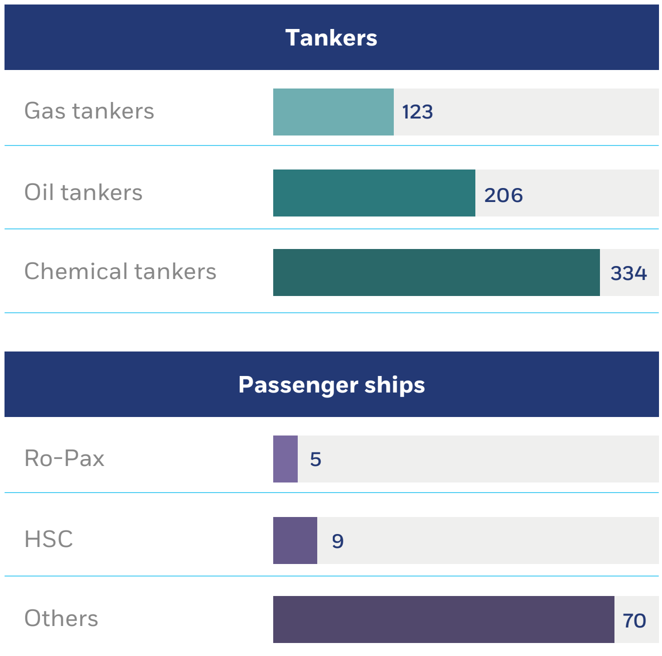


Their division by ship type is shown below. The largest category of ships flying the flag of Malta is that of tankers (36 %), followed by bulk carriers (25 %).

There are 84 passenger ships, including 5 ro-pax and 9 HSC, in the Maltese fleet.

Figure A2.61: Maltese fleet by ship type, including number of tankers by subtype and number of ro-pax and HSC.

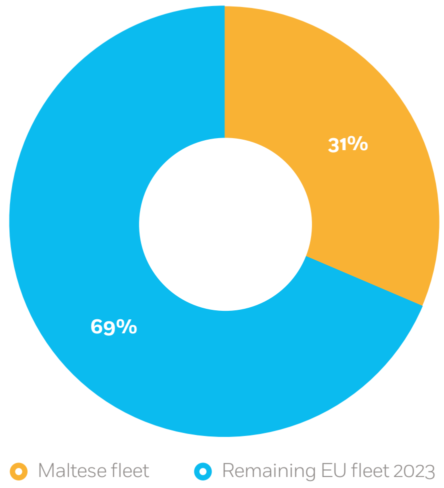




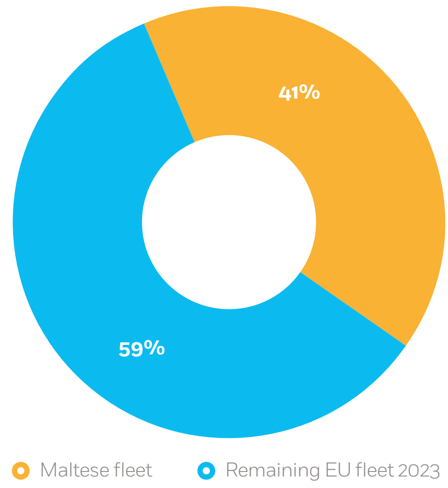
The tankers, bulk carriers and container ships of Malta correspond to 31 %, 41 % and 31 %, respectively, of the total EU Member State fleets of those ship types in terms of the number of ships.

Figure A2.62: Share of the flag of Malta in the EU Member States' tanker, bulk carrier and container ship fleets.

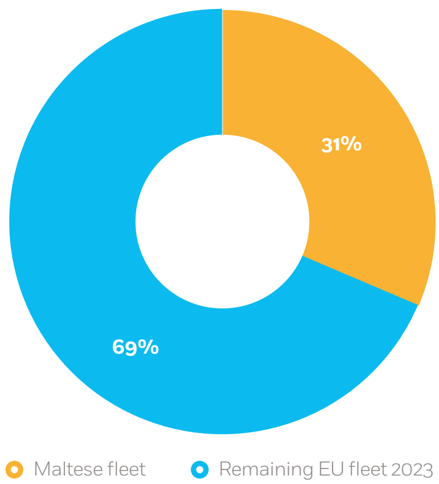
Percentage of EU tanker fleet — Malta



Percentage of EU bulk carrier fleet — Malta

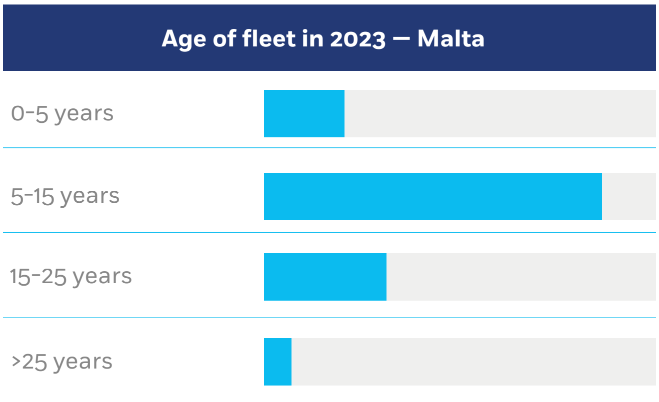


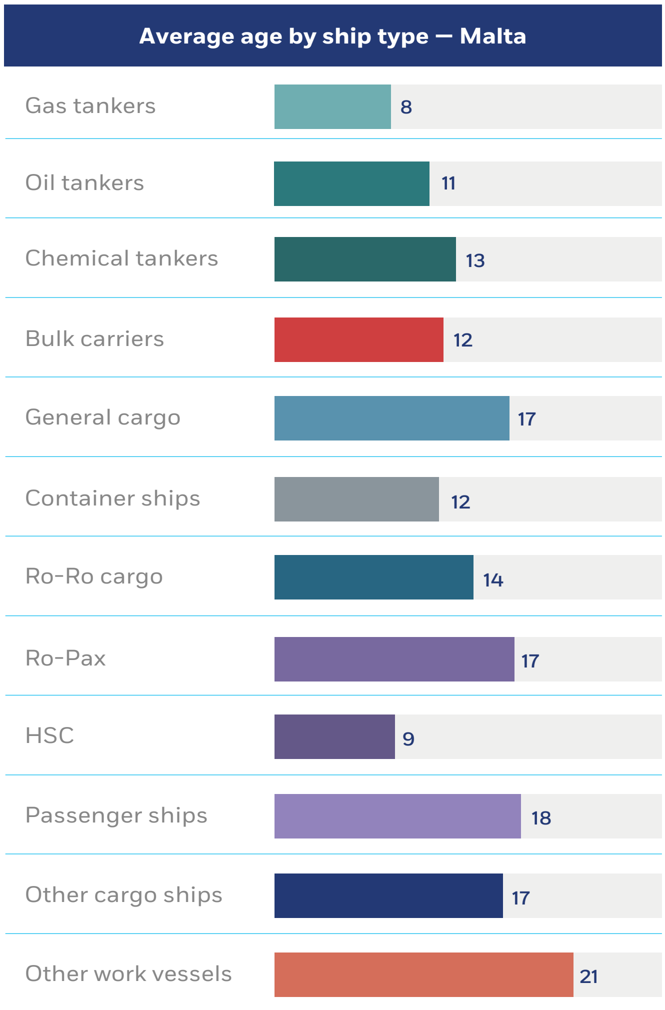
Percentage of EU container ship fleet — Malta



The overall fleet age categories and the average age by ship type of the ships flying the flag of Malta are shown below.

Figure A2.63: Age of the fleet with the flag of Malta – overall and average age by ship type.

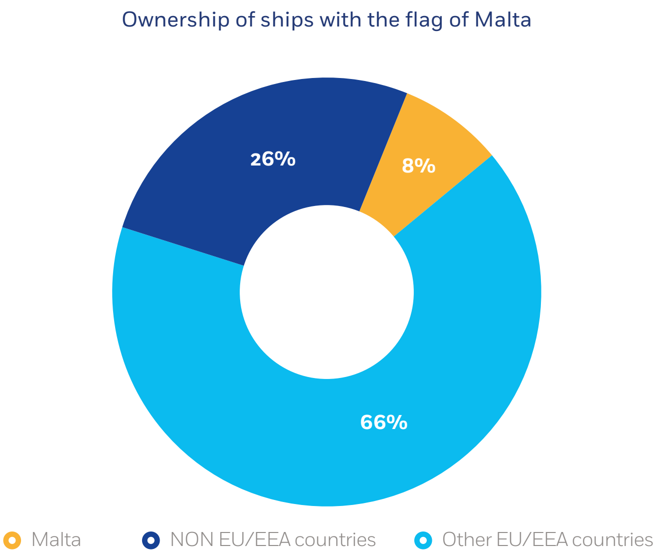


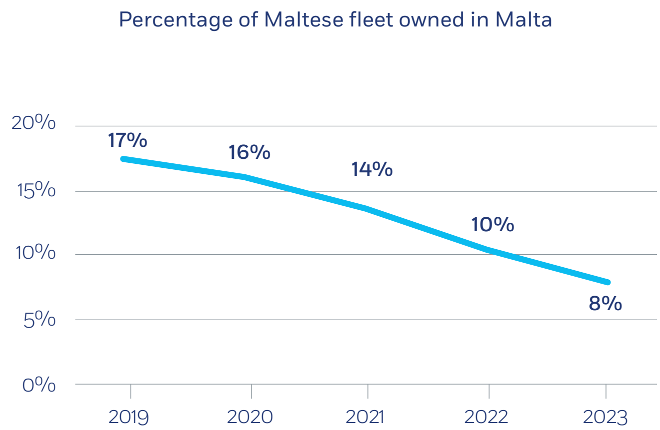


The percentage of ships with the flag of Malta that belong to shipowners registered in the country is shown below.

This percentage has been decreasing since 2019. In addition, 26 % of the ships flying the flag of Malta belong to shipowners based outside the EU.

Figure A2.64: Percentage of Maltese fleet owned by the shipowners of Malta – evolution between 2019 and 2023.



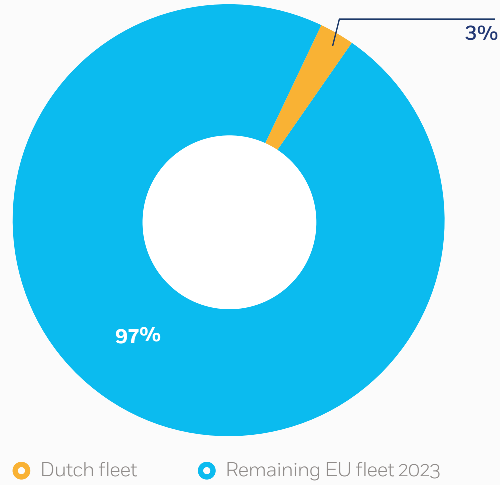


NETHERLANDS

There are 1 141 ships registered with the flag of Netherlands, corresponding to 9 % of the total EU Member State fleet. The sum of the Dutch ships' GT is 6 510 875, corresponding to 3 % of the EU Member States' fleet.

Figure A2.65: GT share of the flag of Netherlands in the EU Member States' fleet.

GT percentage of EU fleet — Netherlans

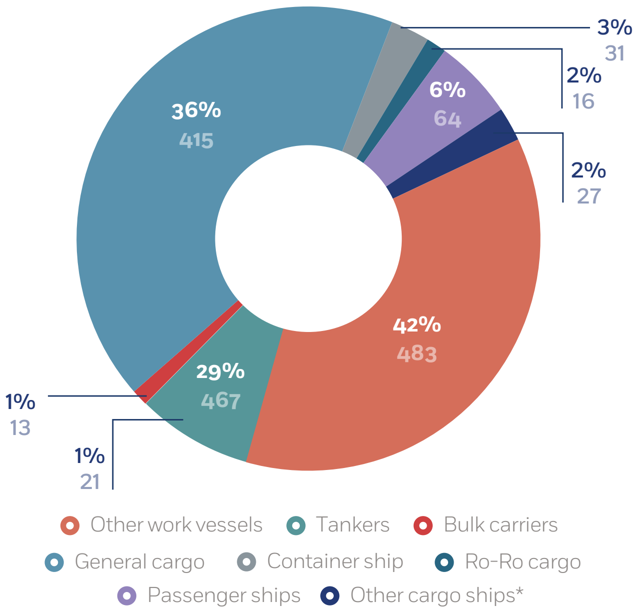


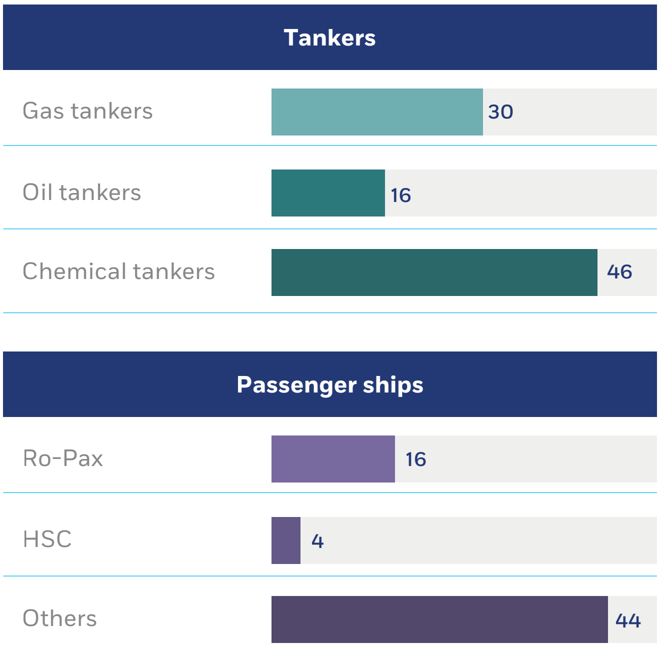
Their division by ship type is shown below. The largest category of ships flying the flag of Netherlands is that of general cargo ships (42 %), followed by other work vessels (36 %).

There are 64 passenger ships, including 16 ro-pax and 4 HSC, in the Dutch fleet.

Figure A2.66: Dutch fleet by ship type, including number of tankers by subtype and number of ro-pax and HSC.

Dutch fleet by ship type

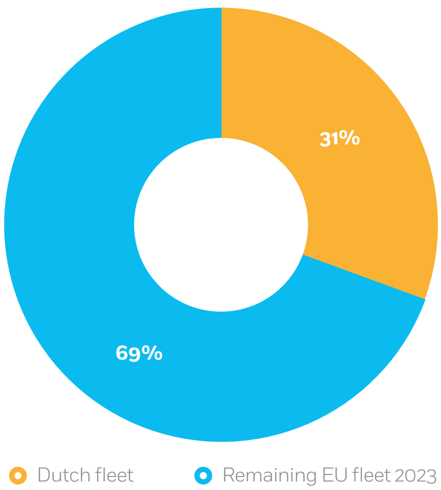




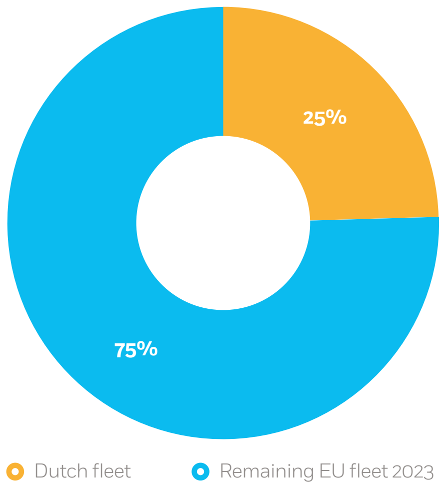
The general cargo ships, other cargo ships and other work vessels of the Netherlands correspond to 31 %, 25 % and 10 %, respectively, of the total EU Member State fleets of those ship types in terms of the number of ships.

Figure A2.67: Share of the flag of Netherlands in the EU Member States' general cargo, other cargo and other work vessels fleets.

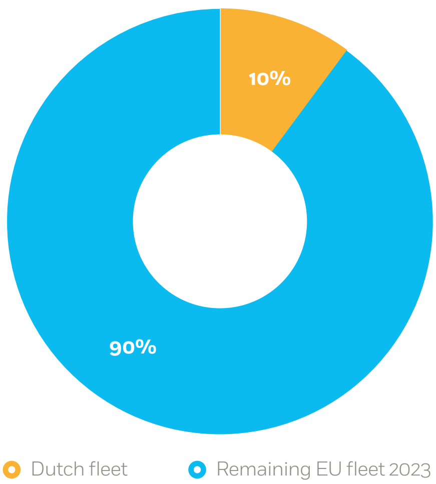
Percentage of EU general cargo fleet — Netherlands



Percentage of EU other cargo fleet — Netherlands

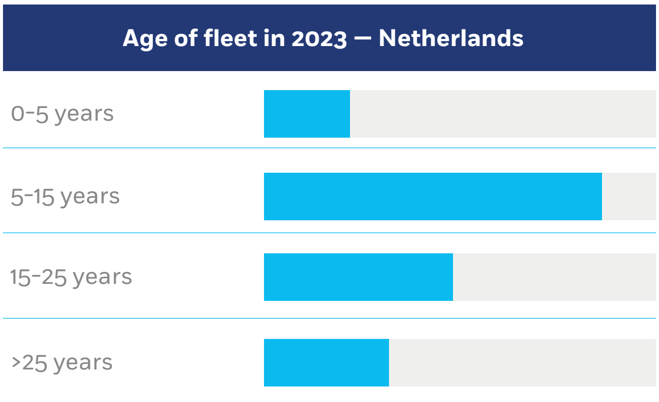


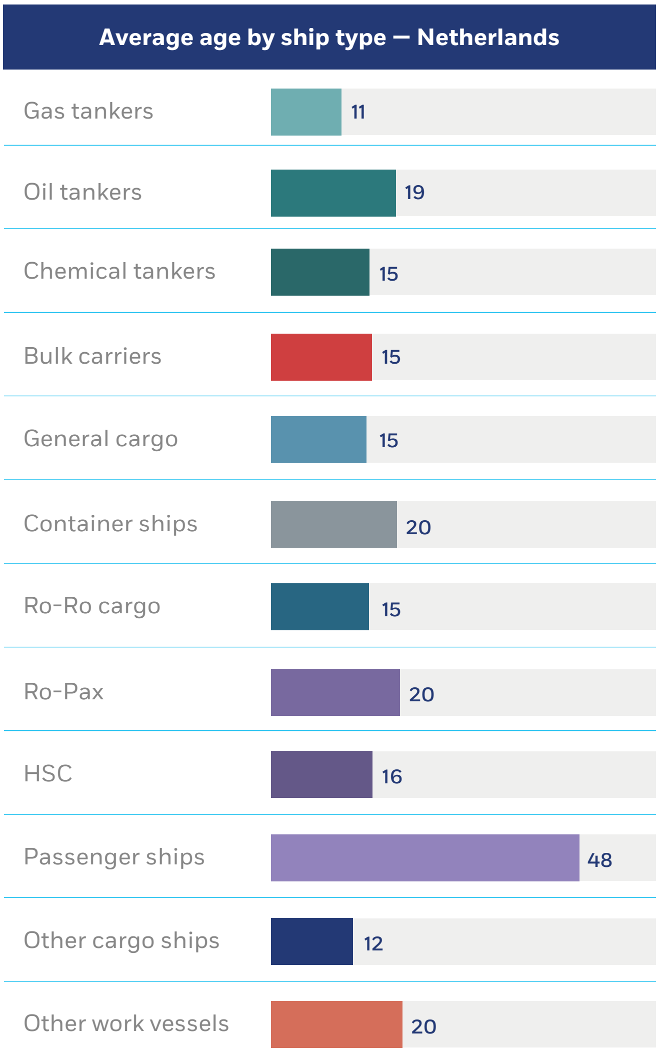
Percentage of EU other work vessels — Netherlands



The overall fleet age categories and the average age by ship type of the ships flying the flag of Netherlands are shown below.

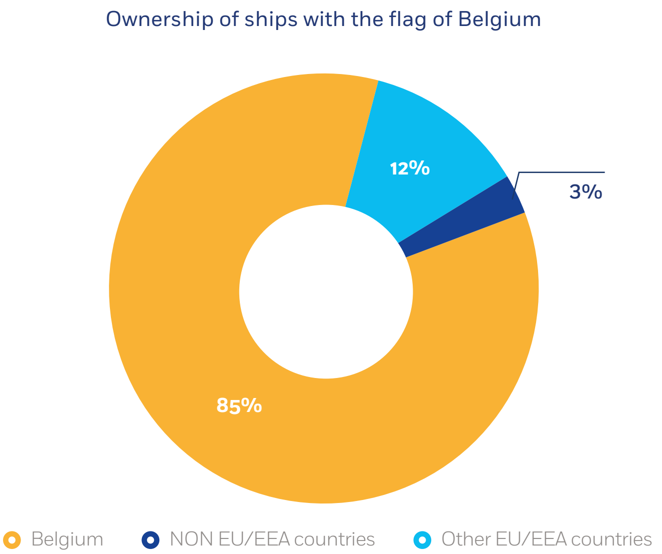
Figure A2.68: Age of the fleet with the flag of Netherlands – overall and average age by ship type.

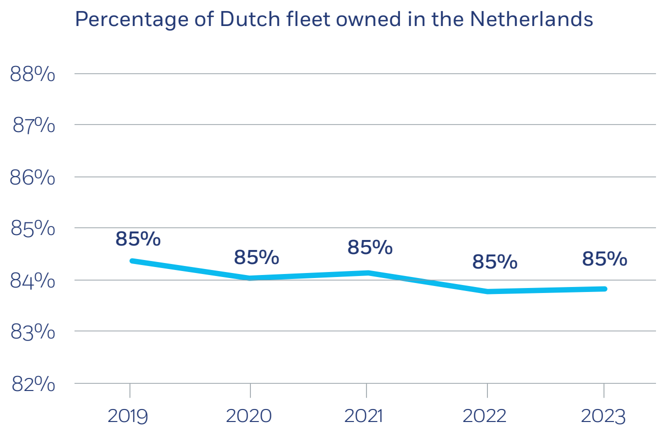




The percentage of ships with the flag of Netherlands that belong to shipowners registered in the country is shown below.

Figure A2.69: Percentage of Dutch fleet owned by the shipowners of Netherlands – evolution between 2019 and 2023.





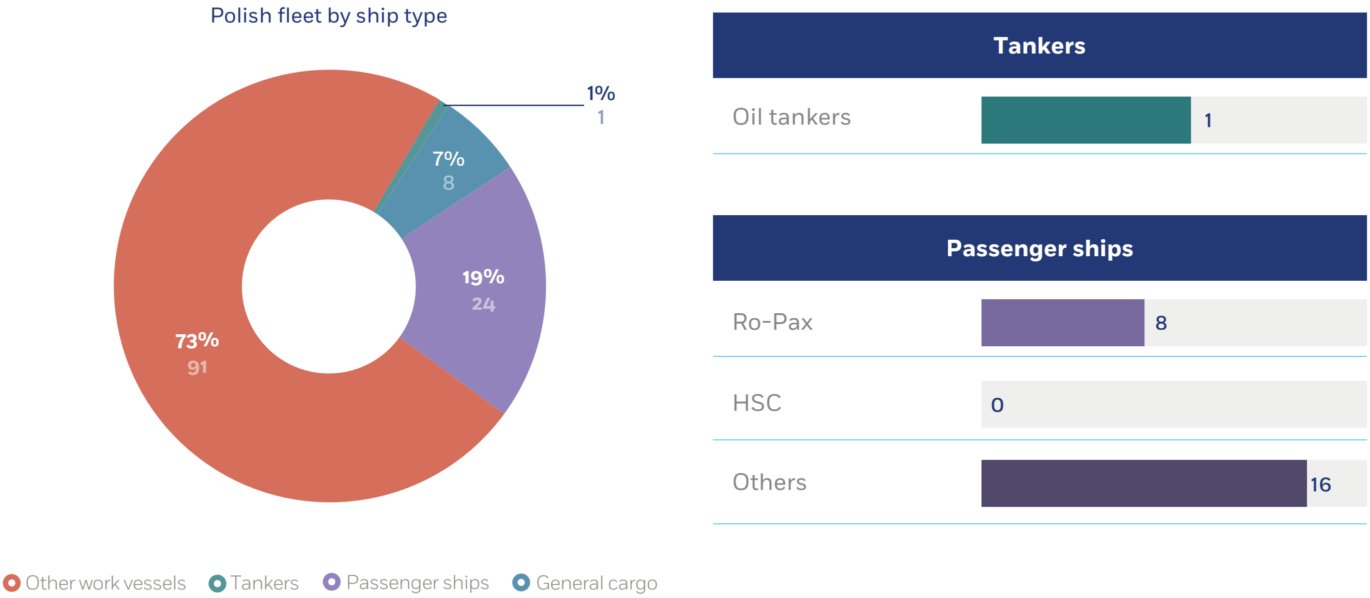
POLAND

There are 124 ships registered with the flag of Poland, corresponding to 1 % of the total EU Member State fleet, with a total of 71 751 GT.

Their division by ship type is shown below. The largest category of ships flying the flag of Poland is other work vessels (73 %). There are 24 passenger ships, including 8 ro-pax vessels, in the Polish fleet.

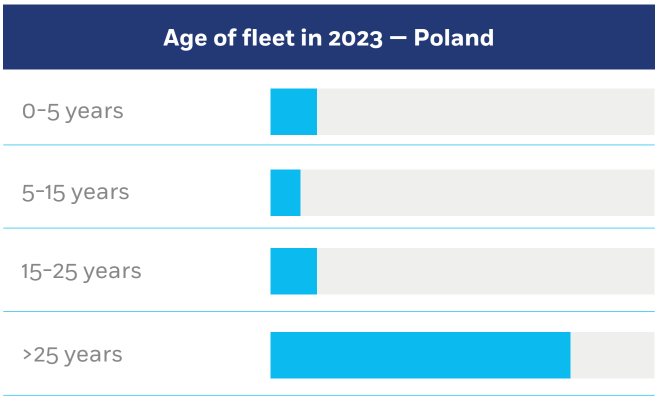
The overall fleet age categories and the average age by ship type of the ships flying the flag of Poland are shown below.

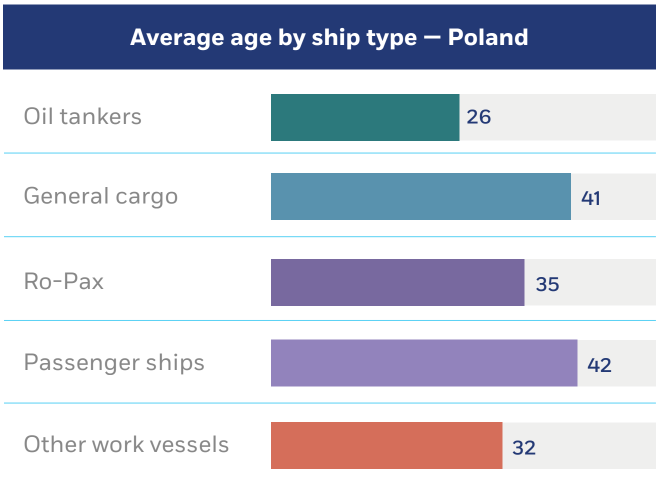
Figure A2.70: Polish fleet by ship type, including number of tankers by subtype and number of ro-pax and HSC.



The overall fleet age categories and the average age by ship type of the ships flying the flag of Poland are shown below.

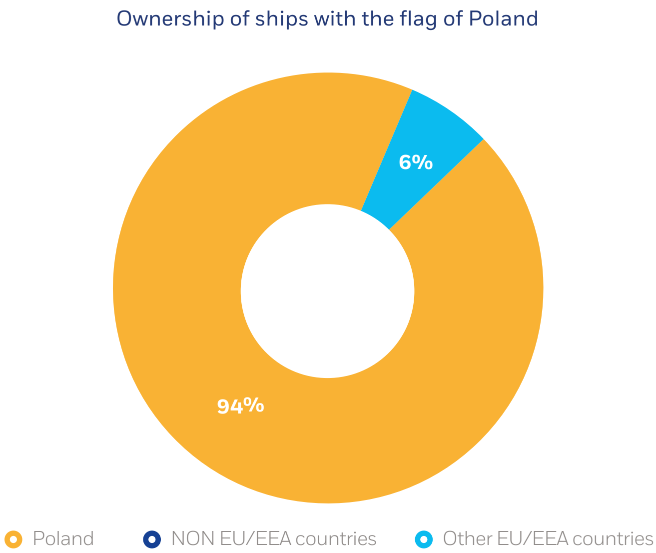
Figure A2.71: Age of the fleet with the flag of Poland – overall and average age by ship type.

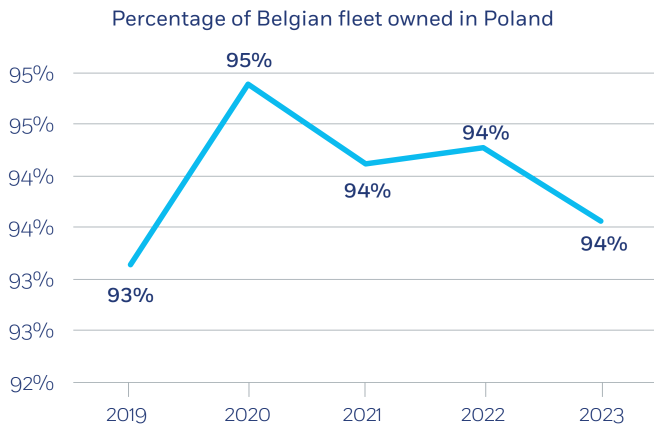




The percentage of ships with the flag of Poland that belong to shipowners registered in the country is shown below.

Figure A2.72: Percentage of Polish fleet owned by the shipowners of Poland – evolution between 2019 and 2023.

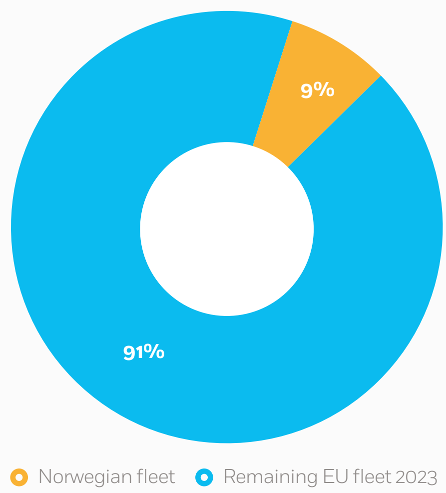




PORTUGAL

There are 1 005 ships registered with the flag of Portugal, corresponding to 8 % of the total EU Member State fleet. The sum of the Portuguese ships' GT is 22 387 164, corresponding to 9 % of the EU Member States' fleet.

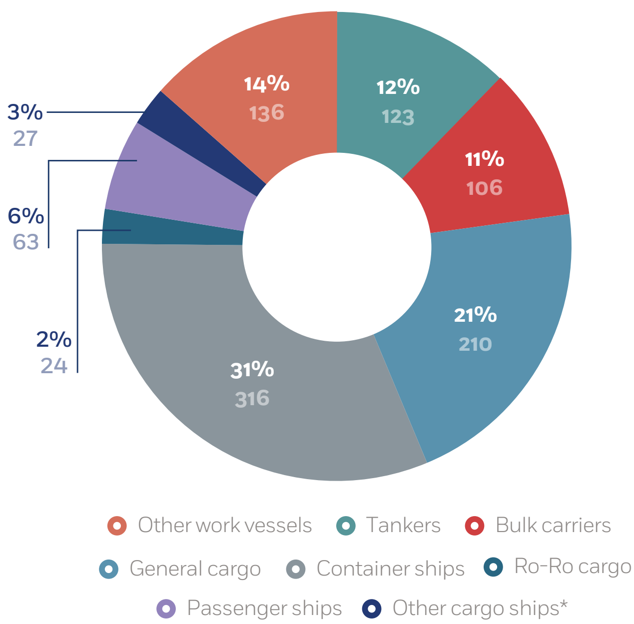
Figure A2.73: GT share of the flag of Portugal in the EU Member States' fleet.

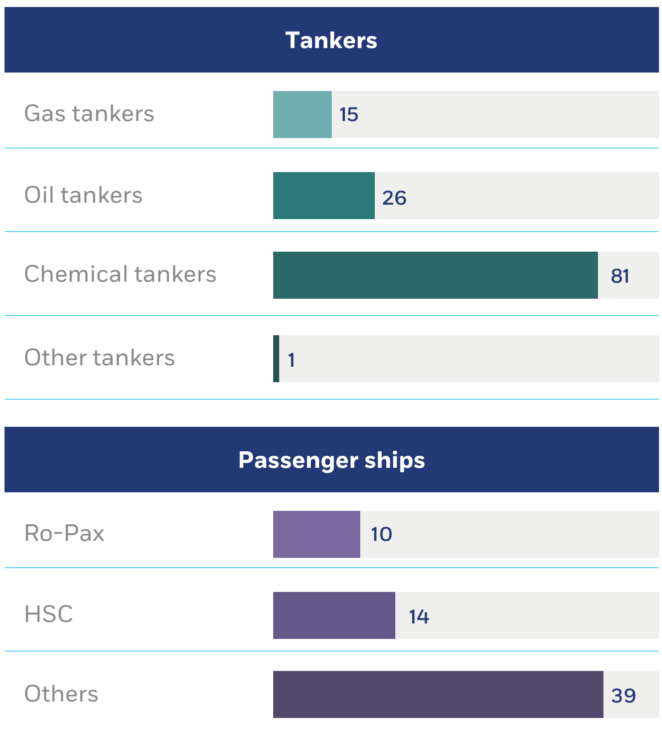


Their division by ship type is shown below. The largest category of ships flying the flag of Portugal is that of container ships (31 %), followed by general cargo ships (21 %).

There are 63 passenger ships, including 10 ro-pax and 14 HSC, in the Portuguese fleet.

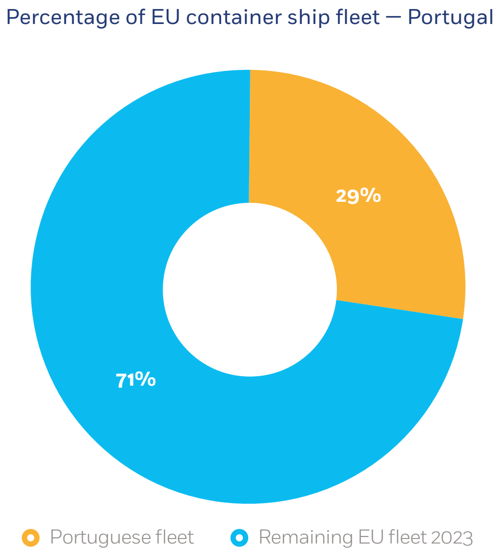
Figure A2.74: Portuguese fleet by ship type, including number of tankers by subtype and number of ro-pax and HSC.

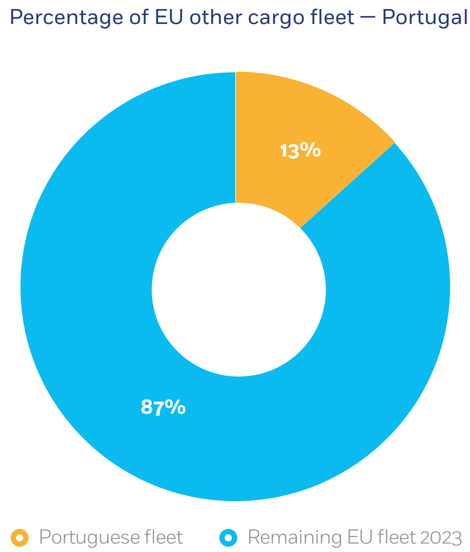


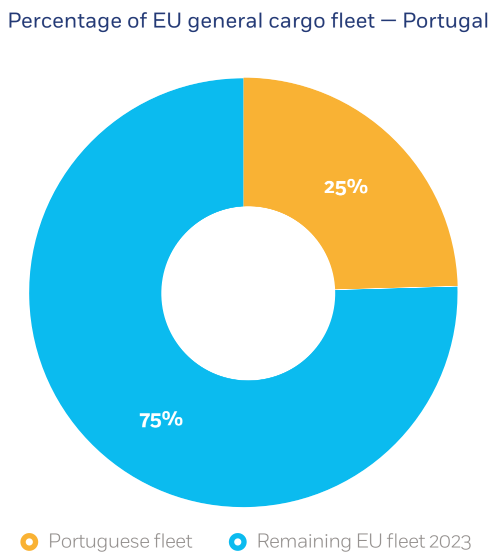


The container ships, general cargo ships and other cargo vessels of Portugal correspond to 29 %, 13 % and 25 % of the total EU Member State fleets of those ship types in terms of the number of ships.

Figure A2.75: Share of the flag of Portugal in the EU Member States' container ships, general cargo and other cargo fleets.

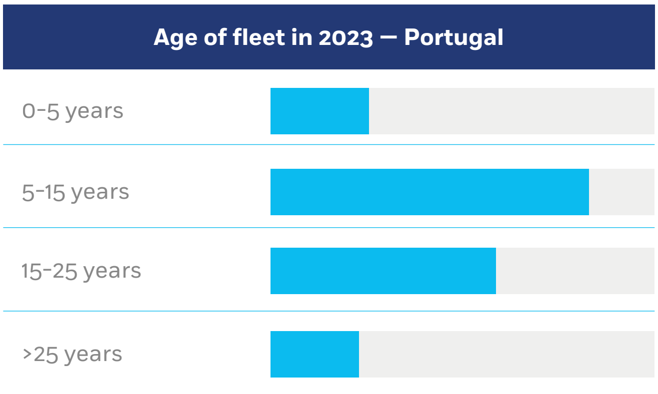


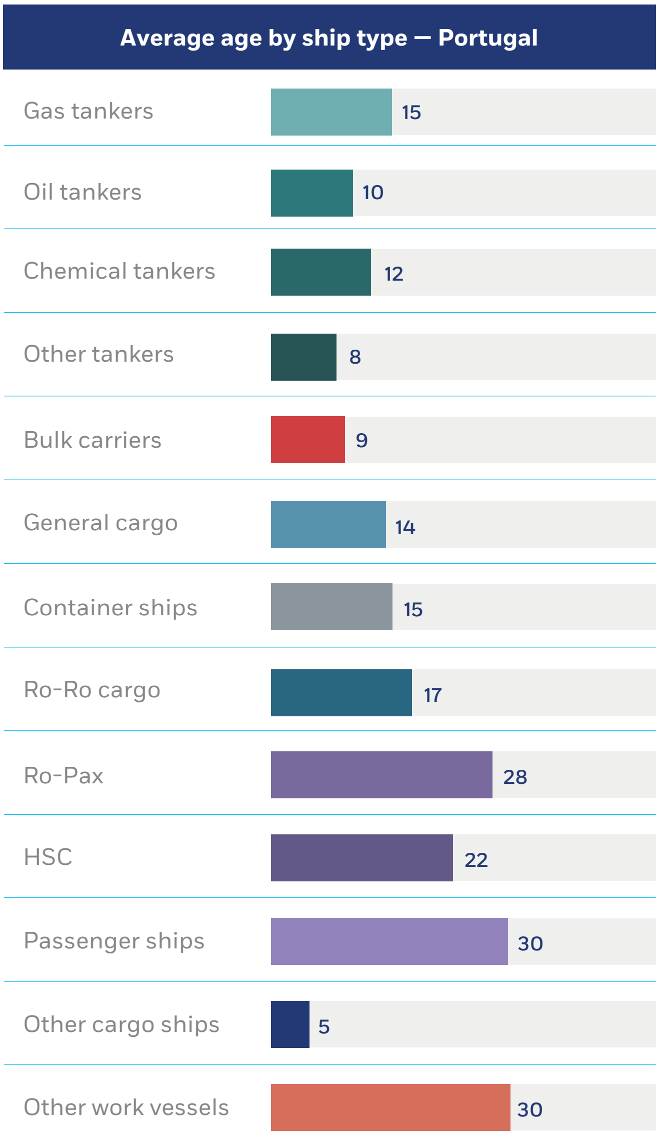




The overall fleet age categories and the average age by ship type of the ships flying the flag of Portugal are shown below.

Figure A2.76: Age of the fleet with the flag of Portugal – overall and average age by ship type.

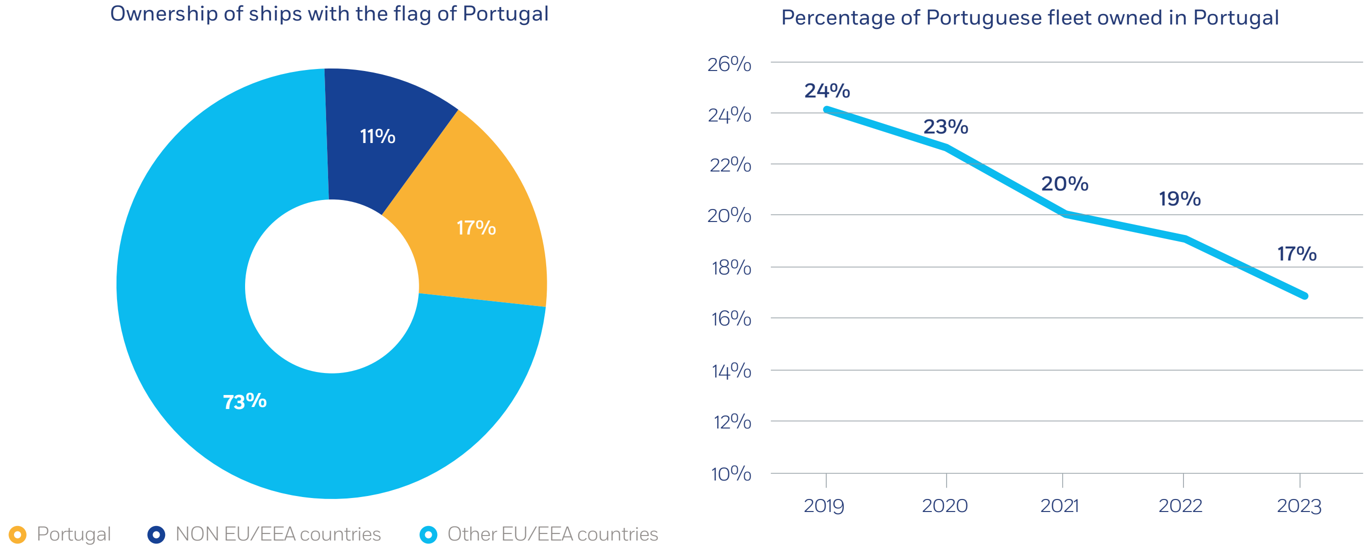




The percentage of ships with the flag of Portugal that belong to shipowners registered in the country is shown below.

This percentage decreased between 2019 and 2023. In addition, 11 % of the ships flying the flag of Portugal belong to shipowners based outside the EU.

Figure A2.77: Percentage of Portuguese fleet owned by the shipowners of Portugal – evolution between 2019 and 2023.

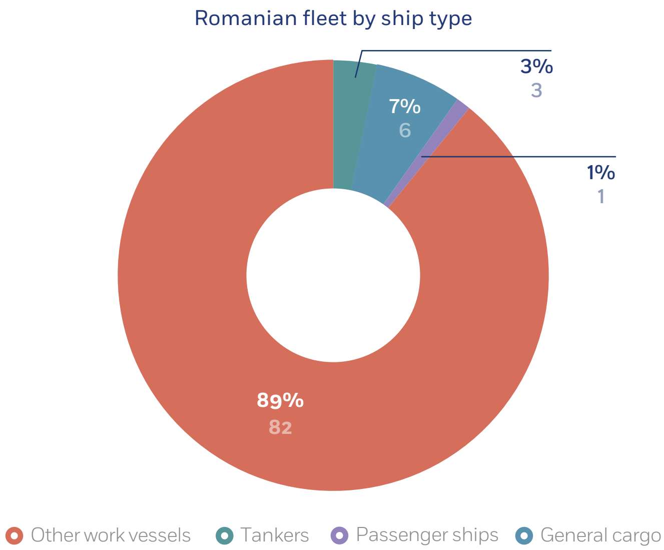


ROMANIA

There are 92 ships registered with the flag of Romania, corresponding to 1 % of the total EU Member State fleet, with a total of 46 902 GT.

Their division by ship type is shown below. The largest category of ships flying the flag of Romania is other work vessels (89 %). There is 1 passenger ship in the Romanian fleet.

Figure A2.78: Romanian fleet by ship type, including number of tankers by subtype and number of ro-pax and HSC.

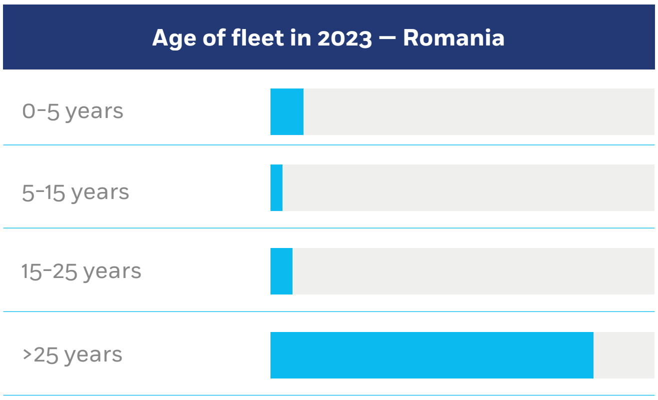


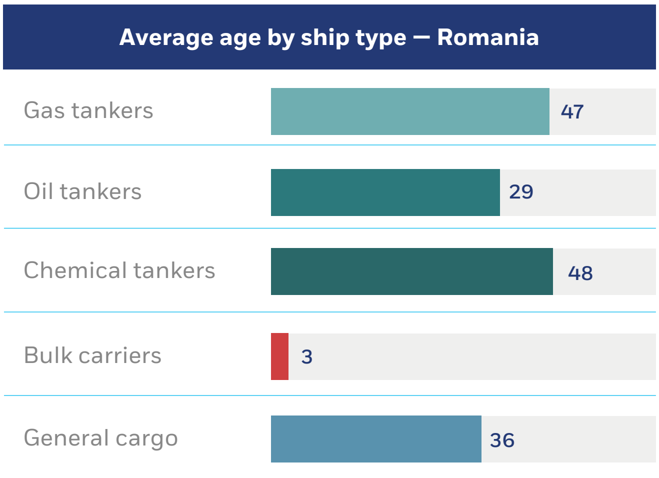
Tankers	
Oil tankers	2
Chemical tankers	1

Passenger ships	
Ro-Pax	0
HSC	0
Others	1

The overall fleet age categories and the average age by ship type of the ships flying the flag of Romania are shown below.

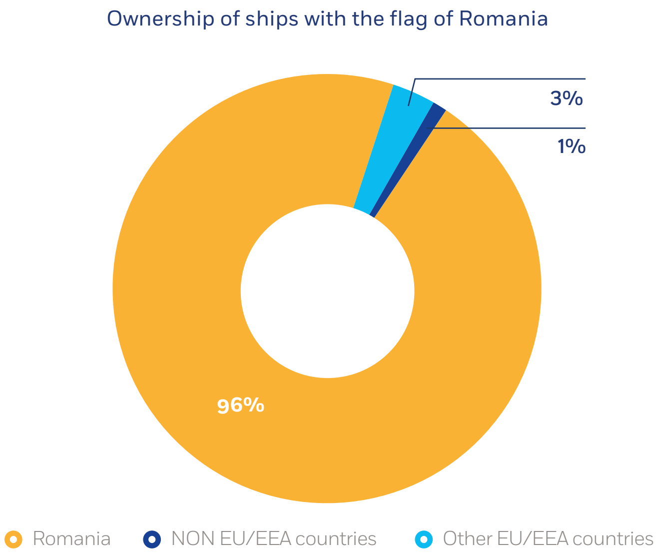
Figure A2.79: Age of the fleet with the flag of Romania – overall and average age by ship type.

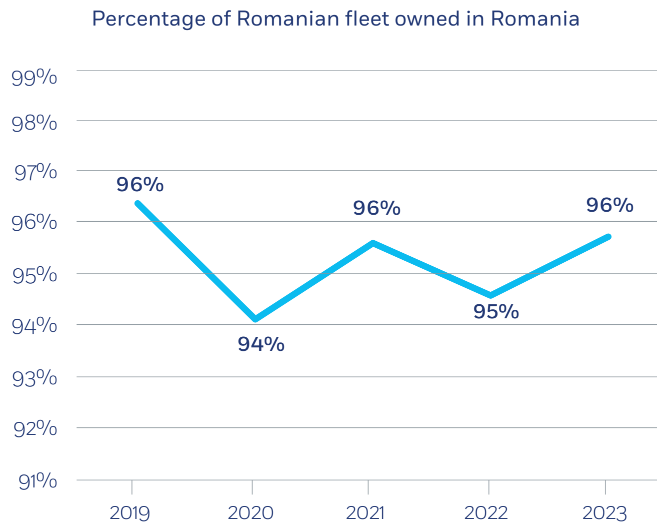




The percentage of ships with the flag of Romania that belong to shipowners registered in the country is shown below.

Figure A2.80: Percentage of Romanian fleet owned by the shipowners of Romania – evolution between 2019 and 2023.





SLOVENIA

There are 6 work vessels flying the flag of Slovenia, with an average age of 22 years, all belonging to Slovenian shipowners. The sum of the Slovenian ships' GT is 2 375.

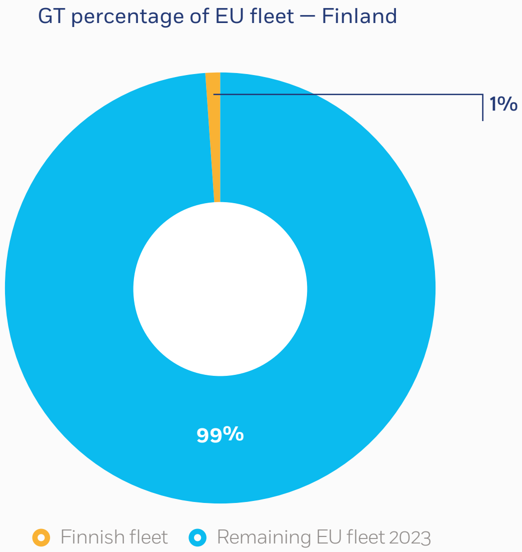
SLOVAKIA

There is 1 oil tanker flying the flag of Slovakia. It is 51 years old and belongs to a non-EU shipowner.

FINLAND

There are 262 ships registered with the flag of Finland, corresponding to 2 % of the total EU Member State fleet. The sum of the Finnish ships' GT is 1 912 443, corresponding to 1 % of the EU Member States' fleet.

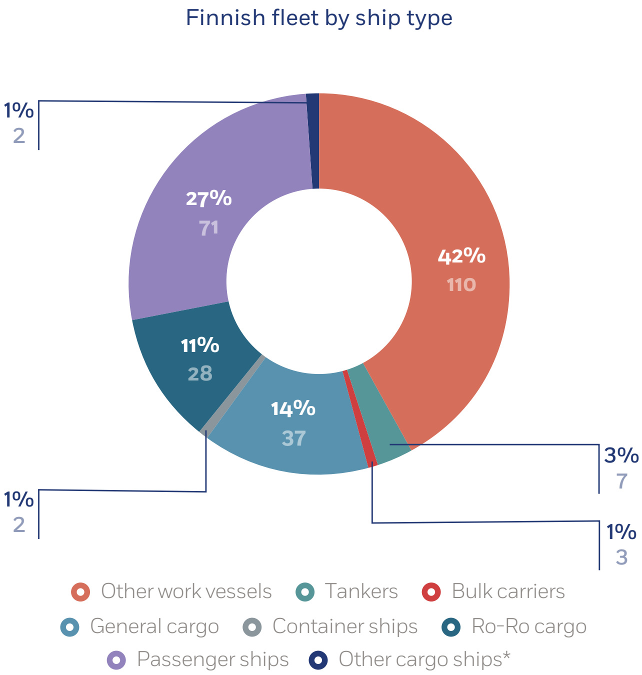
Figure A2.81: GT share of the flag of Finland in the EU Member States' fleet.

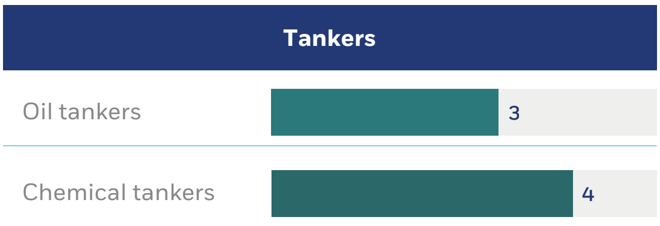


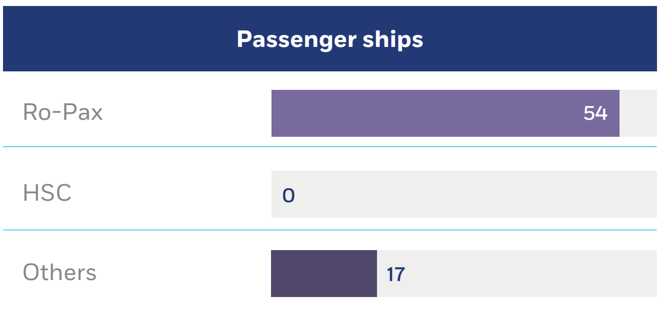
Their division by ship type is shown below. The largest category of ships flying the flag of Finland is that of other work vessels (42 %), followed by passenger ships (27 %), general cargo (14 %) and ro-ro cargo ships (11 %).

There are 71 passenger ships, including 54 ro-pax ships, in the Finnish fleet.

Figure A2.82: Finnish fleet by ship type, including number of tankers by subtype and number of ro-pax and HSC.

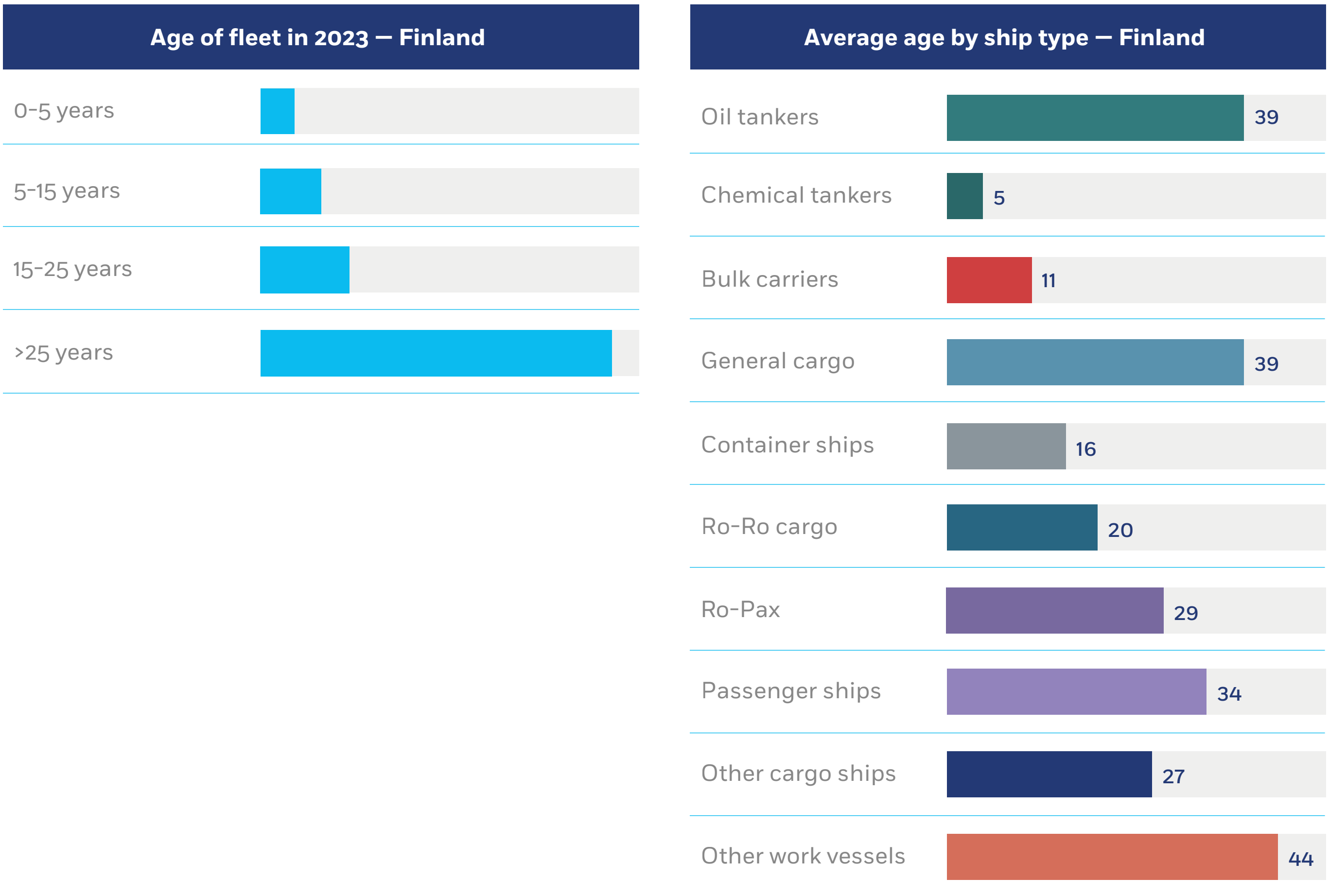






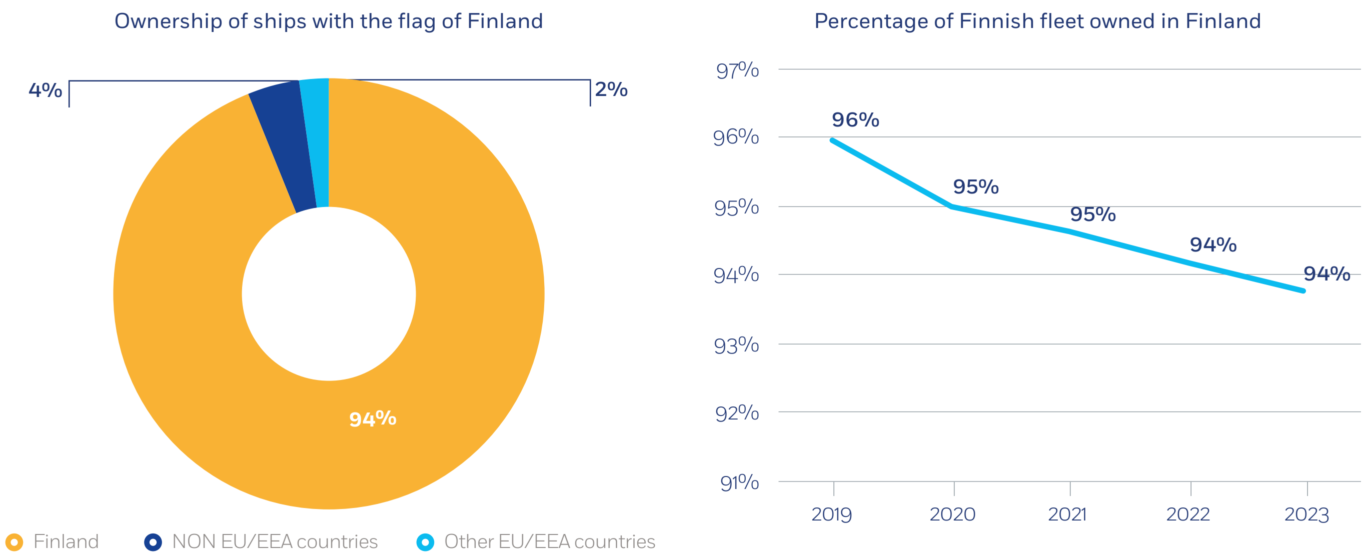
The overall fleet age categories and the average age by ship type of the ships flying the flag of Finland are shown below.

Figure A2.83: Age of the fleet with the flag of Finland – overall and average age by ship type.



The percentage of ships with the flag of Finland that belong to shipowners registered in the country is shown below.

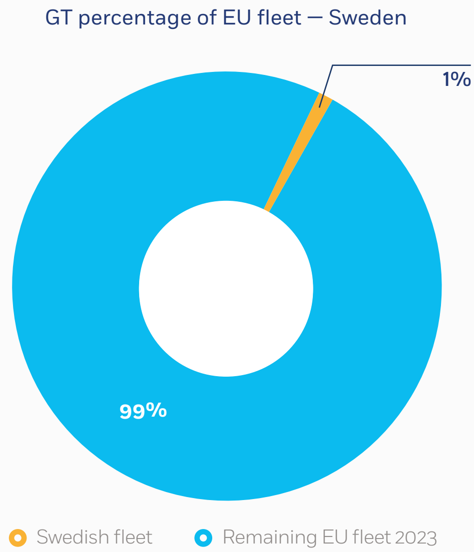
Figure A2.84: Percentage of Finnish fleet owned by the shipowners of Finland – evolution between 2019 and 2023.



SWEDEN

There are 349 ships registered with the flag of Sweden, corresponding to 3 % of the total EU Member State fleet. The sum of the Swedish ships' GT is 2 208 192, corresponding to 1 % of the EU Member States' fleet.

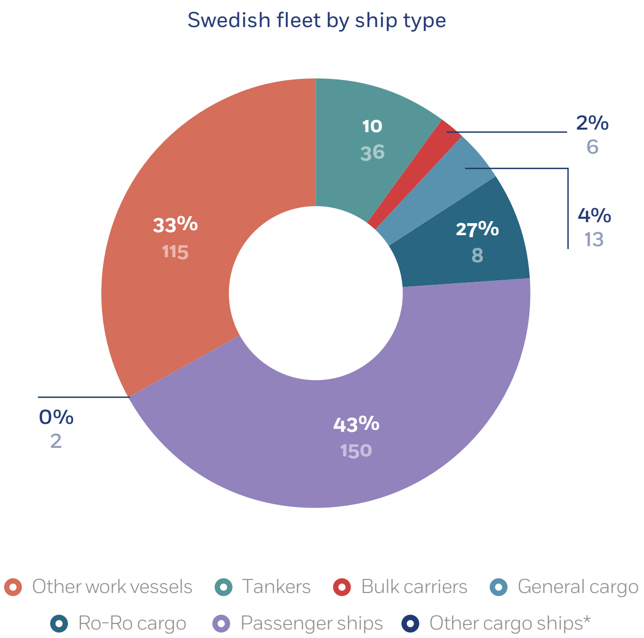
Figure A2.85: GT share of the flag of Sweden in the EU Member States' fleet.

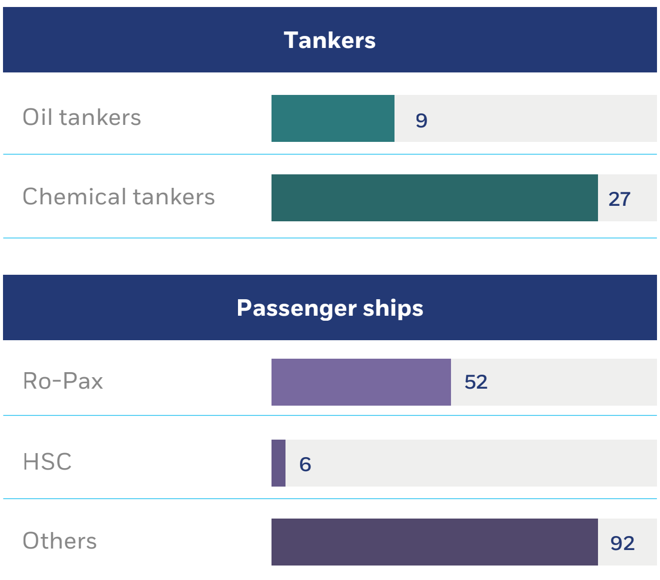


Their division by ship type is shown below. The largest category of ships flying the flag of Sweden is that of passenger ships (43 %), followed by other work vessels (33 %).

There are 150 passenger ships, including 52 ro-pax and 6 HSC, in the Swedish fleet.

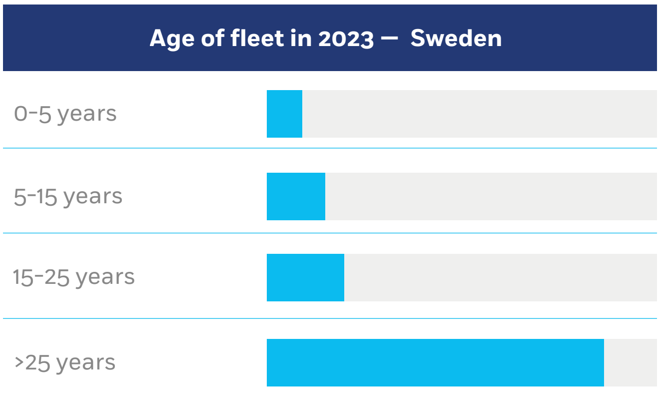
Figure A2.86: Swedish fleet by ship type, including number of tankers by subtype and number of ro-pax and HSC.

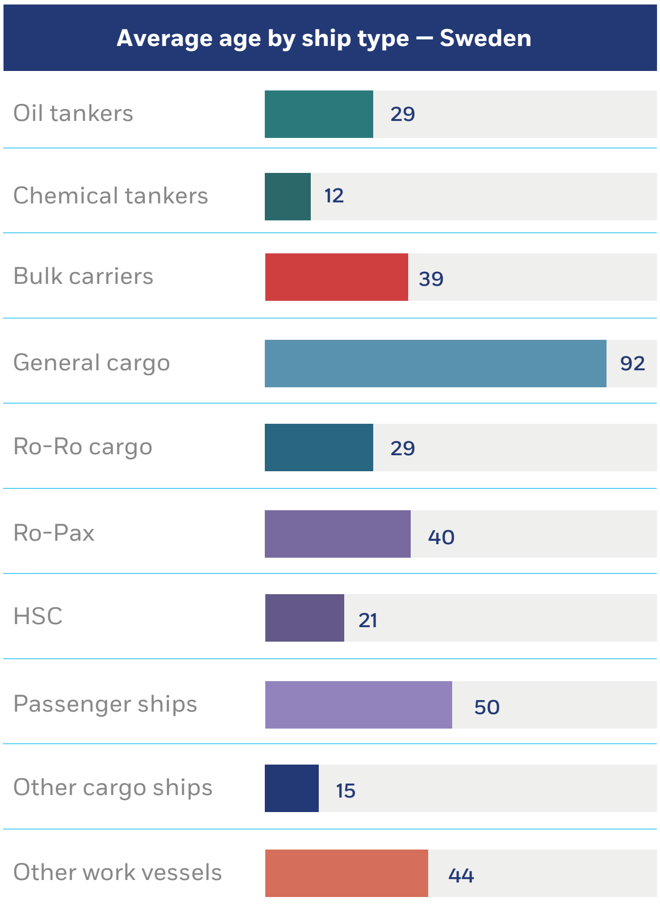




The overall fleet age categories and the average age by ship type of the ships flying the flag of Sweden are shown below.

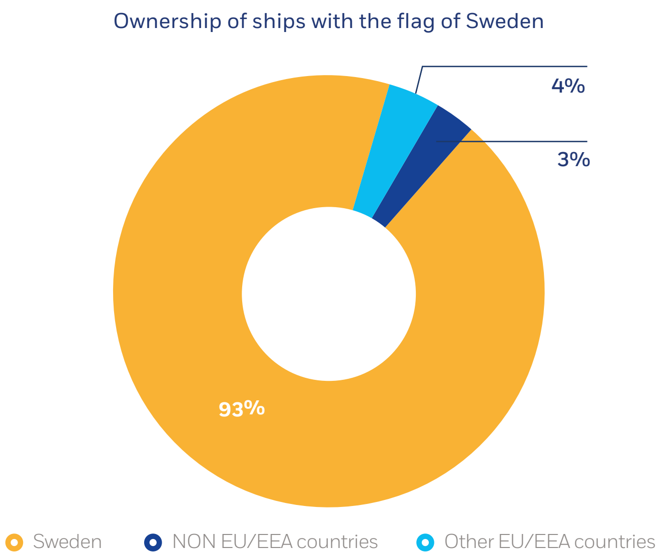
Figure A2.87: Age of the fleet with the flag of Sweden – overall and average age by ship type.

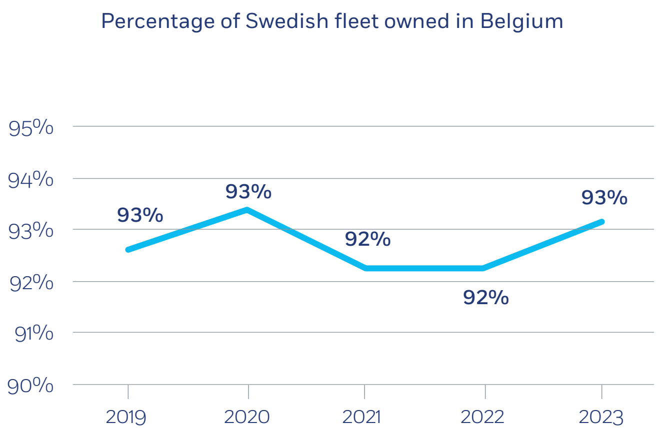




The percentage of ships with the flag of Sweden that belong to shipowners registered in the country is shown below.

Figure A2.88: Percentage of Swedish fleet owned by the shipowners of Sweden – evolution between 2019 and 2023.



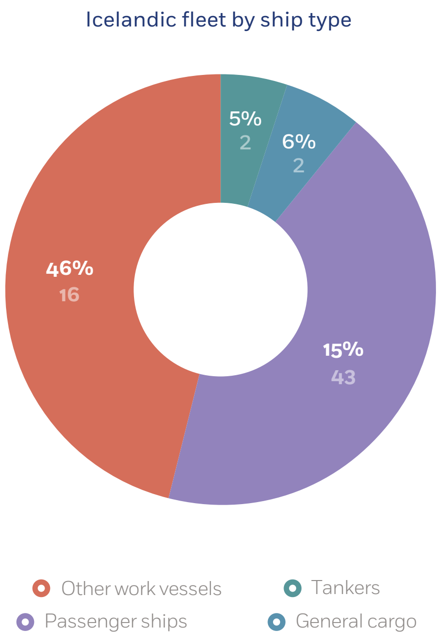


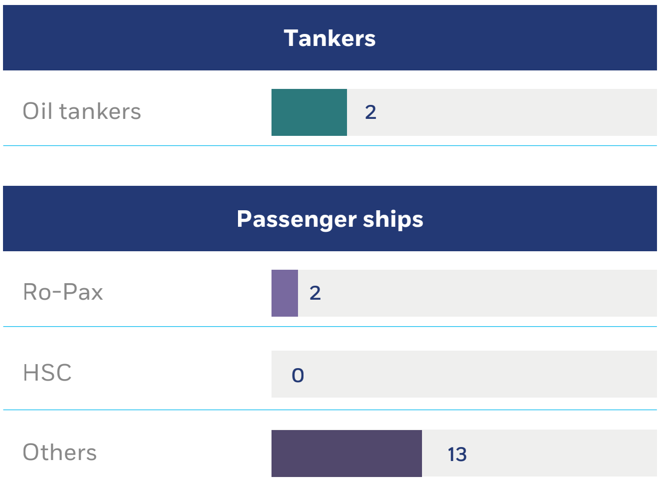
ICELAND

There are 35 ships registered with the flag of Iceland, with a total of 27 200 GT.

Their division by ship type is shown below. The largest category of ships flying the flag of Iceland is other work vessels (46 %), followed by passenger ships (43 %). There are 15 passenger ships, including 2 ro-pax, in the Icelandic fleet.

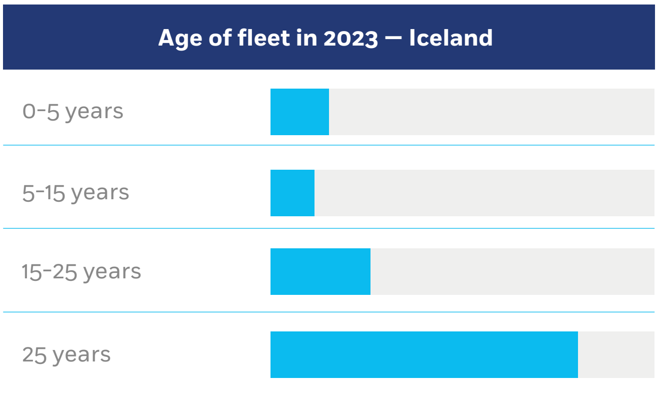
Figure A2.89: Icelandic fleet by ship type, including number of tankers by subtype and number of ro-pax and HSC.

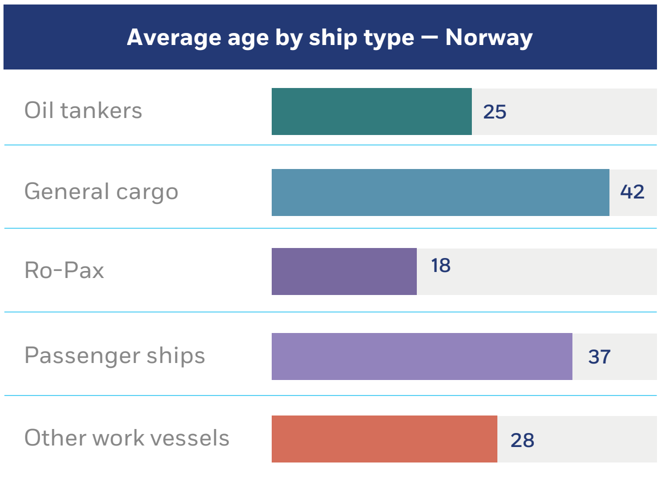




The overall fleet age categories and the average age by ship type of the ships flying the flag of Iceland are shown below.

Figure A2.90: Age of the fleet with the flag of Iceland – overall and average age by ship type.

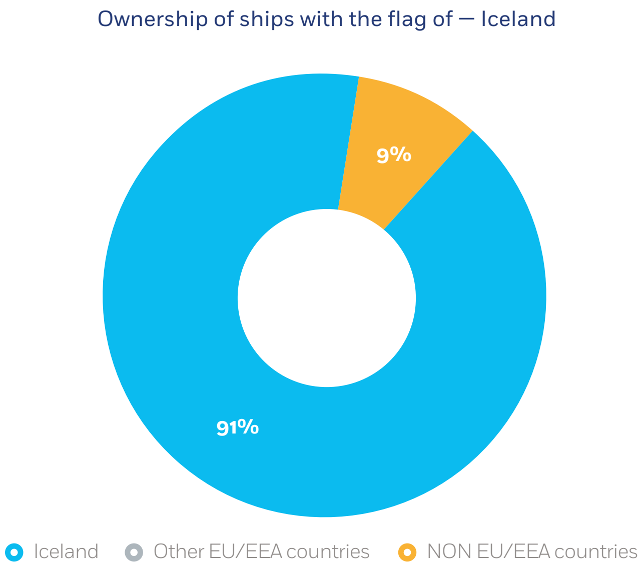


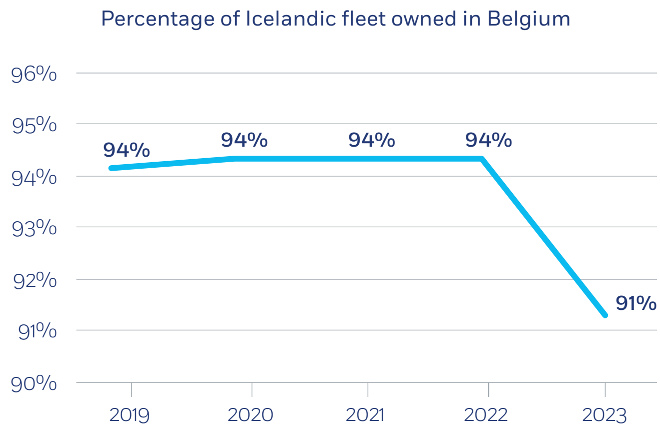


The percentage of ships with the flag of Iceland that belong to shipowners registered in the country is shown below.

That percentage decreased between 2022 and 2023. In addition, 9 % of the ships flying the flag of Iceland belong to shipowners based outside the EU.

Figure A2.91: Percentage of Icelandic fleet owned by the shipowners of Iceland – evolution between 2019 and 2023.

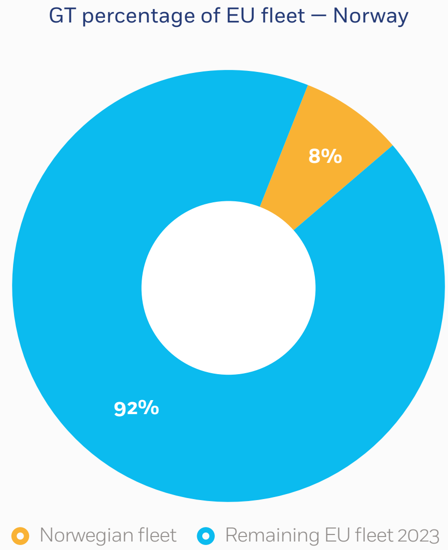




NORWAY

There are 1 616 ships registered with the flag of Norway, corresponding to 12 % of the total EU Member State fleet. The sum of the Norwegian ships' GT is 19 288 929, corresponding to 8 % of the EU Member States' fleet.

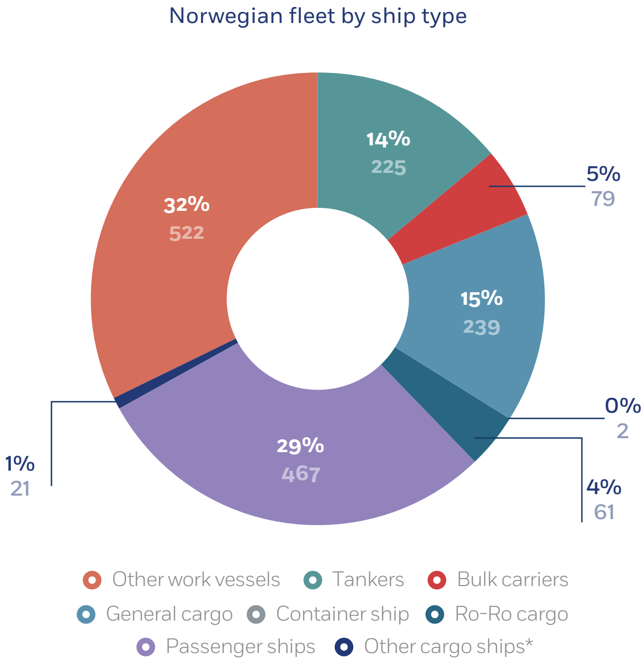
Figure A2.92: GT share of the flag of Norway in the EU Member States' fleet.

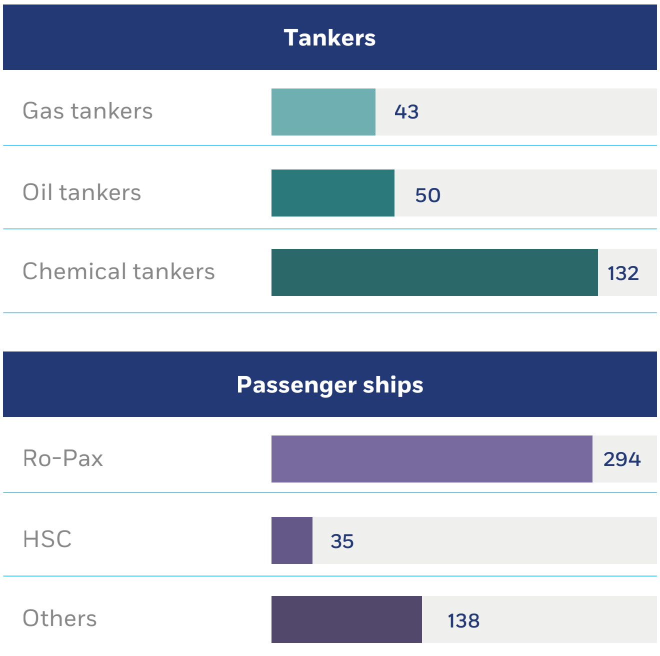


Their division by ship type is shown below. The largest category of ships flying the flag of Norway is that of other work vessels (32 %), followed by passenger ships (29 %).

There are 467 passenger ships, including 294 ro-pax and 35 HSC, in the Norwegian fleet.

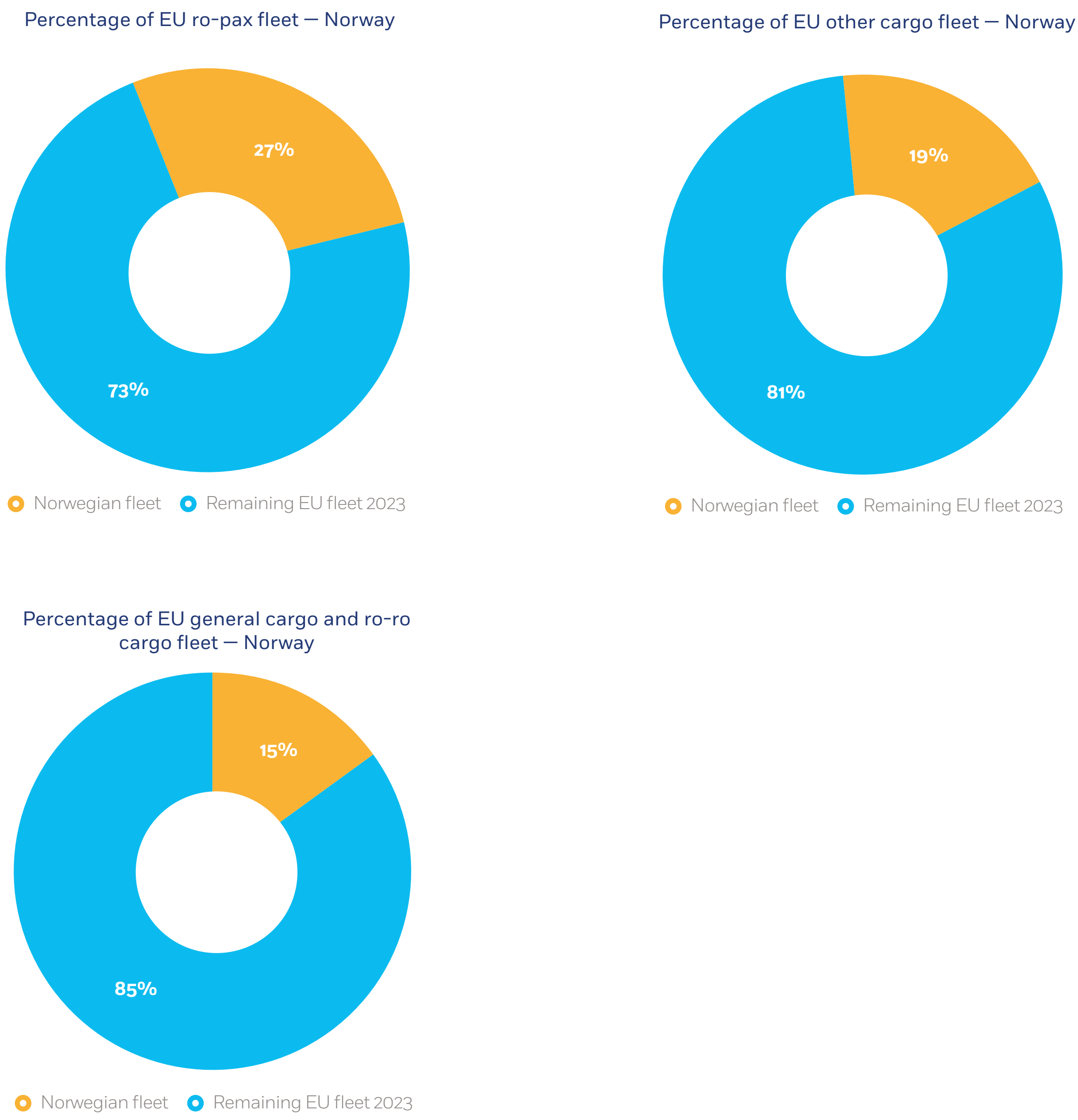
Figure A2.93: Norwegian fleet by ship type, including number of tankers by subtype and number of ro-pax and HSC.





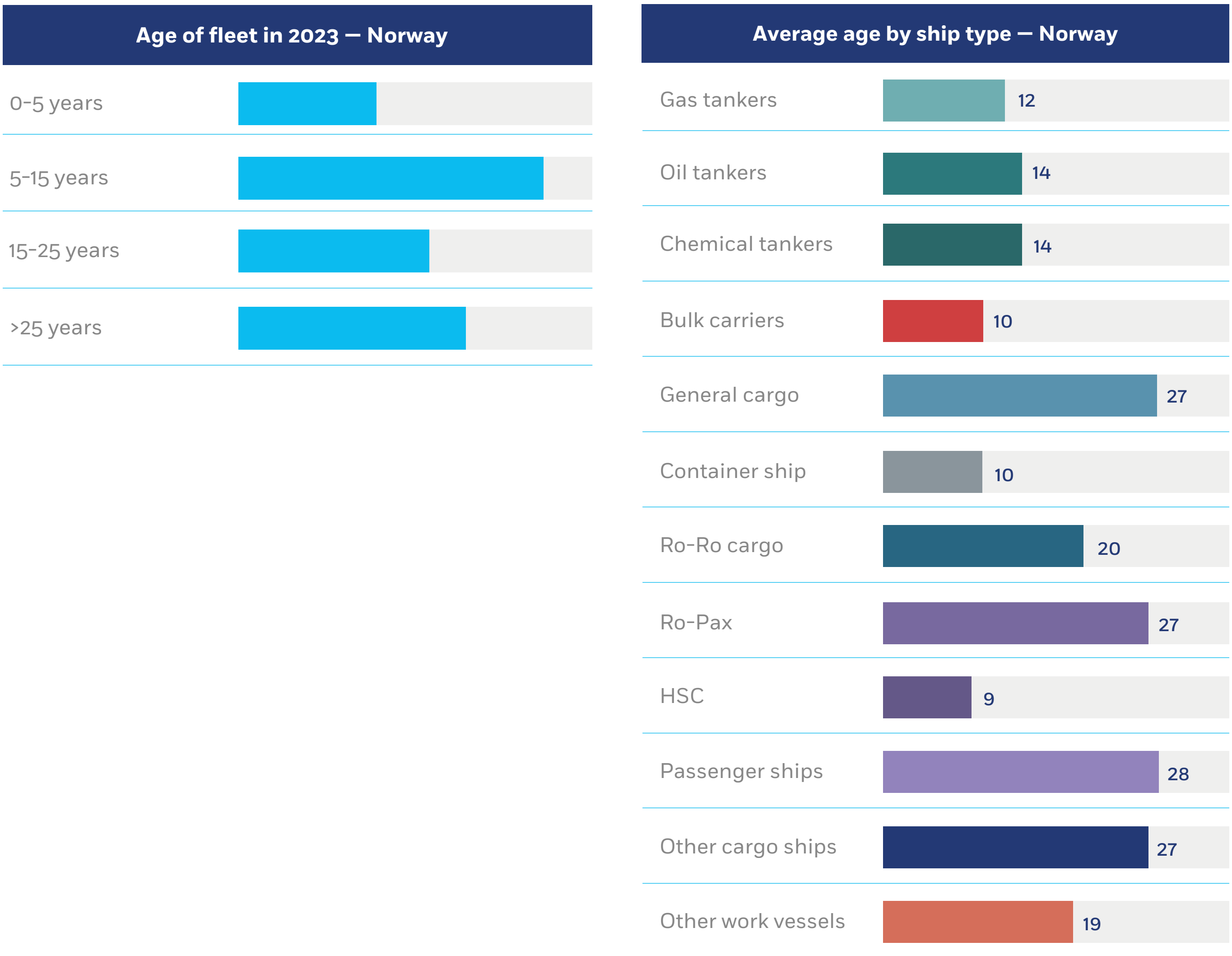
The ro-pax vessels and other cargo ships of Norway correspond to 27 % and 19 %, respectively, of the total EU Member State fleets of those ship types in terms of the number of ships, and the country's general and ro-ro cargo vessels each correspond to 15 %.

Figure A2.94: Share of the flag of Norway in the EU Member States' ro-pax, other cargo, general cargo and ro-ro cargo fleets.



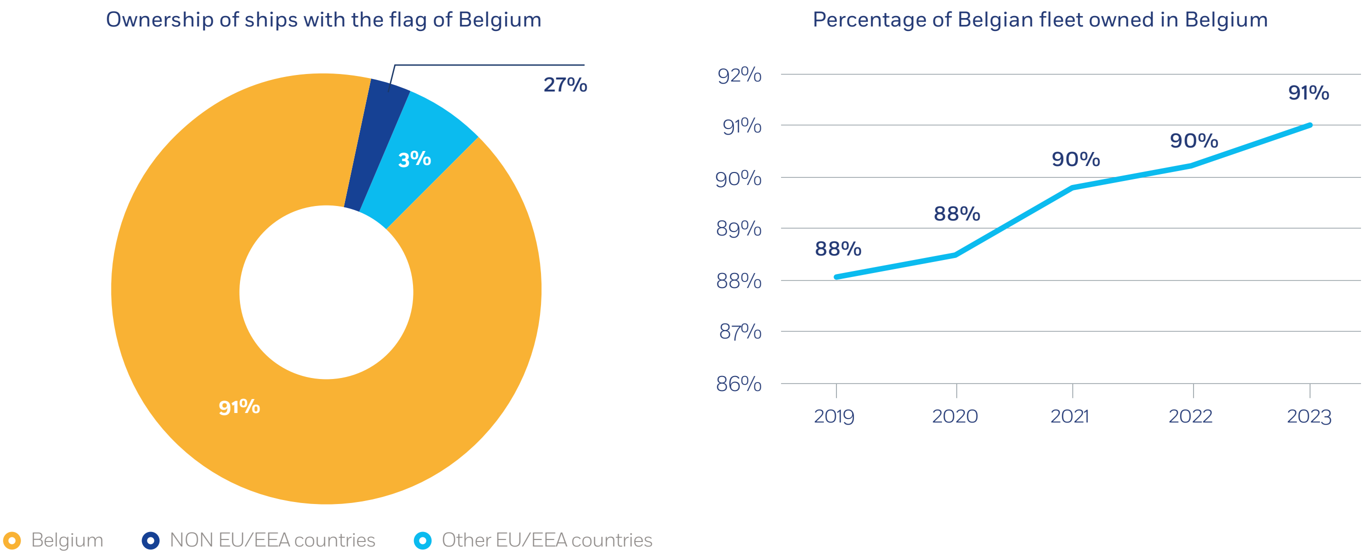
The overall fleet age categories and the average age by ship type of the ships flying the flag of Norway are shown below.

Figure A2.95: Age of the fleet with the flag of Norway – overall and average age by ship type.



The percentage of ships with the flag of Norway that belong to shipowners registered in the country is shown below.

Figure A2.96: Percentage of Norwegian fleet owned by the shipowners of Norway – evolution between 2019 and 2023.



ANNEX 3 EU-funded research and development projects

Human element

Project	Objective	Duration	EU contribution
Blueskilling	The project is committed to empowering individuals with essential skills to drive blue innovation, enhance industrial competitiveness and expedite the implementation of marine renewables and green navigation technology across the Atlantic area.	2 Nov. 2023 – 30 Oct. 2026	EUR 1 440 000.00
Skillsea	The project worked on the shortage of maritime professionals, changing skills requirements due to digitalisation and environmentally conscious transport, limited mobility between land and on-board positions and inadequate stakeholder cooperation on skills requirements.	1 Jan. 2019 – 31 Dec. 2023	EUR 3 996 555.00

Autonomous and highly automated ships

Project	Objective	Duration	EU contribution
AEGIS	Use new innovations from the field of connected and automated transport, including smaller and more flexible vessel types, automated cargo handling, autonomous ships and new digital technologies, to increase the competitiveness of waterborne transport routes in the EU.	1 Jun. 2020 – 30 Nov. 2023	EUR 7 500 000.00
Autoship	Boost Europe's autonomous shipping capabilities by demonstrating cutting-edge innovations on two vessels. Key capabilities installed included navigation and secure operations such as automated mooring and docking.	1 Jun. 2019 – 30 Nov. 2023	EUR 20 109 109.13
RENEW	Introduce an innovative autonomous barge, the ZULU *X-Barge*, to demonstrate resilient inland water transport through digitalisation.	1 Sep. 2022 – 31 Aug. 2025	EUR 7 689 022.88
Seamless	Focus on enhancing autonomous shipping technologies such as remote control.	1 Jan. 2023 – 31 Dec. 2026	EUR 14 986 315.00
Marina	Take the first steps towards addressing a market need to increase the global maritime transport industry's safety, decrease its environmental impact due to collisions and prepare for a future of autonomous shipping. Combine state-of-the-art real-time processing with an advanced object detection and classification algorithm based on machine-learning techniques.	1 Jan. 2021 – 30 Nov. 2023	EUR 2 898 231.01

Alternative fuels and power technologies

Project	Objective	Duration	EU contribution
Current Direct	Develop and demonstrate an innovative interchangeable waterborne transport battery system – swappable container waterborne transport battery – and energy-as-a-service platform in an operational environment at the Port of Rotterdam at TRL 7 that facilitates the fast charging of vessels, fleet optimisation and novel business models.	Jan. 2021 – Dec. 2023	EUR 11 979 875.00
Nemoship	Develop a modular and standardised battery energy storage solution enabling the exploitation of heterogeneous storage units and a cloud-based digital platform enabling data-driven optimal and safe exploitation. Demonstrate these innovations at TRL 7 maturity for hybrid ships and their adaptability for fully electric ships.	Jan. 2023 – Dec. 2026	EUR 7 870 268.00
GAMMA	By integrating biomethanol and NH_3 fuels alongside advanced fuel systems such as biomethanol reformers and NH_3 crackers, GAMMA (green ammonia and biomethanol fuel maritime vessels) seeks to significantly reduce emissions in commercial vessels. The project's goal is to retrofit an Ultramax bulk carrier for international routes, showcasing the viability of alternative fuels and systems. Its objectives include successful vessel retrofitting, demonstrating safe operations and testing the sustainable-fuel value chain.	1 Jan. 2024 – 31 Dec. 2028	EUR 12 986 214.88
NH3craft	The project will showcase the entire chain required for the use of ammonia, from supply to application, and will develop guidelines and standards. This will increase confidence in the use of ammonia and promote its uptake. Researchers will also develop on-board technology with the capacity to store 1 000 m^3 of ammonia.	1 Jun. 2022 – 31 May 2025	EUR 8 497 104.00
LH2craft	Develop next-generation, sustainable, commercially attractive and safe long-term storage and long-distance transportation of liquid hydrogen for commercial vessels (or even as fuel in certain applications). The project aims to develop an innovative membrane-type containment system for high-capacity storage at a temperature of −253 °C and to demonstrate and validate it on a 10 tonne prototype.	1 Jun. 2023 – 31 May 2027	EUR 5 627 596.00
Shyps	Develop a hydrogen-based solution that can be adapted to multiple types of vessels and that in some cases can already achieve the IMO's targets for 2030 and 2050. It will define a logistic based on swapping prefilled containers. It will also define a perspective scale-up of the storage capacity and the supply applied to the Port of Bergen use case.	1 Jun. 2022 – 31 May 2026	EUR 8 621 612.45
CHEK	Develop and demonstrate two bespoke vessel designs – a wind-energy-optimised bulk carrier and a hydrogen-powered cruise ship – equipped with an interdisciplinary combination of innovative technologies working in symbiosis to reduce GHG emissions by 99 %, achieve at least 50 % energy savings and reduce black carbon emissions by over 95 %.	1 Jun. 2021 – 31 May 2024	EUR 9 999 996.25

Project	Objective	Duration	EU contribution
Fastwater	Focus on methanol, a clean fuel, available in large quantities in most ports today and offering a pathway to a climate-neutral synthetic fuel produced from renewables. Develop and demonstrate an evolutionary pathway for methanol technology, including retrofitting solutions and next-generation systems. Include the complete chain from renewable methanol production to ship bunkering; work with regulatory agencies to simplify rules and regulations for methanol as a fuel; and develop and use a training programme for crew and a business plan.	1 Jun. 2020 – 31 May 2024	EUR 4 999 217.51
Safeloop	Work to improve electric vehicle battery safety. The project involves 15 groups from 11 countries and focuses on the entire battery life cycle, including making, testing and recycling batteries.	1 Jun. 2024 – 31 May 2027	EUR 4 749 117.50
Engimmonia	Promote the global introduction of alternative fuels such as ammonia and transfer clean energy technologies successfully demonstrated in terrestrial applications, such as waste heat recovery and renewables, to the maritime sector. The project will explore the benefits of carbon-free fuel for vessel engine applications and develop an exhaust aftertreatment system.	1 May 2021 – 30 Apr. 2025	EUR 9 500 000.00
Nautilus	Develop an integrated marine energy system that will use LNG. The project will build a pilot technology that will gradually replace ICE-based generators with a solid oxide fuel-cell–battery hybrid genset.	1 Jul. 2020 – 31 Dec. 2024	EUR 7 892 362.50
Ammonia2-4	Develop and demonstrate four-stroke and two-stroke dual-fuel marine engines running on ammonia as the main fuel. The four-stroke will be a new engine while the two-stroke can be retrofitted to any commercially available two-stroke engine.	1 May 2022 – 30 Apr. 2026	EUR 9 788 202.25
e-Shyips	Connect the hydrogen and maritime sectors with international-level experts. Conduct a regulatory framework review and assess experimental data on ship design, safety systems, material and components, and bunkering procedures. Formulate a pre-standardisation plan for an updated IGF Code for hydrogen-fuel passenger ships and a roadmap to promote the hydrogen economy in the maritime ecosystem.	1 Jan. 2021 – 31 Dec. 2024	EUR 2 500 000.00
Apollo	Mature and demonstrate, in an operational environment, the disruptive conversion of a dual-fuel main engine of an offshore supply vessel to ammonia operation (tri-fuel: 70 % ammonia, 29 % LNG and 1 % MGO), reducing emissions by 70 %.	1 Jan. 2023 – 31 Dec. 2025	EUR 4 999 999.25
Safecraft	Develop and showcase the efficiency and safety of sustainable alternative fuels for waterborne transport, encouraging their rapid adoption. Assess safety, energy- and cost-efficiency, and environmental impact.	1 Dec. 2023 – 30 Nov. 2027	EUR 9 389 662.50

Project	Objective	Duration	EU contribution
H2Engine	Develop a way to turn a standard ICE into an environmentally friendly one. Its ICE technologies can be integrated with any new or existing ICE and enable it to run on hydrogen; the tipping point is that these new emission-free vehicles and pieces of machinery will be affordable for the first time.	1 Sep. 2020 – 31 Aug. 2022	EUR 1 533 877.63
Seabat	Provide an alternative to previous energy storage solutions for waterborne transport by developing a full-electric maritime hybrid battery concept. This concept combines two different battery types in a standardised and modular package that may allow it to be produced in larger quantities and to profit from economies of scale.	1 Jan. 2021 – 31 Dec. 2024	EUR 9 588 476.50
Synergetics	Advance synergies between research institutions specialising in ship hydrodynamics and energy transition and the shipbuilding industry, regulatory bodies, shipowners and technology providers. The project will demonstrate the greening capacities of retrofitting by implementing hydrogen and methanol combustion in ICEs on selected ships in real-life operational conditions.	1 Jan. 2023 – 30 Jun. 2026	EUR 4 184 312.03
e-Ferry	Prototype and full-scale demonstration of a next-generation 100 % electrically powered ferry for passengers and vehicles.	1 Jun. 2015 – 31 May 2020	EUR 15 141 035.88

Passenger ships' safety

Project	Objective	Duration	EU contribution
Safepass	Redefine the evacuation processes, evacuation systems/equipment and international regulations for passenger ships in all environments, hazards and weather conditions, independently of the demographic factor, by developing an integrated system that will collectively monitor, process and inform both crew and passengers of the optimal evacuation routes during emergencies, coupled with advanced, intuitive and easy-to-use life-saving appliances, resulting in a significant reduction of the total time required for ship evacuation and increased safety.	1 Sep. 2019 – 31 Dec. 2022	EUR 8 270 366.25
Palaemon	Develop and evaluate a sophisticated mass centralised evacuation system, based on a radical rethinking of mass-evacuation vessels combined with an intelligent system of critical components providing real-time access to and representation of data to establish appropriate evacuation strategies for optimising the operational planning of the evacuation process on damaged or flooded vessels.	1 Jun. 2019 – 31 Jan. 2023	EUR 8 943 775.00

Project	Objective	Duration	EU contribution
FLARE	Establish a risk-based methodology for flooding-risk evaluation and management. Create a database of casualties and related damage in passenger ships. Provide a general and comprehensive risk model and a risk-aware procedure for post-flooding casualties. Develop advanced technical solutions aiming to reduce risks.	1 Jun. 2019 – 30 Nov. 2022	EUR 9 375 730.00
LASH FIRE	Develop and demonstrate operational and design solutions to enhance fire prevention and ensure better fire management on all types of ro-ro ships.	1 Sep. 2019 – 31 Aug. 2023	EUR 12 209 148.33
Evrisk	Develop a pioneering risk assessment model that quantitatively measures the risk of electric vehicles catching fire in indoor car parks and proposes prevention and mitigation measures in a selected architectural design of car parks.	1 May 2023 – 30 Apr. 2025	EUR 181 152.96
Fibreship	Provide to the maritime and shipbuilding industry all the necessary design tools, material-selection methodologies, production techniques and shipping market analyses to enable the integral construction of large-length ships over 500 GT (approximately 50 metres in length) from composite materials.	1 Jun. 2017 – 31 May 2020	EUR 8 866 322.75
Ramsses	Obtain recognition and an established role for advanced materials in the European maritime industry. To achieve this, the project will demonstrate the benefits of new materials in 13 industry-led and market-driven demonstrator cases along the entire maritime process chain, from components through equipment and ship integration to repair.	1 Jun. 2017 – 30 Nov. 2021	EUR 10 799 440.65

Container ships

Project	Objective	Duration	EU contribution
Overheat	Develop innovative fire management solutions that comply with IMO regulations, using internet-of-things sensors and integrating them into a digital solution. The project will conduct assessments of best practices and safety culture to prevent fires, along with validation and demonstration activities to showcase the feasibility and benefits of the proposed solutions.	1 Jan. 2024 – 31 Dec. 2026	EUR 5 845 264.50

Safety of navigation

Project	Objective	Duration	EU contribution
Prepare ships	Develop and demonstrate a collaborative resilience navigation solution. Advance and enhance existing software solutions by exploiting the distinguished features of Galileo signals and combine other nautical information on internal and external parameters and on sensor technologies. This improved navigation system increases safety and efficiency significantly, and is intended to become the basis of future autonomous operations.	1 Dec. 2019 – 31 May 2022	EUR 2 975 060.00
Safenav	Develop and test a highly innovative digital collision-prevention solution to reduce the probability of collisions, impact damage and grounding, and increase safe navigation.	1 Sep. 2022 – 31 Aug. 2025	EUR 4 424 871.63

ANNEX 4 Summary tables on alternative fuels

Fuel	Physical presentation	Characteristics				Safety (Criteria in Regulation (EC) No 1272/2008 on classification, labelling and packaging (CLP) of substances and mixtures)				Regulatory		
		Energy density (specific energy, lower heating value) MJ/l (MJ/kg)	**Flashpoint** (°C)	**Auto-ignition temperature** (°C)	**Flammability limits** (% vol. of mixture in air)	**Fire/explosion**	**Toxicity**	**Health hazards**	**Other hazards (low temperature/ pressure etc.)**	**Standard for use as marine fuel**	**Standard for bunkering**	**IMO regulatory framework**
Heavy fuel oil I Intermediate fuel oil I Marine diesel oil (included as reference)	Liquid at atmospheric conditions	35.8 (39.1)	≥ 60	220–400	• (Not classified as flammable liquid but as combustible liquid) • For diesel vapours: 1–10	• Not classified as explosive or flammable under CLP criteria • Flammable and explosive vapour concentrations are possible, requiring careful handling, especially when heated	Not classified as toxic	Fatal if swallowed and enters airways, harmful if inhaled, may cause cancer, damage to organs through prolonged or repeated exposure	No other relevant hazards	ISO 8217:2024 – Products from petroleum, synthetic and renewable sources – Fuels (class F) – Specifications of marine fuels	ISO 13739:2020 – Petroleum products – Procedures for the transfer of bunkers to vessels	SOLAS II-2, Regulation 4.2.1 (flashpoint requirement)
Natural gas	LNG Liquefied at −163 °C (at 1 bar)	20.3 (48)	−175	537	5–17	• Extremely flammable gas. • Explosion of contained concentration • BLEVE • Rapid phase transition	Not classified as toxic Not toxic but can act as an asphyxiant by replacing oxygen in enclosed spaces.	Not classified as a health hazard	Refrigerated gas that may cause cryogenic burns or affect structural integrity due to brittle fracture	ISO 23306:2020 – Specification of liquefied natural gas as a fuel for marine applications	• ISO/TS 18683:2021 – Guidelines for safety and risk assessment of LNG fuel bunkering operations • ISO 20519:2021 – Specification for bunkering of liquefied natural gas fuelled vessels • Industry bunkering guidelines available	• SOLAS II-1, Part-G, Regulation 56, 57 • IGF Code, Part A-1, B-1, C-1, D
	CNG Compressed at 200–250 bar	9 (48)	n/a			• All fire/explosion associated with LNG, except BLEVE and rapid phase transition			Safety hazard associated with storage of flammable gas under pressure	No reference	No reference Unlike LNG, CNG should likely be 'bunkered' via embarkation/ disembarkation of pressurised CNG cylinders	
Methanol (MeOH)	Liquid at atmospheric conditions	15.6 (19.7)	10	455	5.5–44	• Highly flammable liquid and vapour • Burns with a nearly invisible flame but is less flammable than gasoline • Creates ignitable atmosphere inside storage tanks (at temperatures of 5–35 °C)	• Toxic if swallowed • Toxic in contact with skin • Toxic if inhaled • Toxic to humans, the lethal dosage of methanol is between 30 and 10 ml per kilogram of body weight	Causes damage to organs	• No low-temperature hazard • Corrosive to some materials – material compatibility in fuel distribution and use is critical	ISO 6583:2024 – Methanol as a fuel for marine applications – General requirements and specifications	• (Under development) ISO/CD 22120 – Ships and marine technology – Specification for bunkering of methanol fuelled vessels • Industry technical references and bunkering guidelines available • (EMSA study, 'Safe bunkering of biofuels')	• SOLAS II-1, Part-F, Regulation 55 (IGF) • IMO MSC.1/ Circ.1621 – Interim guidelines for the safety of ships using ethyl/ methyl alcohol as fuel

Fuel	Physical presentation	Characteristics				Safety (Criteria in Regulation (EC) No 1272/2008 on classification, labelling and packaging (CLP) of substances and mixtures)				Regulatory		
		Energy density (specific energy, lower heating value) MJ/l (MJ/kg)	**Flashpoint** (°C)	**Auto-ignition temperature** (°C)	**Flammability limits** (% vol. of mixture in air)	**Fire/explosion**	**Toxicity**	**Health hazards**	**Other hazards (low temperature/ pressure etc.)**	**Standard for use as marine fuel**	**Standard for bunkering**	**IMO regulatory framework**
Biofuels I FAME I FT-diesel I and HVO (Blended product characteristic properties may differ)	FAME, FT-diesel and HVO Liquid at atmospheric conditions	HVO 34.4 (44.1) FAME 32.9 (37.1) FT-diesel (35.5)	FAME and HVO > 60 FT-diesel ≥ 60	HVO 204 FAME 256–266 FT-diesel 208	• (Not classified as flammable liquid, but instead as combustible liquid) • For vapour concentrations • FAME: 0.6 – 6.5 • HVO: 0.8–5.4 • FT-diesel • Not available	• None classified as explosive or flammable under CLP criteria • Flammable and explosive vapour concentrations are possible in extreme operating conditions	Not classified as toxic	• May be fatal if swallowed and enters airways • Causes skin irritation • May cause damage to organs through prolonged or repeated exposure	• Potentially relevant hazards related to degradation, cold flow properties, corrosion, degradation of rubber seals • Critical blend properties affecting fuel behaviour	ISO 8217:2024 – Products from petroleum, synthetic and renewable sources – Fuels (class F) – Specifications of marine fuels	• ISO 13739:2020 – Petroleum products – Procedures for the transfer of bunkers to vessels • (Standard procedures for bunkering can be considered fully applicable to oil-replacement biofuels) • (EMSA study, 'Safe bunkering of biofuels')	SOLAS II-2, Regulation 4.2.1 (flashpoint requirement)
	DME Gaseous at atmospheric conditions	DME (28)	DME −41	DME 350	DME 3.4-27	Highly flammable gas, necessitating precautions to avoid heat, hot surfaces, sparks, open flames, and other ignition sources		Possible air displacement and suffocation risk to crew	• Low-temperature exposure hazard • Heavy vapour, white cloud that may travel along the ground or water surface, posing a risk of distant ignition	• No reference for use as marine fuel • ISO 16861:2015 – Petroleum products – Fuels (Class F) – Specifications of dimethyl ether	(EMSA study, 'Safe bunkering of biofuels')	SOLAS II-1, Part-F, Regulation 55 (IGF)
Hydrogen (H_2)	Liquefied hydrogen (LH$_2$) Liquefied at −253 °C (at 1 atmosphere)	9 (120)	< 253 (boiling point)	585	4–75	• Extremely flammable gas, over a wide range of gas–air mixture concentrations • Heating may cause violent combustion or explosion • Reacts violently with halogens, oxidising materials and greases	Not classified as toxic	Not classified as a health hazard	Refrigerated liquefied gas (−253 °C) that may cause deep cryogenic burns or affect structural integrity due to brittle fracture	• No reference for use as marine fuel • Existing hydrogen fuel quality standards: ISO 14687:2019 – Hydrogen fuel quality – Product specification and SAE J2719	No reference	• SOLAS II-1, Part-F, Regulation 55 (IGF) • No interim guidelines yet developed
	Compressed hydrogen (CH$_2$) Compressed at 700 bar	4.7 (120)	n/a						Safety hazard associated with storage of flammable gas under pressure			

Fuel	Physical presentation	Characteristics				Safety (Criteria in Regulation (EC) No 1272/2008 on classification, labelling and packaging (CLP) of substances and mixtures)				Regulatory		
		Energy density (specific energy, lower heating value) MJ/l (MJ/kg)	**Flashpoint** (°C)	**Auto-ignition temperature** (°C)	**Flammability limits** (% vol. of mixture in air)	**Fire/explosion**	**Toxicity**	**Health hazards**	**Other hazards (low temperature/ pressure etc.)**	**Standard for use as marine fuel**	**Standard for bunkering**	**IMO regulatory framework**
Ammonia (NH_3)	• Gas at normal temperature and pressure • • Liquefied at • −33.5 °C (at 1 bar) • or at • 8.6 bar (at ambient temperature ≈ 25 °C) • Freezes to crystals at • −77.7 °C (at 1 atmosphere)	(−33.5 °C, 1 bar) 11.3 (18.4)	n/a	651	Approximately within the range of 15–28%	• Flammable mixtures in air over a narrow flammability range • Reacts with halogens, interhalogens and oxidisers and may cause violent reactions or explosions	• Highly toxic to humans, forms low to high concentrations • Severe effects from prolonged exposure	• Highly hazardous to health • Acute exposure can cause severe injuries in area of contact (eyes, skin)	• Corrosive to several metal alloys and materials • Careful selection of materials is required	No standard for use of ammonia as marine fuel	• No reference • (Existing experience with ammonia cargo and LNG/LPG fuel may be a good reference point)	• SOLAS II-1, Part-F, Regulation 55 (IGF) • **MSC.1/Circ. … – Interim guidelines for the safety of ships using ammonia as fuel (December 2024)**
LPG	• Pressurised • (8.4 bar at 20 °C) • Liquefied • (1 bar at −42 °C)	(depends on composition) 22.6 (46.3) (propane) 25.8 (45.4) (n-butane)	Pro – 60 (butane)		1.8–9	• Extremely flammable gas • Explosion of contained concentration • BLEVE	• Not classified as toxic • Not toxic, but can act as an asphyxiant	Not classified as a health hazard	• Low-temperature hazard if refrigerated • Flammable gas under pressure for pressurised containment	• No reference for use as marine fuel • ISO 9162:2013 – Petroleum products – Fuels (class F) – LPG – Specifications reference	• No bunkering standard • May benefit from experience with LNG bunkering and cargo transfer operations	• SOLAS II-1, Part-F, Regulation 55 (IGF) • MSC.1/Circ.1666 – Interim guidelines for the safety of ships using LPG fuels (June 2023)

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