RO-PAX AND RO-RO FIRE SAFETY

Safety at sea, most particularly on passenger ships, is rightly assumed to require the highest priority. Following a number of catastrophic fires on ro-pax ferries and PCTCs in the last few years, government inquiries have now concluded their findings and a wide range of new measures suggested. All the way from larger-capacity deluge systems to more intelligent detection, improvements are being realised albeit at a near glacial pace.

However, there are still too many older ro-pax ferries and ro-ros sailing today with inadequate fire safety, including side openings on the weather deck and a lack of properly functioning fire extinguishing systems. A recent PCTC fire when alongside in a US port brought into clear focus the huge limitations of using CO_2 as a firefighting medium, useless with an open ramp.

Whether old second-hand vehicles or new battery or hydrogen-powered cars, the risks are there for all to see and it is high time for legislation to improve safety on existing vessels as well as newbuildings.

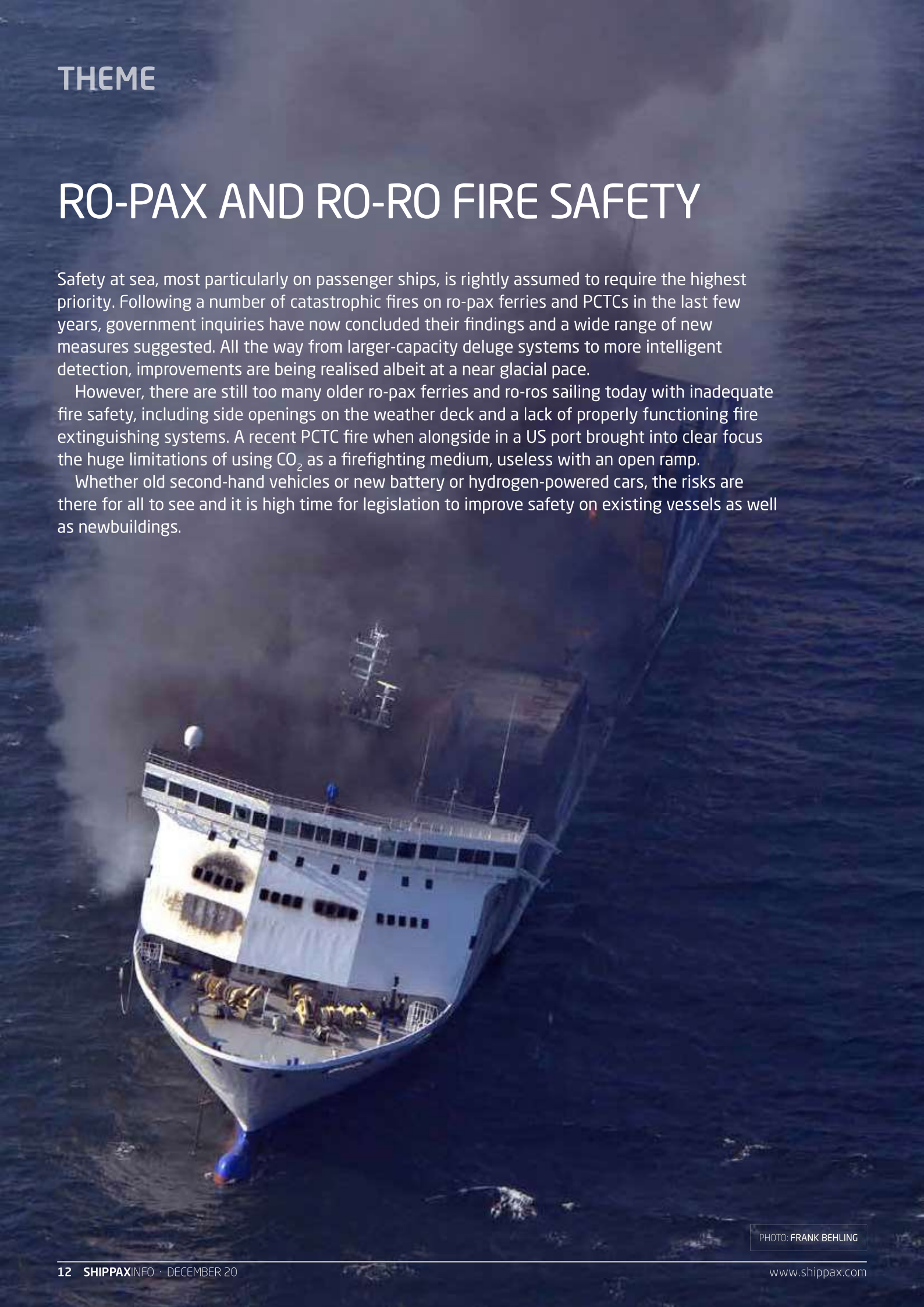


PHOTO: FRANK BEHLING

PHOTO: SELIM SAN

THE FLOATING INFERNO

Fire safety on ro-pax and ro-ro ships continues to be a major concern for the shipping industry. Regulations have become stricter in recent decades, hopefully resulting in fewer and less severe accidents. Still, recent casualties have demonstrated that more attention must be paid to improving fire safety, especially on ro-ro decks.

TEXT: BRUNO JONATHAN

In 2016, the European Maritime Safety Agency (EMSA) listed a total of 132 minor and major fires on ro-paxes in the 2002-2016 period, of which 37 accidents (28%) originated in the vehicle decks. Most of the time, fires are spotted much sooner in the accommodation (passengers and crew members being on site) and in engine compartments. These spaces are equipped with automatic release fixed firefighting equipment (water mist or sprinkler systems), while garage decks often require the manual opening of the drencher zone or CO_2 release on many ro-ro ships. Time being of the essence in fire extinguishing, fires have tended to spread more quickly on ro-ro decks. Having spread, they are difficult to contain because of the difficulty of access, with trucks parked in narrow lanes, and the very nature of ro-ro cargo with trailers and trucks with their fuel tanks, also containing a lot of plastics, rubber and other flammable materials, not to mention hazardous goods. While the number of dramatic fires with a high number of casualties has decreased over time thanks to stronger regulations at all levels (design, safety management and crew training), some accidents revealed glaring deficiencies in the regulations. Among them, three of the most recent in Europe have intriguing similarities which are described below, although the incidents are well known.

LISCO GLORIA

On 9 October 2010, while the LISCO GLORIA was sailing with a total of 236 people on board, a fire in the machinery of a refrigerated trailer was spotted by a member of the crew. The sprinkler system release failed and the fire quickly spread. While confirming that the origin of the fire was from a trailer's refrigeration unit, investigators could not conclude whether the fire started on the truck, the trailer or the shipboard power supply. The fixed firefighting system failed, most probably due to human error, and the open sides of the upper ro-ro deck allowed oxygen to continuously feed the fire, explaining the extent and the quick spread of the fire.

NORMAN ATLANTIC

On 28 December 2014, while the NORMAN ATLANTIC was sailing between Greece and Italy, a fire broke out in the partially open upper ro-ro deck (Deck 4). The statutory investigation highlighted, among many issues, that many trailer reefer units were not plugged in and their reefer power units were still in continuous operation. The crew's response was slow

and the wrong drencher zone was activated, while the fire was made worse due to the side openings. The blackout due to the loss of the main and emergency power were probably due to the damage to the electrical cables which passed through Deck 4's ceiling. From then, without any power, all firefighting efforts were in vain.

SORRENTO

On 28 April 2015, while the SORRENTO was sailing between Mallorca and the Spanish mainland, a fire ignited on Deck 4. Despite the timely release of the drencher system and the attempt from the firefighting team to extinguish the fire, it quickly spread out of control. A force four wind stoked the fire due to the openings on the ship's side. The investigations concluded that the fire broke out on a refrigerated truck, located at the forward part of the partially open upper ro-ro deck, while the extent of the damage did not allow the investigators to determine which part of the unit failed. As on the NORMAN ATLANTIC a few months before, it was also concluded that both main and emergency power were quickly lost, most probably due to the electrical cables passing above the area of the fire. Investigators pointed out that despite a rapid and correct response from the crew with correct use of the firefighting system, the fire could not be extinguished.

European initiatives, suggesting ship design regulation improvements

These three accidents were the catalyst for some European countries and the European Union to study fires in the vehicle decks of ro-ro and ro-pax vessels. Among the initiatives are the international FIRESAFE I (2016) and FIRESAFE II (2017) studies, initiated by the European Maritime Safety Agency (EMSA, an EU body), LASH FIRE (2019) – Legislative Assessment for Safety Hazards of Fire and Innovations in Ro-ro ship Environment, supported by the EU and the German government-financed ALBERO project.

New IMO initiatives

IMO themselves concluded that the A.123 existing rules governing the capacity of drencher systems was inadequate which required a coverage of five litres of water per square metre of deck per minute

PHOTO: RICHARD SEVILLE

The fire that quickly spread on NORMAN ATLANTIC was the deadliest ro-pax accident in European waters in the past years.

(lpm/m²). Already in May 2012, MSC.1/Circular 1430 introduced more onerous design guidelines for newbuildings. For ro-ro decks having a free height of between 2.5m and 6.5m, covering the vast majority of ro-pax vessels, the minimum water discharge density has been tripled to 15mm/min. over an area of 365m² for dry pipe and 280m² for wet pipe systems. For deluge systems, typically used on decks with side openings, the discharge density should be 10mm/min/m² over a correspondingly larger area of 40m x the width of the deck. These new regulations imply much greater fire pump capacity in addition to larger scuppers, drainage and bilge systems.

FIRESAFE I & II

In 2016, the FIRESAFE I study started "to investigate cost-efficient measures for reducing the risk from fires on ro-ro spaces with a focus on electrical fire as ignition source as well as fire extinguishing failure." A year later, a second study, FIRESAFE II was initiated to investigate risk control options in relation to detection and decision making as well as containment and evacuation. "After concluding the FIRESAFE studies, our goal was to bring our amendment proposals to IMO," explains Sifis Papageorgiou, Senior Project Officer (safety & security) at EMSA. "Shipowners don't want European regulations to be stricter than the international ones, and we agree with them. It would create a competition distortion with non-EU operators. That is why our suggestions went directly to IMO, in order to incorporate them into the SOLAS code. At first, we expected to see our proposals included in the SOLAS 2024 amendments. However, due to the COVID-19 outbreak many meetings and consultations were delayed. Unfortunately, unless the IMO makes a special exception to its standard procedures, these amendments might not be published before the next set of amendments, which is due in 2028."

LASH FIRE is also a European initiative, aiming at reducing risks of fires in ro-ro spaces, with a section looking at new types of vehicles and cargo. While some of the investigated aspects are similar to what was studied during FIRESAFE, LASH FIRE looks at the bigger picture, with more partners and a larger budget.

Side openings

All three ships had a similar design, two being near sister ships, part of the so-called Visentini series. In all three cases, fire broke out under the accommodation superstructure, on the open-sided upper ro-ro deck. Concluding that the ships were 100% built according to the regulations in force at the time of construction, investigators found that the side openings were a major cause of the rapid and extensive spread of the fire. While the ventilation systems (including from the closed ro-ro decks) are equipped with dampers to isolate the compartments in case of fire, the side openings (which are also used for ventilation) have no means of closure. Due to the constant airflow and smoke dissipation, the ship's fire detection system raised the alarm only at a very late stage. Moreover, the supply of fresh air made the fire spread more quickly.

The FIRE SAFE study suggests amending the SOLAS regulations so that "vehicle spaces and ro-ro spaces are to be either closed spaces or open weather decks. Closed vehicle or ro-ro spaces shall be closed at both ends and the number of

According to SOLAS, there are three types of garage decks:

- The weather deck is a deck which is completely exposed to the weather from above and from at least two sides.
- Open ro-ro spaces are those ro-ro spaces which are either open at both ends or have an opening at one end and are provided with adequate natural ventilation effective over their entire length through permanent openings distributed in the side plating or deckhead or from above, having a total area of at least 10% of the total area of the space sides.
- Closed ro-ro spaces are ro-ro spaces which are neither open ro-ro spaces nor weather decks.

Testing a drencher system.

side openings shall be reduced to the minimum compatible with the design and proper working of the ship."

"I think that it was the most important proposal of our study. Closing any large side openings means a very high reduction of fire risk in ro-ro decks. However, we are not in position to make it mandatory because our study showed it was not cost effective to modify existing ships. This cost-effectiveness notion can be discussed but we conform to the definition given in the Formal Safety Assessment Guidelines of IMO. However, I am happy to see many industry players such as some classification societies now almost consider the elimination of side openings as mandatory after the adoption of the Interim Guidelines," explains Papageorgiou.

In the meantime, side openings on the upper ro-ro decks of ro-paxes have become less common on recent newbuildings. In the most recent evolutions of Visentini's successful series, the upper ro-ro deck on the MARIE CURIE, HYPATIA DE ALEJANDRIA and CIUDAD DE VALENCIA is fully enclosed, requiring additional mechanical ventilation. In contrast, many new ro-ro vessels, such as DFDS's giant 6,695-lanemetre series and Grimaldi's 7,800-lanemetre GG5Gs, not to mention the long Flensburger series, all feature openings in the side structure, albeit with uprated deluge firefighting systems on those decks.

> ***Closing any large side openings means a very high reduction of fire risk in ro-ro decks.***
>
> Sifis Papageorgiou, Senior Project Officer (safety & security), EMSA

Reefer plugs correctly connected.

Fixed firefighting equipment

Engine and accommodation spaces are now often fitted with automatic high-pressure water mist systems. However, only very few ro-ro and ro-pax vessels have been fitted with such high-pressure systems on the ro-ro decks because of the high CAPEX costs. In two of the above accidents (LISCO GLORIA and NORMAN ATLANTIC), the drencher system was not released properly due to a human error. For the third accident, investigators came to the conclusion that despite the proper use of the fixed firefighting system, it was insufficient to fight a fire of such amplitude. FIRESAFE published a review of the current firefighting systems and known alternatives. Drencher systems were found satisfactory; the overall performance of a deluge system was evaluated to be similar to the low-pressure system in an enclosed ro-ro deck. Foam-based systems were found ineffective and sometimes dangerous. Installing both an automatic and a remotely controlled manual release system would however reduce both the response time and the risk of a human error.

Detection

Fire detection technologies have not evolved so quickly. While existing fixed firefighting systems were generally found to be effective, new alternative detection systems are now available and are considered to be complementary to existing systems. The most common are flame detectors, mostly used in engine spaces, heat and smoke detectors. For example, "Fibre optic linear heat detection seems to be a very good system in addition to existing smoke detectors. In specific situations where wind may significantly

influence the smoke detector efficiency, fires could be detected more rapidly with such a system," explains Papageorgiou. So far, the regulations do not require any detection or firefighting systems on open or partially open ro-ro decks, as traditional systems can only be installed above the ro-ro deck, requiring some sort of ceiling. "Implementing mandatory detection systems on weather decks in SOLAS 2024 seems feasible because the technology exists, and cost-effectiveness has been demonstrated in FIRE SAFE studies." For the moment, regulation requires that heat detectors trigger an alarm when the temperature reaches 56°C. The alarm threshold is thus the same for a ro-pax facing the freezing-cold winter in the Baltic sea and a ro-ro sailing in summer in the Red Sea! "We suggested to the IMO to rather base the alarm triggering on the rate of temperature rise. We considered that a 14°C rise of temperature in less than two minutes would be more important to measure than a simple temperature trigger," says Papageorgiou.

Electric wiring and thermal insulation

Electric wiring insulation and electrical powering of firefighting equipment was also found weak. Due to the fire breaking out under main cables, the whole network was out of order very quickly, interrupting the use of firefighting equipment. Recent fires also raised the question of passive fire insulation, at least to protect in key areas. "It is still permitted to have A0 class separation between ro-ro decks under some conditions," pinpoints Papageorgiou. "This means that a fire can spread between two ro-ro decks in less than 10 minutes if firefighters don't perform boundary cooling. Building ships with A30 fire insulation separating the ro-ro decks would be a great improvement. We did not evaluate this solution in the FIRESAFE study. However, we support it's mandatory inclusion in the coming SOLAS amendments because it has proved to be effective in the past."

PHOTO: FRANK HEINE
The upper deck on Visentini's latest newbuilds no longer has side openings and is no longer open aft – it is fully enclosed, using mechanical ventilation.

Weaknesses in the regulations of reefer trailer transport

All three investigations pointed to a refrigerated truck as being responsible for the fires. In both NORMAN ATLANTIC and SORRENTO cases it was mentioned that "reefer trucks are permitted to be loaded on ro-ro vessels and remain in operation during voyage without any evidence that they have been properly maintained or inspected in order to assure that they will not pose a risk to the vessel. The only measures that can be applied by the crews to mitigate the risk from the operation of this equipment are to perform a macroscopic inspection and most probably an electrical check on the plugs before they are connected to the vessel's power."

Going further than the regulations

Encouragingly, some new ships are built to a higher standard than the regulations require in terms of fire safety in the ro-ro decks. Two ro-ro vessels, the TASMANIAN ACHIEVER II and VICTORIAN RELIANCE II, were built for the Australian Toll Group in 2018. Instead of having the drencher nozzles positioned according to the minimum spacing required by the regulations, they are located to match the real cargo stowage pattern and therefore likely to be more efficient in case of fire. Supplementary low-level nozzles were fitted along the sides of the main deck to reach the underside of trailers.

> ***Building ships with A30 fire insulation separating the ro-ro decks would be a great improvement.***
> Sifis Papageorgiou, Senior Project Officer (safety & security), EMSA

"We will be able to have a better perspective in 10 years' time. But I don't think it is a coincidence that in the 2016-2020 period there has not been any major fire in Europe, compared with one every two years before. Let's hope it will continue like that. I'm happy to see many shipowners involved in improving fire safety. Not only will they assist quicker change in the regulations, but they also will make existing ships safer," concludes Papageorgiou. ■

What happens if there are more reefer trailers than available plugs?

ILLUSTRATION: LASH FIRE

STENA TAKES A LEAD IN FIRE SAFETY

Shippax talked with Martin Carlsson, Project Manager, Fire Safety at Stena Teknik, to understand the present and future challenges facing fire safety on board ro-pax and ro-ro ships.

TEXT: BRUNO JONATHAN

Shippax: Can you introduce yourself?
Martin Carlsson (MCA): I am a naval architect with additional two years of nautical training. I started my professional career as deck crew and cadet, partly on board Stena Line ships, at the beginning of the 1990s. My first vessel was the STENA NORDICA. Then I worked at Lloyd's Register and in the automotive industry before coming back to the maritime industry.

Between 2011 and 2017, I worked as design manager, contract manager and with cruise business development with a leading ro-ro equipment supplier. Since 2019, I have been working for Stena Teknik focusing on fire safety. Apart from internal work, we are mainly working with fire safety in the LASH FIRE project, funded by the European Union's Horizon 2020 programme, and the ALBERO project, funded by the German Federal Ministry of Education and Research. We also give support on an industry level to the Swedish flag state, European Union and IMO via the Swedish Shipowners' Association, Interferry and ECSA. I'm passionate about improving safety and since fires are the most recent severe issues in our industry, that is where we should focus our efforts now.

Shippax: How and why did Stena step in European Union missions like FIRESAFE and LASH FIRE?
MCA: Stena has high safety ambitions which includes caring for passengers, crew members, cargo and assets. Also, it is company policy to share our experience and knowledge. It is our way to contribute to our industry. We are in many cases competitors in the commercial field, but never in terms of safety. If any of us gets into trouble, we will all suffer from this. At the time of the NORMAN ATLANTIC disaster, Stena Line's management decided that such an event must never happen on a Stena vessel. A fire safety group was formed and internal projects were initiated to evaluate fire safety within the Stena fleet.

At the same time, EMSA initiated the FIRESAFE project and Stena stepped in. Once FIRESAFE I & II came to an end, it was very natural for us to continue working within the LASH FIRE project which aimed to have a more complete approach to the cargo fire safety topic, with more partners. We are happy to see that DFDS, another large operator, also joined the study as well as Wallenius Marine. Via an advisory group, even more operators have become involved. I think it would be great to see a wider group of shipowners involved.

The Visentini Class ships operated by Stena were modified after the NORMAN ATLANTIC accident with a number of side openings closed to better safeguard LSAs as evidenced on STENA FLAVIA.

Having operators as part of the team brings a realistic and viable perspective into the work. Delivering a purely scientific report would be a waste of time. We need both theoretical and practical inputs to achieve relevant proposals.

Shippax: The investigation reports concluded that the SORRENTO and NORMAN ATLANTIC were 100% built according to the regulations. However, some weaknesses contributed to the extent of the fires. Did the regulation evolve on these points?
MCA: These fires triggered the FIRESAFE studies. From FIRESAFE, the IMO issued SOLAS Interim Guideline MSC.1/Circular 1615 in June 2019. This guideline addresses all phases of a fire scenario and suggests improvements in electrical systems and connections, detectors and CCTV, decision support, manual and fixed fire suppression, structural fire integrity and the protection of life-saving appliances (LSAs). While these guidelines currently are only recommendations, we expect to see it becoming mandatory in the future. However, it takes time and we are now looking at SOLAS amendments stemming from Circular 1615 in 2024 at the earliest. The global pandemic surely does not speed up the process...

Shippax: Stena owns a few Visentini Class ships. Were some of the issues raised in the NORMAN ATLANTIC and SORRENTO investigations and in FIRESAFE considered to mitigate the risks on board Stena's own ships?
MCA: As part of the roll-out of Stena's fire safety projects, fleetwide investments were made. It included improved reefer electric systems, fire detection systems, equipment for first response and firefighting teams, reliability of drenchers and the adding of water monitors on weather decks. For our vessels similar to the NORMAN ATLANTIC and SORRENTO, a number of side openings have been closed to better safeguard LSAs. Stena is committed to immediately implement MSC.1/Circular 1615. Due to our participation in the preceding internal work and FIRESAFE studies, compliance was in most cases already secured at the time of issue.

Shippax: So far there is no obligation to fit fire detection and firefighting systems on weather decks. Do you expect this to change?
MCA: This is part of the ongoing work for the SOLAS amendments due in 2024, but it takes time to change the regulations. In the meantime, shipowners can invest when they think it is needed. Most of our vessels now have fire monitors installed. We are testing visual fire detection with cameras on two of our ships (STENA SCANDINAVICA and STENA TRANSPORTER). We also decided to test it on STENA TRANSPORTER's open ro-ro deck to see if it brings an improvement compared with classic technology (smoke detectors).

Shippax: Given the LISCO GLORIA, NORMAN ATLANTIC and SORRENTO accidents, can the transport of reefer trucks be considered as safe?
MCA: Our industry carries a large number of reefer units and very few of them cause problems. However, in case of fire, we must handle the situation in a proper way. As a ship operator we are obviously not in control of the source of the hazard in this case. But, when the reefer units arrive, we try to observe any signs of malfunction. We also focus on what we can influence, such as cable and power supply and training our crew on safeguarding procedures, decisions and actions at time of connection and during the voyage. It must also be sure that supporting systems such as fire detection and the drenchers are fit for purpose.

Shippax: In a recent LASH FIRE webinar, the risk of fire in electric-powered cars was discussed. While the regulation on this topic is still in discussion, how does Stena consider these cars? Are they handled in a different way than others?
MCA: Scientific studies and statistics show a lower probability of electric vehicle (EV) fires than for a fossil fuel (ICE) car. Also, the total energy released by a fire would be similar. However, there are certain aspects that are new for us. Among them are the characteristic of batteries' thermal runaway effects and the large amount of toxic gases produced in case of battery fire. We promote and participate in the investigations being made in the LASH FIRE and ALBERO projects to know more about these matters first hand.

According to the regulations, we may carry EVs in a similar way to fossil fuel cars, as long as both the car and its battery are produced in an industrial QA process and do not show any sign of damage. As part of our ramp cargo/vehicle screening, potential damages or signs of homemade modifications can be detected. Having said that, one must keep in mind that it is in many cases hard to distinguish an EV from an ICE car. In case of a doubt, the EV can be refused boarding. Crew awareness training on lithium-ion battery thermal runaway and fire is ongoing and planned across our fleet.

Shippax: How do you imagine the future of fire safety in the shipping industry in the long term? A SOLAS


PHOTO: STENA REDERI

> *It would be interesting to connect electric cars, reefer units and other sensitive cargo, maybe with wireless technology, to the ship's system. It would allow a continuous monitoring of the cargo status for both commercial and safety reasons, giving a warning as soon as something might be wrong.*
>
> Martin Carlsson, Project Manager, Fire Safety, Stena Teknik

amendment based on MSC.1/Circular 1615 is expected in 2024, both for newbuilds and existing ships.

MCA: The main challenge would be, I think, to produce a balanced regulation fit for these two categories and, at the same time, being futureproof to allow for and promote emerging technologies. For existing ships, changes may involve crew training and procedures and limited but highly valued upgrades of existing safety systems. For new ships, we may allow for larger steps, still focusing on available resources for the best outcome. For the future, we should embrace and further develop new technologies such as fire risk management, detection, fire suppression and decision support. I think early warning is everything when talking about fire safety. Electric cars already have monitoring systems the user can access from their phone, for example, showing the car and battery status. It would be interesting to connect electric cars, reefer units and other sensitive cargo, maybe with wireless technology, to the ship's system. It would allow a continuous monitoring of the cargo status for both commercial and safety reasons, giving a warning as soon as something might be wrong. Such connected systems will bring new challenges such as cyber security and the need to follow applicable international guidelines. One could imagine the information received from the vehicles being displayed in a ship safety system combined with other data, such as the position of the fire detectors and fire extinguishing system nozzles on the actual stowage plan with relevant info (IMDG class for instance), etc. on the same screen. ■

PHOTO: UWE JAKOB

MAKING INNOVATION SAFE

The typically conservative shipping industry has never evolved as rapidly as it has in the last few years. Even a decade ago, few would have expected to see today a large ro-pax such as the COLOR HYBRID able to sail up to one hour fully on battery power. By 2050, greenhouse gas emissions generated by shipping should be cut by 50% in comparison to 2008, according to the IMO, so technical evolution will become even more intense with the risk of going down some blind alleys.

TEXT: BRUNO JONATHAN

A few years ago, LNG was fast becoming the new mainstream green technology, despite some parties from the industry describing it only as a transition fuel. Today, Flettner rotors, solar panels and heat-recovery systems are becoming commonplace with hydrogen and wind-powered ro-ros and ferries soon becoming a reality. Regulation generally works in 'catch-up' mode. In order to maintain a high level of safety while not restricting innovation, more flexibility is being offered. A goal-based approach is now in favour at IMO and the classification societies. The pathway matters less than the achieved goal.

Make future ships safe

Some technologies are mainly based on existing systems so the fire safety regulations did not require many adjustments. To keep the regulations up to date for the growing number of LNG-powered ships, the International Code of Safety for Ships using Gases or other Low-flashpoint Fuels (IGF Code) entered into force in 2017. Not only does it give new rules for ship construction and inspection, but also crew training and bunkering. The code also covers other known gases and fuels that are in use or anticipated such as LPG and methanol.

However, limited experience with some new technologies, such as hydrogen, in a maritime environment obviously require their own set of regulations.

Among the challenging specifications of H_2 is its flammability in the atmosphere, with a very wide volume ratio of 4 to 75%, and the density of the gas. These two characteristics could mean that in case of leakage or emergency release, the ship might be in an explosive area. Fuel Cells and Hydrogen 2 Joint Undertaking (FCH 2 JU) is a public-private partnership supporting research, technological development and demonstration (RTD) activities in fuel cell and hydrogen energy technologies in Europe. At the beginning of 2020 it issued a tender to study the relevant regulatory framework and to "identify and ensure the correct management of risks in all design and operational aspects" of hydrogen-powered passenger ships. The aim of this study is to "smooth and speed up the development of a comprehensive set of international regulations". In the meantime, a very limited number of ships

using small experimental hydrogen fuel cells already exist. Just as LNG-powered ships were built before the IGF code was updated, they are built, bunkered and operated according to general guidelines and standards. The designers must carry out a safety risk assessment and provide the related safety solutions which will be approved by a competent authority, most of the time a classification society.

Learning from feedback and accidents

Once a significant number of ships are in service with an alternative technology which is not fully covered by specific regulation, feedback from incidents and accidents are considered to be vital in bringing maturity to proposed regulation.

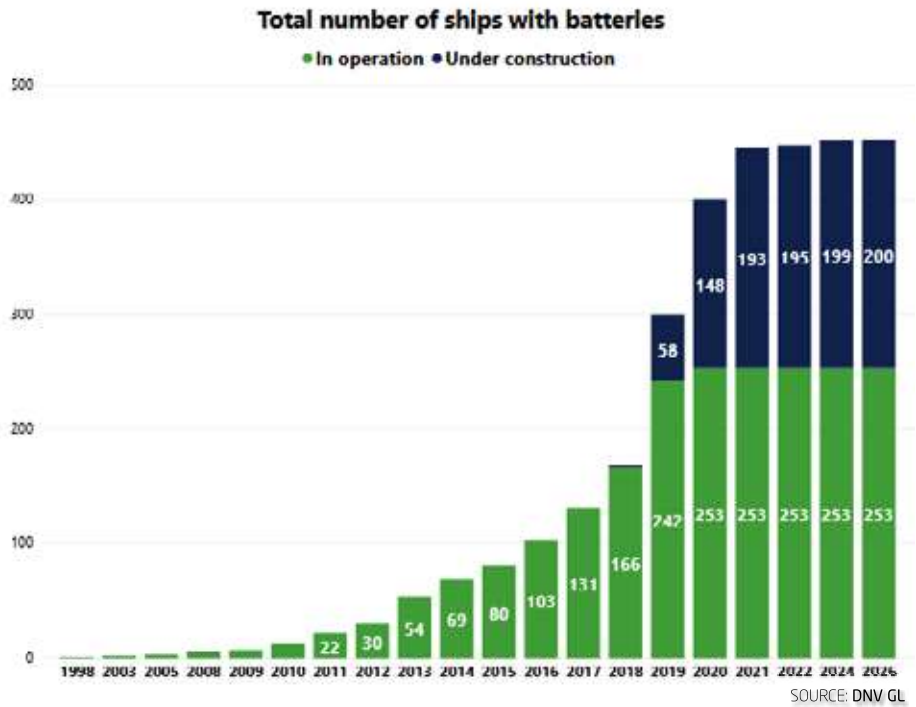
Battery-powered ships are an example of this category. Many ships have been equipped with varying sizes of battery packs for hybrid or full-electric operation while international regulations are still lacking. Feedback is still important to evolve the local and classification societies regulations. In 2019, an accident occurred in Norway, the country with by far the largest number of battery-operated ferries. It required less than a year for the Norwegian Maritime Authority (NMA) and classification societies to issue new regulations which took into account the lessons learnt in this accident.

In October 2019, a fire broke out on board the YTTERØYNINGEN. Built in 2006, this small double-ended ferry sailing in Norway was retrofitted in mid-2019 with liquid-cooled batteries to transform her into a hybrid vessel. At the time of the fire, she was running on her diesel engines and was able to reach the pier to disembark passengers. A leakage from the battery cooling system created arcing, igniting a fire. Since the batteries and alarm system were disconnected by the crew to perform maintenance, the battery alarm system did not warn the crew about the failure. Some of the battery cells went into a thermal runaway, which is the main safety concern in relation to the use of lithium-ion batteries. In a chain chemical reaction, the temperature of the battery cells increases and can produce a fire with toxic smoke. The firefighting system fitted in the battery room during the ship's retrofit was a seawater sprinkler system. Corvus, the battery manufacturer, transparently indicated that "both the vessel's Novec 1230 inert gas system and the vessel's seawater fire sprinkler system were deployed during the event. The seawater sprinkler system was installed as an additional safety barrier. Indications are that the activation of the seawater sprinkler system contributed to escalating the incident," because seawater is conductive and created short circuits.

In July 2020, the classification society DNV GL issued a new set of rules, only nine months after the accident, taking into consideration the lessons learned from the YTTERØYNINGEN fire. Among them is the mandatory fitting of a freshwater-based firefighting system with at least 30 minutes of fresh water capacity, in order to avoid the problems of seawater conductivity. Moreover, the minimum ventilation capacity in the battery room has been increased from two to six air changes per hour, reducing the air toxicity in case of fire.

Following technology

The IMO anticipated in the 1990s that it wouldn't be able to cope with future changes in ship design within an appropriate timescale, delegating oversight to local authorities and classification societies. This has given a measure of freedom to the shipping industry to innovate in the last ten years by finding the balance between flexibility and safety, most of the time through risk assessment and mitigation methodology and quickly reacting to feedback from experience and accidents. While changes to the IMO's regulations require years due to the requirement to consult the signatory countries and shipping industry players,



SOURCE: DNV GL

Many ships have been equipped with varying sizes of battery packs for hybrid or full-electric operation, yet international regulations are still lacking.

> *The YTTERØYNINGEN fire, small in terms of size and damages but big in lessons and consequences for the industry, demonstrated that classification societies can act more quickly in order to offer a transitional safety framework until international regulation is achieved.*

the YTTERØYNINGEN fire, small in terms of size and damages but big in lessons and consequences for the industry, demonstrated that classification societies can act more quickly in order to offer a transitional safety framework until international regulation is achieved.

The ro-ro and ro-pax industry will also have to cope with the rising number of electric vehicles (EVs) being transported. While recent studies show EVs may have a lower risk of fire than fossil fuel vehicles, the main concern with battery fires is the thermal runaway of multiple battery cells which could lead to an unextinguishable fire. According to Bloomberg, "by 2025, EVs will comprise 10% of global passenger vehicle sales, rising to 28% in 2030 and 58% in 2040." With this potentially high number of battery cells parked in proximity on a ro-ro deck, new safety systems and routines will be needed. While new tools to evaluate the problems, such as AI simulation, have greatly improved, it will be interesting to see how safety regulation will need to evolve in response to this challenge. ■

A BURNING ISSUE

As a dual merchant navy officer, I worked on deck and in the engine on board of several passenger ships, from small ferries to big cruise ships. A few years ago, while I was a deck cadet officer on board a ro-pax sailing between two Caribbean islands, a fire broke out in the engine room. It was quickly realised that it would not be possible to get it under control. We were close to arriving at our destination and near to shore, so the master decided to abandon the ship. During this event, many systems, previously checked and certified by the manufacturer or approved technicians, did not perform as expected.

TEXT: BRUNO JONATHAN

Subsequently, what struck me was that, while highly stressful for the people on board during a short period lasting a few hours, the case occupied many people for months afterwards. Months later I met the ship's superintendent in his office. He was on the phone with one of the insurers, still clarifying some issues concerning the fire. For months, the ship's total loss was considered only as an asset loss for the owner while waiting for the insurance payout. In contrast, following a long process, the P&I insurers finally reimbursed the crew members and passengers for their lost possessions, a full five months after the accident. The fire had broken out in seconds. The decision to abandon the ship had been taken in minutes. All passengers and crew members were safe and sound ashore in a few hours. The fire was under control (thanks to shore firefighters) in a matter of days. But the case was only settled many months later, occupying a variety of professional people including investigators, lawyers, insurers, shipowner's employees and many others.

A feared event

This event confirmed many things I had heard at school and on board all the ships where I had worked. Fire is the most feared accident by seafarers. Unpredictable, it can happen even on board the most modern and reliable ships. It can get out of hand very quickly, sometimes requiring to abandon the ship. Professional firefighters consider fires on board ships as among the most dangerous. Ships are huge with conductive steel boxes carrying lots of potentially dangerous substances (fuel, lube oil, gases, cargo, ...). At worst, fires can spread even if they are physically isolated through steel plates and electrical cables. Bearing this in mind, it would be unrealistic to expect the crew's firefighting teams, trained for a week every five years, to face and extinguish a major ship fire like professionals do after years of experience. During the fire we experienced, the fireteams mustered and were ready to investigate until it was confirmed that all crew members were accounted for and all accesses to the engine room closed. From then, their intervention was limited to boundary cooling. There was no point in risking people's lives in the hell-like environment.

Firefighters have two primary goals which are often repeated at school, firefighting training centres and on board. They investigate (for example to know the extent and origin of a fire or if a fire is fully extinguished after the use of a fixed-fire extinguishing system) and evacuate any potential victims from the affected area. They will try to extinguish minor fires (for instance in a cabin following a garbage fire) or do their best to control bigger ones (for instance carrying out boundary cooling on the adjacent walls and floors or closing a fuel valve to isolate a fuel line or tank from the fire).

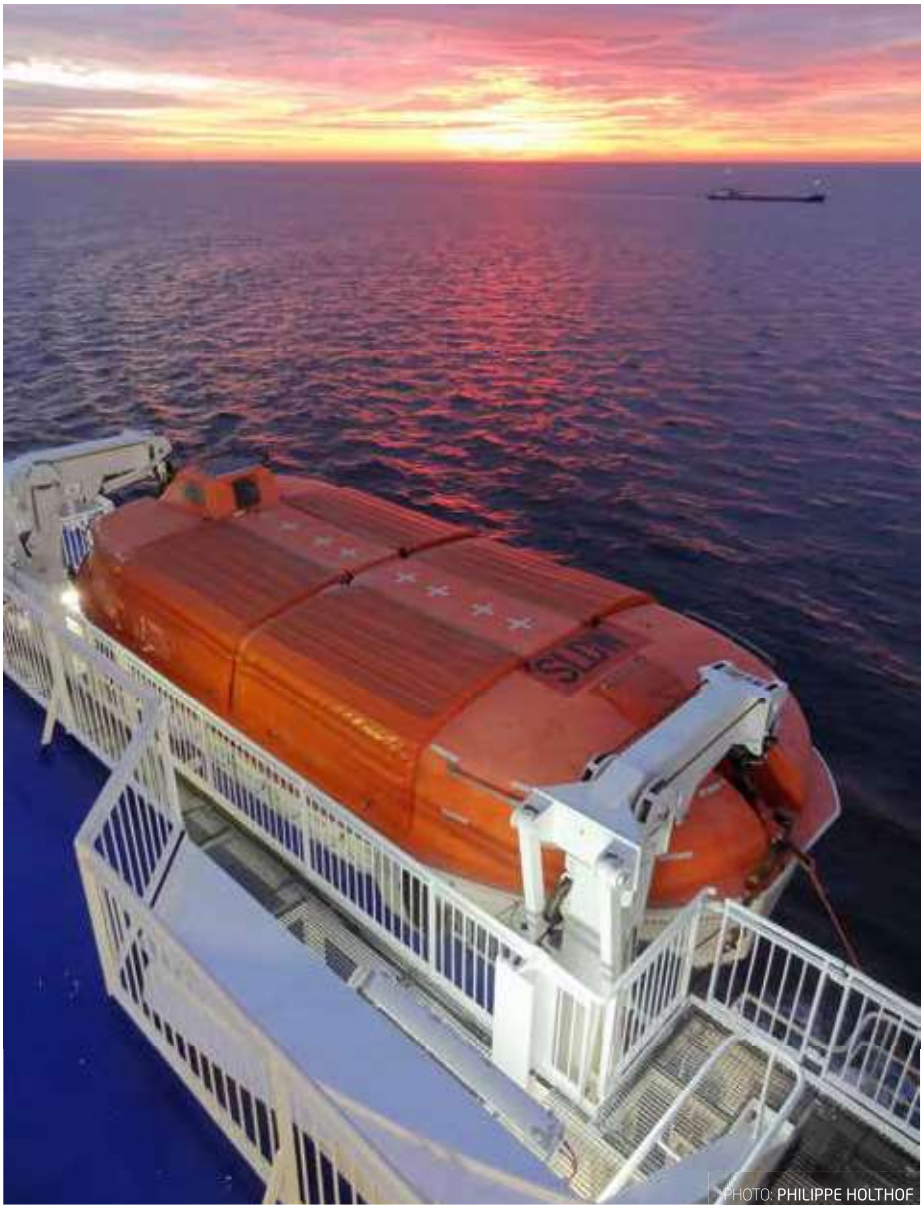
Passenger ships: difficulty doubled in case of fire

The difficulty is multiplied on board passenger ships because trained crew members have to handle the safety of untrained and often panicked passengers in addition to their own. Proper crowd management will highly influence the outcome of a fire event. The presence and professionalism of the crew members will be of great help in managing passengers. During the fire we faced, thanks to hotel crew members acting professionally with the passengers, only two passengers panicked.

Recent events have demonstrated a chilling fact: even with the best lifesaving equipment, it can be completely impossible to evacuate a passenger ship in a challenging environment such as a rough sea or major fire. In 2014, a fire broke out on board the ro-pax NORMAN ATLANTIC, sailing between Greece and Italy. At first, due to the rough sea and later because of the fire's heat and flames, passengers and crew could not launch all the lifeboats and liferafts. In 2019, the cruise ship VIKING SKY had a mechanical malfunction, losing all propulsion while ploughing through a rough sea, hindering passengers and crew from evacuating. In both cases, a helicopter shuttle was put in place, requiring days to complete the rescue operation. Most passenger ship masters would probably say that the safest place for passengers is the ship itself as long as the fire is under control. Abandoning the ship is not an easy decision to take because many things can go wrong. The SOLAS Safe Return to Port (SRtP) 2010 amendments were introduced as a result. To be able to keep the ship safe until rescue teams come to assist will require, among other things, proper firefighting systems.

Time is of the essence!

Rapid response is the key, giving automatic fixed firefighting systems an undeniable advantage. They are activated as soon as something goes wrong and they can cover a large area. Recently attending Carnival's own state-of-the-art training centre in IJmuiden, the Netherlands, before boarding one of their ships as a third engineer, three key themes were taught. Carnival's own procedures and way of thinking, compliance with environment regulation and the vital need to react quickly in case of fire. To illustrate the latter before performing challenging simulator exercises, two videos were shown. They were CCTV footage taken on board two cruise ships of the same series (of a competitor group, of course said the instructor). Same angle, same engine. Due to a fuel oil leakage, a fire had ignited. In one of the videos, the water mist was probably in automatic mode and triggered very quickly. The fire was rapidly extinguished. In the other one, it took more time before the water mist system activated allowing the fire to spread before being (thankfully) extinguished. ■



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