EUROPEAN MARITIME TRAFFIC RISK ASSESSMENT ON SHIP FIRES
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1. BACKGROUND

This analysis contains an overview of trends in European commercial maritime traffic, as well as ship fires and the threat of ship fires in the area. It was performed by the Finnish Transport Safety Agency for use in the Baltic Sea Maritime Incident Response Group (Baltic Sea MIRG) project, which is being led by the Finnish Border Guard.

In the analysis, the following questions were assessed on a general level:
1. How has European commercial maritime traffic developed in recent years?
2. What is Europe’s maritime safety status with regard to ship fires?
3. How great a threat do ship fires pose to European maritime safety when the risk is loss of human life or serious injury?

When assessing the threat of ship fires to maritime safety, the analysis was restricted to ship fires in which the risk was loss of human life or serious injury. The analysis was also restricted to incidents occurring during legal activities and does not therefore cover ship fires on, for example, refugee boats.

Both a statistical risk assessment method and a risk assessment workshop were used to analyse the threat posed by ship fires. In accordance with contemporary safety thinking, risk assessments cannot be supported by statistical methods alone, as statistics cannot provide anywhere near the whole picture – the world is forever changing and surprises occur. The methods and materials used to find answers to the research questions are presented in more detail in Appendices 1 and 2.

This study has been classified as a narrow analysis, and as such its results should be considered indicative.

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1 A threat is a way in which certain risk factors can cause an accident. Threats are, therefore, types of accident relating to certain activities. Maritime threats include ship fires, running aground, and collisions.

2 A risk is an abstract concept whose closest equivalent in the real world is a sense of fear. The general definition of ‘risk’ is the probability of an event occurring multiplied by the seriousness of its consequences. Risks are often presented in two-dimensional diagrams with probability on the horizontal axis and seriousness on the vertical axis – in mathematical terms, the risk is a vector formed by these two components. Two examples of maritime risks are environmental damage and loss of human life.
2. EUROPEAN COMMERCIAL MARITIME TRAFFIC

2.1. The volume of seaborne trade and passenger traffic at ports

Sea transports play a central role in Europe’s goods and passenger traffic. Almost 90 per cent of Europe’s foreign trade is seaborne, and every year about 400 million passengers either embark or disembark at European ports. Generally speaking, sea transports and their related operations are a significant source of both employment and income in Europe.

In 2013, the volume of seaborne trade at European ports totalled 3,716 million tons. Liquid bulk cargo accounted for the largest proportion of this, at 38 per cent. The next most significant product groups were solid bulk cargo, containers, and multimodal ro-ro transports. Exports accounted for 1,472 million tons of all seaborne trade, and imports for 2,244 million tons. When these figures are compared to those for global seaborne trade, European ports accounted for 17 per cent of exports and 21 per cent of imports (Figure 1).

![Figure 1. Global seaborne imports and exports by geographical region, 2013 (UNCTAD 2014).](image)

In terms of cargo weight (Figure 2), the majority of Europe’s seaborne trade in 2013 was handled by ports in the Netherlands (548 million tons), the UK (503 million tons) and Italy (457 million tons). The major ports were Rotterdam (407 million tons), Antwerp (172 million tons) and Hamburg (121 million tons). These ports are the central nodes for Europe’s maritime traffic. In 2013, European passenger traffic was at its most brisk at ports in Italy (73 million passengers), Greece (73 million passengers) and Denmark (41 million passengers). The major ports for passenger traffic were Dover (13 million passengers), Helsinki (11 million passengers) and Perama (11 million passengers).

![Figure 2. Goods traffic volumes at Europe’s major ports in 2013 (EUROSTAT 2015).](image)

2.2. Trends in commercial maritime traffic

The volume of sea transport of goods at European ports in 2013 was almost the same as in the previous year, with a difference of only -0.6 per cent (Figure 3). Exports grew by 0.4 per cent on the previous year, totalling 1,471 million tons. Imports fell by 1.2 per cent to 2,244 million tons. No substantial changes are apparent when these figures are compared to trends in sea transport of goods over the period 2003–2013. The 2009 recession can, however, be seen as a clear dip in the graph. Sea transport of goods in European ports has still not recovered to pre-2009 levels.

Trends in the volume of sea transport of goods in European ports have not followed the general global trend, in which imports have risen by 2.1 per cent and exports by 2.2 per cent compared to 2012. This is probably due to the current economic situation in Europe, which has also not followed the general global trend. However, the general economic situation in Europe has shown some signs of recovery recently, and moderate GDP growth has been forecast1.

1http://ec.europa.eu/economy_finance/eu/forecasts/2015_spring_forecast_en.htm
3. **SHIP FIRES IN EUROPEAN SEA AREAS**

### 3.1. Previous studies of ship fires

The probability of a ship fire can be assessed by determining the ratio of the number of ship fires to the number of vessels. This information can then be used to calculate the annual frequency of ship fires aboard different types of vessel. According to a 2007 study performed by Det Norske Veritas, the global frequency is seven ship fires per 1,000 ship-years (Table 1). A comparison of the figures for different types of vessels shows that the vessels with the highest frequencies of ship fires are passenger ships, gas carriers, and ro-ro/container ships. A Faros study from 2013 states that, on a global scale, insufficient attention has been paid to preventing ship fires. For example, the fire frequencies of ro-ro passenger ships and tankers have remained almost unchanged for the last 24 years.

### Table 1. The annual fire frequency for different types of ships (DNV 2007).

<table>
<thead>
<tr>
<th>Ship type</th>
<th>Fire frequency per ship-year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole DNV fleet, 4,300 vessels</td>
<td>$7 \times 10^{-3}$</td>
</tr>
<tr>
<td>Oil carriers</td>
<td>$2 \times 10^{-3}$</td>
</tr>
<tr>
<td>Fishing vessels</td>
<td>$2 \times 10^{-3}$</td>
</tr>
<tr>
<td>Supply vessels</td>
<td>$2 \times 10^{-3}$</td>
</tr>
<tr>
<td>Dry cargo</td>
<td>$3 \times 10^{-3}$</td>
</tr>
<tr>
<td>OBO</td>
<td>$4 \times 10^{-3}$</td>
</tr>
<tr>
<td>Bulk</td>
<td>$4 \times 10^{-3}$</td>
</tr>
<tr>
<td>Chemical carriers</td>
<td>$6 \times 10^{-3}$</td>
</tr>
<tr>
<td>RoRo, container</td>
<td>$7 \times 10^{-3}$</td>
</tr>
<tr>
<td>Gas carriers</td>
<td>$7 \times 10^{-3}$</td>
</tr>
<tr>
<td>Passenger</td>
<td>$1.6 \times 10^{-2}$</td>
</tr>
</tbody>
</table>

In 2009, Lund University studied the number of ship fires that led to loss of life and injuries as a percentage of the total number of ship fires. According to the average calculated on the basis of the figures in Table 2, 4.5 per cent of ship fires have led to injuries and 6.6 per cent to fatalities. Eleven per cent of all ship fires have led to either injuries or fatalities (hereinafter ‘a serious ship fire’).

### Table 2. The proportion of ship fires that have led to fatalities or injuries as a percentage of all ship fires (LUND 2009).

<table>
<thead>
<tr>
<th>Thesis Database Search</th>
<th>USCG Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Incidents With Fatalities</td>
<td>2</td>
</tr>
<tr>
<td>Number of Fatalities</td>
<td>5</td>
</tr>
<tr>
<td>Percentage of Incidents With Fatality</td>
<td>6.9</td>
</tr>
<tr>
<td>Number of Incidents With Personal Injuries</td>
<td>1</td>
</tr>
<tr>
<td>Number of Personal Injuries</td>
<td>1</td>
</tr>
<tr>
<td>Percentage of Incidents With Personal Injury</td>
<td>3.4</td>
</tr>
<tr>
<td>Percentage of Incidents With Personal Injury/fatality</td>
<td>10.3</td>
</tr>
</tbody>
</table>

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1. http://ec.europa.eu/eurostat/statistics-explained/index.php/Maritime_ports_freight_and_passenger_statistics. EU statistics usually count both arriving and departing passengers, which means that the actual number of passengers is half of this figure.

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Det Norske Veritas’ study shows that 63 per cent of ship fires originated in engine rooms, 27 per cent in cargo areas, and 10 per cent in accommodation areas (Table 3). According to the study, the most common cause of fires in engine rooms is damage to fuel injection systems, which results in fuel leaking onto hot surfaces. Various underlying causes have been identified for these accidents, such as the incorrect installation of equipment, faulty maintenance, deficiencies in monitoring, and the vibration of the vessel. The fires that have started in cargo areas have resulted from both transport conditions and the characteristics of the cargo. Some examples of incidents resulting from transport conditions are cargo igniting due to an excessively high temperature in the hold or an electrical short circuit. Incidents resulting from the characteristics of the cargo have involved either chemical reactions or substances with a low spontaneous combustion temperature. Most of the fires that originated in crew or passenger accommodation were a result of smoking or electrical short circuits.

<table>
<thead>
<tr>
<th>Origin of fire</th>
<th>Number (%)</th>
<th>Fire frequency per ship-year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine room</td>
<td>63</td>
<td>$4.4 \times 10^5$</td>
</tr>
<tr>
<td>Accommodation</td>
<td>10</td>
<td>$7.0 \times 10^4$</td>
</tr>
<tr>
<td>Cargo area</td>
<td>27</td>
<td>$1.9 \times 10^5$</td>
</tr>
</tbody>
</table>

Table 3. The origin of ship fires by area (DNV 2009)

3.2 European maritime accidents

According to Lloyd’s List Intelligence statistics, there were 1,278 maritime accidents in Europe’s sea areas in 2014, which is 10 per cent more than in the previous year (Figure 5). No substantial changes are apparent when these figures are compared to trends in the number of accidents over the period 2010–2014. A total of 5,881 accidents occurred during the five-year period, 2 per cent of which had serious consequences. These figures do not include accidents involving refugee boats in the Mediterranean.

On the basis of EMSA statistics for 2011–2013, the sea areas in Europe that are most prone to accidents are the North Sea, the English Channel, the Baltic Sea, and the east Mediterranean. Factors that increase the risk of a vessel having an accident are, for example, brisk maritime traffic and difficult weather conditions. Substantial vessels are a risk factor that has been observed in the Mediterranean and Black Sea in particular. However, their number has reduced in recent years due to, for example, intensified Port State Control inspections. On the other hand, the current political unrest in the region has had a negative impact on these favourable developments.

During the period studied, the majority of maritime accidents – 40 per cent – involved machinery damage or failure. Ship fires accounted for 6 per cent (Figure 6). Of the accidents involving collisions, 3,283 were cargo ships, 1,026 passenger ships, and 675 tankers. According to IUMI statistics, these days almost half of all maritime accidents occur during difficult weather conditions, and this trend has been increasing in recent years.

Maritime Accidents 2010 - 2014

<table>
<thead>
<tr>
<th>Year</th>
<th>Accidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>1278</td>
</tr>
<tr>
<td>2011</td>
<td>1178</td>
</tr>
<tr>
<td>2012</td>
<td>1208</td>
</tr>
<tr>
<td>2013</td>
<td>1278</td>
</tr>
<tr>
<td>2014</td>
<td>1378</td>
</tr>
</tbody>
</table>

Figure 5. Maritime accidents in Europe, 2010–2014, plus serious accidents and trends in their total number (LLI 2015).

Marine Casualties by Type of Event and Ship 2010 - 2014

- General Cargo Ships
- Passenger Ships/Ferries
- Tankers
- Bulk Carriers
- Fisher Vessels
- Offshore
- Other Ships

<table>
<thead>
<tr>
<th>Type of Event</th>
<th>General Cargo Ships</th>
<th>Passenger Ships/Ferries</th>
<th>Tankers</th>
<th>Bulk Carriers</th>
<th>Fisher Vessels</th>
<th>Offshore</th>
<th>Other Ships</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundered</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hull damage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire/explosion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miscellaneous</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contact (eg. Harbour wall)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collision (involving vessels)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wrecked/stranded</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machinery damage/failure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 6. Maritime accidents in European sea areas by type of event and vessel (LLI 2015).

*IUMI: Casualty and World Fleet Statistics as at 1 January 2015 (2015)*
3.3. Trends in the number of maritime accidents in Europe

When maritime accidents are examined for the period 2010–2014, a clear rise can be seen in the number of incidents involving machinery damage or failure in particular (Figure 7). There were a total of 571 such incidents in 2014, which is 13 per cent more than in the previous year. Machinery damage or failure also played a part in many of the more serious accidents. On the other hand, significant favourable developments can be seen over the same period in incidents involving hull damage. Only 14 such incidents occurred in 2014, which is 43 per cent less than in the previous year. Trends in the number of ship fires will be examined in Section 6.5.

![Figure 7. Trends in the number of maritime accidents in Europe by type of event (LLI 2015).](image)

3.4. Ship fires in European sea areas

Many passengers and crew members have died in ship fires in European sea areas. The most serious of these have been on ro-ro passenger ships. The worst accident in recent history occurred in 1990, when 159 people were killed in a ship fire aboard the Scandinavian Star. This tragedy played a significant role in the IMO’s decision to launch preparations for the ISM Code. When it came into force, safety management systems became compulsory for many operators and vessels. In seafaring, it is quite typical for significant safety-enhancing measures to be launched in the wake of catastrophes rather than on the basis of risk assessments.

According to Lloyd’s List Intelligence statistics, 74 ship fires occurred in European sea areas in 2014, 10 of which were serious (Figure 8). A total of 799 ship fires occurred during the period 2004–2014, 10 per cent of which were serious. The worst incident occurred in December 2014, when 11 people were killed and several injured in a fire aboard the ro-ro passenger ship Norman Atlantic. The fire originated on the ship’s car deck. Other ship fires resulting in multiple fatalities or injuries also occurred during this period:

- In 2010, 28 people were injured in a fire aboard the ro-ro passenger ship Lisco Gloria. The fire originated on the ship’s car deck.
- In 2008, 10 people were killed and several injured after an explosion aboard the general cargo ship Enisey. The explosion was caused by welding sparks while the ship was docked.
- In 2008, 8 people were killed and several injured after an explosion aboard the gas carrier Friendshipgas. The explosion was caused by welding sparks while the ship was docked.

![Figure 8. The number of ship fires in Europe, including those that have led to fatalities or injuries (LLI 2015).](image)

3.5. Trends in the number of ship fires

When the number of ship fires is examined over the period 2004–2014, a slight rise can be detected (Figure 9). Ship fires have increased among, for example, general cargo ships, ro-ro passenger ships and cruise ships. Nordic insurance companies and the EMSA11 have also noted this increase in the number of ship fires aboard ro-ro passenger ships. It is also worth noting that there has been a significant reduction in the number of ship passengers in Europe in recent years, and this must also have been reflected in the number of ro-ro passenger ships. On the basis of this data, it can be assumed that a greater number of fires per vessel are occurring aboard ro-ro passenger ships. On the other hand, favourable developments can be seen in, for example, the number of fires aboard oil tankers, chemical tankers and fishing vessels, which have all decreased in recent years.

A Poisson distribution indicates that the changes in the total number of ship fires during the period stem from chance variation rather than being statistically significant. However, statistically significant results have been found for individual types of vessels. An exceptional number of fires occurred aboard passenger ships in 2008, aboard ro-ro passenger ships in 2010, and aboard container ships in 2014.

12EMSA workshop on fires in the cargo decks of ro-ro vessels (2015)
3.6. Regulations on vessel fire safety and their supervision

Several international regulations on vessel fire safety have been passed. The key ones are SOLAS Chapter II, the FSS Code, and Section A of the STCW Code. These international regulations seek to both prevent ship fires (preventative measures) and minimise their consequences (proactive measures). Table 4 contains examples of regulations governing fire safety on ro-ro passenger ships.13

![Figure 9. Trends in the number of ship fires in Europe by type of vessel (LLI 2015)](image)

<table>
<thead>
<tr>
<th>Table 4. Examples of preventative and proactive fire safety regulations for ro-ro passenger ships (GL 2013).</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preventive measures</strong></td>
</tr>
<tr>
<td>Fire protection insulation of cargo spaces</td>
</tr>
<tr>
<td>Electrical equipment and wiring</td>
</tr>
<tr>
<td>Fire prevention (crew)</td>
</tr>
<tr>
<td>Fire fighting</td>
</tr>
<tr>
<td>Fire detection and alarm system</td>
</tr>
<tr>
<td>Ventilation system</td>
</tr>
</tbody>
</table>

Compliance with fire safety regulations is supervised during both inspections performed by the ship’s flag state and Port State Control inspections carried out by foreign states. A total of approximately 27,500 Port State Control inspections were carried out at European ports during the period 2012–2014. Fire safety was the second largest category of deficiencies reported, accounting for 14 per cent of all deficiencies (Figure 10). This communicates a certain level of negligence concerning fire safety among both operators and crew members. The deficiencies in fire safety mainly concerned fire doors and their correct usage, general fire safety, and fire-fighting equipment (Figure 11).

![Figure 10. Deficiencies in vessel fire safety reported during Port State Control inspections in Europe, 2012–2014 (ParisMoU 2015).](image)

![Figure 11. Deficiencies in vessel fire safety reported during Port State Control inspections in Europe, 2012–2014 (ParisMoU 2015).](image)

13Germanischer Lloyd: Study on fire safety in connection with the transport of vehicles with electric generators or electrically powered vehicles on ro-ro and ro-pax ships (2013)
Compliance with fire safety regulations does not guarantee that a vessel is safe, but it is a good starting point for safe operations. According to researchers from the Finnish Safety Investigation Authority, attitude plays a key role in fire prevention. A good attitude towards safety can often be seen in the thorough performance of basic procedures, such as keeping areas clean and tidy and maintaining equipment in proper working order. However, preventing fires can be difficult, as there are such a wide range of potential causes, from electrical faults to a variety of human activities. It is therefore impossible to prepare for all eventualities. This is why specific causes of fire are not always significant with regard to the overall safety of a vessel. Instead, it is often easier to influence the prompt detection of fires and their effective extinguishment, and these factors therefore play a key role in minimising fire damage aboard vessels.

Lloyd’s List Intelligence has defined a Hull Risk profile for operators that is based on the way ship insurance companies assess safety risks. A Hull Risk profile can also be used to roughly estimate developments in an operator’s safety culture. Figure 12 depicts a distribution of the Hull Risk profiles of 381 different operators. Only operators that have had at least one fire aboard their vessels in the last 15 years have been included. The chart shows that no less than 72 per cent of fires have occurred on vessels belonging to operators with an average risk – that is, typical operators. Such operators largely comply with regulations, but do not actively invest in fire safety improvements as per the ISM Code. The chart also shows that 11 per cent of fires have occurred on vessels belonging to low-risk operators. It can be assumed that these vessels are better prepared to minimise fire damage, as fire-fighting is actively practised and developed.

3.7. Ship fires and fire safety deficiencies by type of vessel

3.7.1. General cargo ships

When ship fires occurring in European sea areas are examined by type of vessel for the period 2004–2014, the highest percentage of accidents have involved general cargo ships (Figure 13). A total of 193 fires occurred aboard general cargo ships, 8 per cent of which were serious. According to the Faros study, 39 per cent of fires aboard general cargo ships originated in the cargo hold and 37 per cent in the engine room. The most fire safety deficiencies have also been found on general cargo ships during Port State Control inspections (Figure 14). During inspections performed in Europe in the period 2012–2014, a total of 7,869 deficiencies were found on general cargo ships, which is 42 per cent of all deficiencies. The high number of ship fires and deficiencies stem from both the large number of vessels in use and the fact that many operators still need to make a lot of improvements in fire safety.

3.7.2. Ro-ro passenger ships

The second highest number of fires occurred aboard ro-ro passenger ships. There were a total of 95 incidents, 6 per cent of which were serious. According to the Faros study, 43 per cent of these fires originated either in the engine room or on the car deck. Figure 14 shows that, during the period studied, the most fire safety deficiencies per Port State Control inspection were found on ro-ro passenger ships. The general assumption that can be made from this is that operators do not have sufficiently high standards of safety considering the vast numbers of people they transport.

Figure 11. Deficiencies in vessel fire safety by sub-category (ParisMoU 2015).

Figure 12. A Hull Risk profile distribution for operators that have experienced at least one fire aboard a vessel in the period 2000–2015 (LLI 2015).

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13Safety Investigation Authority: M/S LEMO, fire in a ship’s galley off Kotka (2008)
3.7.3. Chemical tankers
The third highest number of fires – a total of 82 – occurred aboard chemical tankers. No less than 20 per cent of these fires were serious. Fires aboard chemical tankers have mostly originated either on deck or in the cargo tanks, and have been ignited by, for example, static electricity generated during tank cleaning and ventilation operations. Over the three-year period, 1,078 fire safety deficiencies were found aboard chemical tankers during Port State Control inspections, which is 6 per cent of all deficiencies. The safety cultures of the companies operating these vessels is often rated more mature than average. It is, perhaps, time for a change in attitude.

Figure 13. European ship fires, including fires leading to injuries or fatalities, by type of vessel (LLI 2015).

Figure 14. Fire safety deficiencies found during Port State Control inspections in Europe, including the ratio of deficiencies per inspection, by type of vessel (ParisMoU 2015).

3.8. Ship fires by geographical area
Unlike many other maritime accidents, ship fires are not directly linked to any particular geographical factors. In theory, ship fires can occur in any trafficked location. The greatest percentage of European ship fires have occurred in the region formed by the North Sea, English Channel and Bay of Biscay (Figure 15). During the period 2004–2014, a total of 328 ship fires occurred in this region, which is 41 per cent of all European ship fires (Figure 16). Eight per cent of all these fires were serious. The vessel involved was usually either a general cargo ship (58) or a ro-ro passenger ship (35). One major reason for the large number of fires – and also the number of other accidents – may be the very brisk traffic in the region (Figure 17). When trends in the number of ship fires in the area is examined for a ten-year period, a slight fall can be seen (Figure 18). The highest number of ship fires occurred in 2008, after which there has been a notable downswing. These favourable developments are probably due to the negative impact of the European recession on vessel traffic in the region.

The second highest number of European ship fires have occurred in the east Mediterranean and Black Sea. A total of 192 fires occurred during the period studied, which is 24 per cent of all European ship fires. Six per cent of the ship fires that occurred in this area were serious. The vessels involved were usually general cargo ships – there were 73 fires aboard such vessels. The east Mediterranean and Black Sea are also briskly trafficked. Quite a lot of old and poorly maintained vessels also sail in this area, which may be another factor contributing to the large number of ship fires. A slight increase in the number of ship fires can be seen in this area during the period studied.

In this analysis, product tankers were included in the same category as chemical tankers.  
http://www.chemicaltankerguide.com
The Baltic Sea was ranked third in this comparison. A total of 141 fires occurred here during the period studied, which is 18 per cent of all European ship fires. Only 3 per cent of these fires were serious, which is clearly lower than the average (10%). It can therefore be assumed that many of the area’s operators have made greater-than-average investments in fire-fighting. Most of the fires in the Baltic Sea occurred aboard general cargo ships (36) and ro-ro passenger ships (30). No substantial changes are apparent when these figures are compared to trends in ship fires in the area.

Figure 15. European ship fires and their geographical concentrations (LLJ 2015).

Figure 16. The number of fatalities and injuries in European ship fires by geographical area (LLJ 2015).

Figure 17. European seaborne freight traffic in 2011 (IL 2015).
3.9. Ship fires at sea and in port or dock

According to a 2001 IAEA study, the majority of ship fires have started at sea (Table 5)\(^{17}\). The Faros study supports this\(^{18}\), and also states that sea and weather conditions do not play a significant role in ship fires. Fires start aboard ships in both good and bad weather conditions, and in varying sea conditions.

According to the IAEA report, it takes more time to extinguish a fire at sea than it does in port or dock (Table 6). One key reason for this is that it is more difficult to obtain external assistance when extinguishing a fire at sea. The NFPA table gives a good overview of the benefit of external assistance. It shows, for example, that a fire measuring 37.16 m\(^2\) (400 ft\(^2\)) is more than 33 times more likely to be extinguished by the fire department than by the vessel’s crew (Table 7).\(^{19}\)

Of all the ship fires that occurred in European sea areas during the period 2004–2014, 56 per cent occurred at sea and 44 per cent in port or dock (Figure 19). This ratio is similar to the one given in the earlier IAEA study. Ten per cent of the ship fires occurring at sea were serious compared to 9 per cent of those occurring in port or dock – there is therefore no difference in practice. One reason for this may be that hot work is often carried out in port or dock during vessel maintenance and repair. When hot work causes a fire or explosion aboard a vessel, the accident will quickly claim its first victims. Although it is easier to obtain external assistance on the shore than at sea, it still takes time.

18Faros: Risk models for aboard fires on cargo and passenger ships (2014)

Table 5. Ship fires occurring at sea and in port or dock

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Port fires</td>
<td>43.4%</td>
<td>38.2%</td>
<td>37.6%</td>
</tr>
<tr>
<td>Non-port fires</td>
<td>56.6%</td>
<td>61.8%</td>
<td>62.4%</td>
</tr>
</tbody>
</table>

Table 6. Time taken to extinguish ship fires at sea and in port or dock (IAEA 2001).

<table>
<thead>
<tr>
<th>Time to extinguish</th>
<th>At port (%)</th>
<th>Under way (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–30 min</td>
<td>20</td>
<td>18</td>
</tr>
<tr>
<td>+30 min–2 hr</td>
<td>31</td>
<td>28</td>
</tr>
<tr>
<td>+ 2 hr–10 hr</td>
<td>29</td>
<td>28</td>
</tr>
<tr>
<td>+ 10 hr–1 day</td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>more than one day</td>
<td>11</td>
<td>11</td>
</tr>
</tbody>
</table>

Specifications:
Type of ship World fleet (reported to IMO) + UK registered RoRos and ferries
Database and source IMO + MAIB (SRD) x
Reference period 1962–1989
Fire casualties 382

Table 7. This table is an excerpt from the NFPA table\(^{20}\). Section 1 shows the fire department’s ability to extinguish ship fires, while Section 2 shows the crew’s ability to extinguish ship fires.

<table>
<thead>
<tr>
<th>Area (ft(^2))</th>
<th>Area (m(^2))</th>
<th>P[fail]</th>
<th>Area (ft(^2))</th>
<th>Area (m(^2))</th>
<th>P[fail]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1500</td>
<td>139.34</td>
<td>99.043</td>
<td>1500</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1000</td>
<td>92.89</td>
<td>71.679</td>
<td>1000</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>400</td>
<td>37.16</td>
<td>2.995</td>
<td>400</td>
<td>37.16</td>
<td>99.894</td>
</tr>
<tr>
<td>200</td>
<td>18.58</td>
<td>0.292</td>
<td>200</td>
<td>18.58</td>
<td>90.204</td>
</tr>
<tr>
<td>100</td>
<td>9.29</td>
<td>0.130</td>
<td>100</td>
<td>9.29</td>
<td>30.646</td>
</tr>
<tr>
<td>60</td>
<td>5.57</td>
<td>0.1</td>
<td>60</td>
<td>5.57</td>
<td>1.149</td>
</tr>
<tr>
<td>40</td>
<td>3.72</td>
<td>0.1</td>
<td>40</td>
<td>3.72</td>
<td>0.267</td>
</tr>
<tr>
<td>20</td>
<td>1.86</td>
<td>0.09</td>
<td>20</td>
<td>1.86</td>
<td>0.14</td>
</tr>
<tr>
<td>10</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>0.93</td>
<td>0.09</td>
</tr>
</tbody>
</table>

\(^{20}\)VTT: Survivability for ships in case of fire (2009)
4. THE THREATPOSEDBYSHIPFIRESINEUROPE

4.1. The threat posed by ship fires in relation to other maritime accidents

Thissectionassesshowsgreatariskshipfireposesinrelationtoothermaritimeaccidentswhentheriskislossofhumanlifeorseriousinjury.Bothastatisticalriskassessmentmethodandariskassessmentworkshopwereused.

4.1.1. Statistical risk assessment

Thevariablesusedinthestatisticalriskassessmentweweretheprobabilityofmaritimeaccidentsandthefrequencyoffatalitiesandinjuriesinaccidents(Figure20).Theestimateshavebeenmadebytypeofaccident,whichenablecomparisonbetween
differenttypesofaccidents.Theprobabilityestimatesarebasedonstatisticalten-yearaveragestheshavebeenscaledtothetotallvolumeofvesseltrafficinEuropein2011(xaxis).Thefrequencyoffatalitiesorinjurieshasbeesnestimatedbydeterminingtheratio
ofseriousincidentstothetotalnumbertofaccidents(yaxis).Thegradientalseshows
thenumberoffatalitiesandinjuriesaccordingtotheIMO’sFSAmethod,inwhichone
fatalitycorrespondstoteninjuries(theareasofthecircles).Inaddition,thepossibility
ofacatastrophicaccidenthasbeesnestimatedbytypeofeventinTable8.

Whenthepurposeoftheriskassessmentisconsidered—toachievethemaximum
possibleimprovementintherisksusingtheavailableresources—a generalassumption
canbemade:itismorebeneficialtoallocate资源tominimisingtheconsequences
ofaccidentsthanhonoringtheirprobability.Thetreatmentisthereforegearedtowards
thedimensional’syaxis.

Thisfocuscanbejustifiedbythefactthatmaritimeaccidentshavesuchabroadrange
ofcausesthatitisimpossibletoprepareforalleventualities.Thismakesitvery
difficulttolowertheprobabilityofaccidents.However,onceanaccidenthasoccurred,
therefarefewersafetyfactorsremaining—mainlyrangingfromcrewcompetence-
relatedfactorsto basicsafetyfactors, such as maintainingthevessel’sstabilityand
sustainingliveableconditionsaboardthevessel.althoughitalseadifficulttoinfluence
thesefactorsto orderTominimisetheconsequencesofanaccident,therearemore
realisticopportunitiestodoso—wehaveabetterideaofwheretoreallocateresources.

UsingthisprincipleandthedatasetinFigure20andTable8,a ship fire poses the greatest
threat of all maritime accidents, as sinking is usually a consequence of another accident,
such as running aground or shifting cargo.

4.1.2. Workshop-based risk assessment

Theworkshopparticipantsweretaskedwithansweringthe aforementionedquestions
usingacombinationofstatisticalriskassessmentsandtheirownexpertise,andto
decidetheirconclusions.

Results: Ship fires are the greatest of all maritime threats

Justification: Ship fires are very frightening events with a high risk of loss of life or
serious injury. Ship fires disturb a vessel’s normal routines, and key fire-fighting
personnel may be unavailable due to, for example, injury.

Reliability of assessment: Good.
4.1.3. Summary

The risk assessment indicates that ship fires are the greatest of all maritime threats when the risk is loss of human life or serious injury. Workshop participants focused their assessment on minimising the consequences of an accident rather than lowering its probability. This assessment is reliable, as the participants were almost unanimous in their conclusion, which was also well supported by the statistical risk assessment.

4.2. The threat posed by a ship fire by type of vessel

This section assesses the threat posed by a ship fire in European sea areas by the type of vessel when the risk is loss of human life or serious injury. Both a statistical risk assessment method and a risk assessment workshop were used.

4.2.1. Statistical risk assessment

The variables used in the statistical risk assessment were the probability of a ship fire and the frequency of fatalities and injuries in ship fires. The method described in the previous section was also used to draw Figure 21. In addition, the possibility of a catastrophic ship fire at sea and in port or dock has been estimated by type of vessel in Table 9.

In accordance with the principle defined in the previous section, generally speaking, it is more beneficial to allocate resources to minimising the consequences of ship fires than lowering their probability – although general cargo ships in particular may be an exception to this. A statistical risk assessment based on this principle gave the most surprisingly negative findings for chemical tankers. The probability of a ship fire occurring aboard a chemical tanker is 17.6 – the third highest – and almost one fifth of all accidents have led to loss of life or serious injury. On the basis of the estimates in Table 9, ship fires aboard chemical tankers may also have catastrophic consequences both at sea and in port or dock. Oil tankers represent the most significant positive finding. The probability of a ship fire occurring aboard an oil tanker is 3.4 – the third lowest. About 6 per cent of fires aboard these vessels have led to loss of life or serious injury.

Table 9. The threat of a catastrophic ship fire by type of vessel at sea and in port or dock.

<table>
<thead>
<tr>
<th>Type of ship</th>
<th>Possibility of catastrophic type of accident at sea</th>
<th>Possibility of catastrophic type of accident at port or dry-dock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk carrier</td>
<td>Not likely</td>
<td>Possible</td>
</tr>
<tr>
<td>Chemical tanker</td>
<td>Possible</td>
<td>Possible</td>
</tr>
<tr>
<td>Fishing vessel</td>
<td>Not likely</td>
<td>Not likely</td>
</tr>
<tr>
<td>Container ship</td>
<td>Possible</td>
<td>Not likely</td>
</tr>
<tr>
<td>Gas Carrier</td>
<td>Not likely</td>
<td>Possible</td>
</tr>
<tr>
<td>General Cargo</td>
<td>Not likely</td>
<td>Not likely</td>
</tr>
<tr>
<td>Offshore vessel</td>
<td>Not likely</td>
<td>Not likely</td>
</tr>
<tr>
<td>Other vessel</td>
<td>Not likely</td>
<td>Not likely</td>
</tr>
<tr>
<td>Passenger (Cruise)</td>
<td>Possible</td>
<td>Not likely</td>
</tr>
<tr>
<td>Passenger Ro/Ro</td>
<td>Possible</td>
<td>Not likely</td>
</tr>
<tr>
<td>Passenger ship</td>
<td>Possible</td>
<td>Not likely</td>
</tr>
<tr>
<td>Reefer</td>
<td>Not likely</td>
<td>Not likely</td>
</tr>
<tr>
<td>Roll On Roll Off</td>
<td>Not likely</td>
<td>Not likely</td>
</tr>
<tr>
<td>Tanker</td>
<td>Not likely</td>
<td>Possible</td>
</tr>
<tr>
<td>Tug</td>
<td>Not likely</td>
<td>Not likely</td>
</tr>
</tbody>
</table>

4.2.2. Workshop-based risk assessment

The participants worked in teams of three. The teams were tasked with using the method described in the previous section to assess in which of the five vessel categories the threat posed by a ship fire was greatest when the risk is loss of life or serious injury. They were also tasked with prioritising their chosen vessel categories and justifying their conclusions.

The teams’ assessments were later combined by cross-tabulating their results and weighting the chosen priorities. Vessel-specific accident scenarios for incidents requiring external assistance were also drawn up. The results of the assessment are as follows:

1. Type of vessel: Ro-ro passenger ships

Justification: Ro-ro passenger ships have a high risk potential when the risk is loss of human life or serious injury. A single vessel may carry over 1,000 people – both passengers and crew.

Preventing fires aboard ro-ro passenger ships is extremely difficult, as every passenger or cargo item may be trigger. Fires often originate in the vessel’s engine room. One particular challenge aboard these vessels is posed by multimodal transports with a large fire load, which may also illegally contain dangerous substances. Drunken passengers that do stupid things are another challenge.

It is difficult to minimise the consequences of a fire aboard a ro-ro passenger ship. There are many reasons for this. For example, the vessel’s inbuilt fire-extinguishing system does not have sufficient capacity to deal with the large open spaces on the car decks, which are often packed with cargo as well. Fire-fighting is also a difficult task for the crew to perform. The fire pocket is often difficult to reach, and there may be zero visibility in

Figure 21. The threat posed by a ship fire by type of vessel when the risk is loss of life or serious injury (LLI 2015/IL 2011).
its vicinity. If the ship has to be evacuated, there may be almost two thousand people to evacuate.

Scenario: During the voyage, a fire breaks out on a ro-ro passenger ship’s car deck due to a short circuit in an electric car charger. The vessel’s crew are unable to get the fire under control, and there are a total of 1,000 passengers and crew aboard.

**Reliability of assessment: Good**

2. **Type of vessel:** Ro-ro cargo ship

*Justification:* Ro-ro cargo ships have a moderate risk potential, as the only people aboard are the crew.

It is difficult to prevent fires aboard ro-ro cargo ships, but easier than on ro-ro passenger ships. There are fewer triggers, as the vessel only carries cargo. Ro-ro cargo ships also transport dangerous substances and goods, but otherwise the fire safety challenges posed by cargo are similar to those on ro-ro passenger ships.

Minimising the consequences of ship fires is also easier on a ro-ro cargo ship than on a ro-ro passenger ship. The fire-fighting challenges are the same on both types of vessel, but there is a significant difference when it comes to evacuation. Those being evacuated from ro-ro cargo ships are professional sailors, and the number of people to be evacuated is significantly smaller, about 15 people.

Scenario: During the voyage, a fire starts on the car deck of a ro-ro cargo ship after an electro-chemical reaction occurs in a load of scrap batteries being transported in a truck. The vessel’s crew are unable to get the fire under control, and there are 12 crew members aboard.

**Reliability of assessment: Moderate**

3. **Type of vessel:** Cruise ships

*Justification:* Cruise ships have a very high risk potential, as a single vessel may carry over 6,000 people – both passengers and crew.

Preventing fires aboard cruise ships is extremely difficult, as every one of its 3,000-5,000 passengers may be a trigger. These ships are usually also very large, which makes it more difficult to monitor fire safety. The fires that start aboard cruise ships often originate in the engine room, laundry, or passenger cabins.

Minimising the consequences of fires aboard cruise ships is difficult. There are many reasons for this. One example worth mentioning is the vessels’ fire compartmentation, which may be insufficiently sealed. Such deficiencies can enable a fire to easily spread throughout the ship. However, the greatest challenge on a cruise ship is evacuation. Not all of the passengers being evacuated will necessarily understand the language being used, some of them may panic, and there may be several thousand people to evacuate.

Scenario: During the voyage, a fire starts in the engine room of a cruise ship and spreads through the stairwells, because the fire doors are not properly sealed. The vessel’s crew are unable to get the fire under control, and there are a total of 5,000 passengers and crew aboard.

**Reliability of assessment: Moderate**

4. **Type of vessel:** Container ship

*Justification:* Container ships have a moderate risk potential, as the only people aboard are the crew.

It is extremely difficult to prevent fires aboard container ships. These ships transport dangerous substances alongside regular cargo, and information on the contents of the containers is not always correct. Faults also occur in the containers’ electronics. If the containers have been incorrectly loaded, their contents can also react either with other cargo in the container or with cargo in neighbouring containers. Container stacks may also collapse due to a poor loading plan or improperly attached cargo.

Minimising the consequences of fires aboard container ships is difficult, as, for example, the fire pocket is often very difficult to access. Those being evacuated from container ships are professional sailors, and the number of people to be evacuated is quite small, about 15 people.

Scenario: During the voyage, a fire starts on the deck of a container ship after a chemical reaction occurs in a container holding a dangerous substance. The vessel’s crew are unable to get the fire under control, and there are 15 crew members aboard.

**Reliability of assessment: Moderate**

5. **Type of vessel:** Bulk ships

*Justification:* Bulk ships have a moderate risk potential, as the only people aboard are the crew.

Preventing fires aboard bulk ships is slightly easier than on the aforementioned ships. Bulk ships carry extremely large volumes of cargo, but these cargoes are usually harmless. On the other hand, they may also transport dangerous substances, such as fertilisers, whose chemical reactions may be fire triggers.

Minimising the consequences of fires aboard bulk ships has its own challenges, mainly relating to the large volume of cargo and the size of the vessel. Those being evacuated from bulk ships are professional sailors, and the number of people to be evacuated is quite small, about 20 people.

Scenario: A fire starts in the cargo hold of a bulk ship that is in port after welding sparks fly into the hold during repair work. The vessel’s crew are unable to get the fire under control, and there are 20 crew members aboard. The smoke from the fire is poisonous and easily drifts towards a nearby residential area.

**Reliability of assessment: Good**

4.2.3. Summary

The risk assessment indicates that the threat posed by a ship fire is greatest on ro-ro passenger ships when the risk is loss of human life or serious injury. The reliability of this assessment has been classified as ‘good’ on the same grounds as described above. The next highest risk is on ro-ro cargo ships, which face very similar fire safety challenges to ro-ro passenger ships, but the risk potential is lower. The reliability of this assessment has been classified as ‘moderate’. The most surprising aspect of the results is that chemical tankers and general cargo ships received little attention during the workshop.

The threat of a fire aboard a chemical tanker – and likewise aboard other tankers – was found to be significantly reduced by the shippers’ vetting system. The risks posed by tankers were also considered to pose more of a threat to the environment than to people.
The results of the risk assessment indicate that problems relating to vessel fire safety are difficult to solve. When vessel fire safety is divided into preventative factors and proactive factors (that is, measures to minimise the consequences of fires), there are more realistic opportunities to influence the latter. Therefore, in order to reduce the threat posed by a ship fire, it is more sensible to allocate resources to developing proactive measures of protecting a ship, such as alarm and fire-extinguishing systems, rather than preventative measures.

On the basis of discussions held during the workshop, deficiencies in vessel fire safety are quite common – in both preventative and proactive measures. This view is also well supported by the previously presented statistics on Port State Control inspections. It is probable that fire safety deficiencies mainly stem from financial factors. Operators often prioritise financial issues above safety, which leads to the danger of them operating above an acceptable risk level. In the worst case scenario, this means that risks will be realised – that is, loss of life or serious injuries. One underlying cause of this is the operator’s safety culture – many operators have a lot of improvements to make.

4.3. Future threats

This section seeks to determine the most significant factor that will influence the threat posed by ship fires in the future. The assessment was performed by experts during a risk assessment workshop.

Results: New fuels are the most significant factor that will influence the threat posed by ship fires in the future.

Justification: New ships are entering the market, and their fuel requirements will be met with new types of solutions. Two examples worth noting are the use of liquid hydrogen, which is highly flammable, and hybrid vessels that are partially powered by electricity. Other new fuels, such as LNG and methanol, have a low flash point. Above all, the problem is that no one really knows how the use of these new fuels will impact the threat posed by ship fires in the future.

New fuels and energy solutions may also have an unfavourable impact as cargo. These days, ro-ro ships are increasingly carrying vehicles that are powered partially or wholly by electricity. New vehicles powered by hydrogen are also entering the market. When it comes to the threat posed by a ship fire, vehicles powered by these new energy solutions may lead to unfortunate surprises. As new energy solutions for ships are still quite rare, problems relating to their cargoes will most probably be encountered first.

Reliability of assessment: Moderate.

5. CONCLUSIONS

This analysis gave an overview of trends in European commercial maritime traffic, as well as ship fires and the threat of ship fires in the area. The analysis examined the following questions in particular:

How has European commercial maritime traffic developed in recent years?

European commercial maritime traffic has not kept pace with global trends. The volume of cargo handled by European ports has remained at almost the same level, and there has been a clear fall in passenger numbers.

A total of 3.716 million tons of cargo was handled by European ports in 2013. When these figures are compared to those for global ports, European ports accounted for 17 per cent of exports and 21 per cent of imports.

Trends in the volume of seaborne trade in European ports have not followed the general global trend, in which imports have risen by 2.1 per cent and exports by 2.2 per cent compared to 2012. Ports handled 0.6 per cent less cargo in 2013 than in the previous year. Exports grew by 0.4 per cent on the previous year, totalling 1,471 million tons. Imports fell by 1.2 per cent to 2,244 million tons.

No substantial changes are apparent when the figures are compared to trends in sea transports at European ports over the period 2003–2013. The 2009 recession can, however, be seen as a clear dip in the graph. Seaborne trade in European ports has still not recovered to pre-2009 levels.

A total of about 400 million passengers travelled through European ports in 2013, representing growth of 0.5 per cent on the previous year. However, there has been a clear reduction in passenger numbers in the area during the period 2007–2013.

What is Europe’s maritime safety status with regard to ship fires?

With regard to ship fires, Europe’s maritime safety status can be classified as ‘moderate’ and ‘quite stable’ when based on accident statistics. On the basis of Port State Control inspections, neither operators nor vessels are paying sufficient attention to fire safety.

Ship fires in Europe are quite rare. During the period 2010–2014, there were 353 ship fires, which accounted for 6 per cent of all maritime accidents. However, the consequences of ship fires have usually been serious. About 10 per cent of ship fires that occurred during the period 2004–2014 led to loss of life or serious injury. The worst incident occurred in 2014, when 11 people were killed and several injured in a fire aboard the ro-ro passenger ship Norman Atlantic.

The percentage of European ship fires resulting in fatalities or injuries was lowest in the Baltic Sea. During the period 2004–2014, a total of 141 ship fires occurred in the Baltic Sea, only 3 per cent of which had serious consequences. The location of a vessel when fire breaks out – at sea or in port/dock – has little impact on the seriousness of a ship fire. In both instances, about every tenth accident results in loss of life or serious injury.

When the number of European ship fires is examined over the period 2004–2014, a slight rise can be detected. However, statistical analysis shows that this change stems from chance variation. On the other hand, statistically significant results can be found for
individual types of vessels. For example, an exceptional number of fires occurred aboard ro-ro passenger ships in 2010. Nordic insurance companies and the EMSA have also noted this increase in the number of ship fires aboard ro-ro passenger ships.

Deficiencies in fire safety are commonly found during Port State Control inspections in Europe. During the period 2012–2014, a total of 18,812 fire safety deficiencies were found, which is 14 per cent of all deficiencies. This communicates a certain level of negligence concerning fire safety among both operators and crew members. Although it is extremely difficult to prevent ship fires – they also occur aboard vessels owned by operators with quite good safety cultures – a mature safety culture plays a key role in preventing ship fires and, above all, minimising their consequences. A mature safety culture is based on compliance with regulations.

How great a threat do ship fires pose to European maritime safety when the risk is loss of human life or serious injury?

Ship fires pose a great threat to European maritime safety when the risk is loss of human life or serious injury. Fire poses the greatest threat aboard ro-ro passenger ships. The reliability of these assessments is good. New fuels are the most significant factor that will have a negative influence on the threat posed by ship fires in the future. The reliability of this assessment has been classified as ‘moderate’.

Ship fires are the greatest threat to maritime safety in Europe. They are very frightening events with a high risk of loss of human life or serious injury. The reliability of this assessment has been classified as ‘good’, because the participants were almost unanimous in their conclusion, which was also well supported by the statistical risk assessment. Both assessments focused on the consequences of accidents rather than their probability, as there are more realistic opportunities for influencing the former.

The threat posed by fire is greatest on ro-ro passenger ships. Participants in the risk assessment workshop were almost unanimous on this. Ro-ro passenger ships have the highest risk potential, as a single ship may carry over 1,000 people. It is very difficult to prevent ship fires and minimising their consequences also poses great challenges. The statistical risk assessment also supported this conclusion. The probability of a fire occurring on a ro-ro passenger ship was the second highest, and about 6 per cent of these fires have resulted in loss of life or serious injury. Every year, tens of millions of people travel in ro-ro passenger ships in Europe.

The statistical risk assessment gave the most surprisingly negative finding for chemical tankers. The probability of a ship fire occurring aboard a chemical tanker was the third highest, and almost one fifth of all accidents have led to loss of life or serious injury. On the other hand, oil tankers represent the most significant positive finding. However, chemical tankers were given little attention during the workshop. The threat of a fire aboard a chemical tanker – and likewise aboard other tankers – was found to be significantly reduced by the shipping’s vetting system.

New fuels are the most significant factor that will influence the threat posed by ship fires in the future. New ships are entering the market, and their fuel requirements will be met with new types of solutions. Above all, the problem is that no one really knows what their impact on safety will be. New fuels and energy solutions may also have an unfavourable impact as cargo. This threat affects ro-ro ships in particular, as they transport large numbers of trailers, trucks and cars.

APPENDIX 1: METHODS

1. Trends in commercial maritime traffic

The analysis assessed trends in the volume of sea transports and passenger traffic at European ports. It has been performed using UNCTAD and EUROSTAT statistics. The analysis also used expert opinions based on these statistics.

2. Ship fires in Europe

The analysis assessed the safety status of commercial maritime traffic in Europe with regard to ship fires. It was performed using Lloyd’s List Intelligence accident statistics. A moving average was used to determine trends in the number of ship fires – this is a commonly used method of analysing time series. As the number of accidents occurring within any specific time period also varies by chance, there is also good reason to assess whether the results for ship fires were statistically significant or merely stemmed from chance variation. A Poisson distribution was used to determine this. The analysis also employed the Getis-Ord Gi-Hot Spot method to determine geographical concentrations of ship fires.

Statistics on Port State Control inspections were also used to determine how well vessels operating in European sea areas meet official fire safety standards, that is, one of the basic requirements for safe operations. As compliance with official standards alone does not guarantee safety, the analysis also examined the risk profiles of operators that had experienced fires on their vessels. The operators’ risk profiles were based on Lloyd’s List Intelligence statistics. These profiles were used to form an understanding of the maturity of operators’ safety cultures.

3. The threat posed by ship fires in Europe

Maritime risk assessments seek to achieve the maximum possible improvement in risks using the available resources. This requires threats to be identified and prioritised. On the basis of the IMO’s guidelines, risk analyses must pay attention to risks that involve loss of life, environmental damage, or financial losses.

The analysis has assessed how great a threat ship fires pose to European maritime safety when the risk is loss of human life or serious injury. The analysis was restricted to incidents occurring during legal activities and does not therefore cover ship fires on, for example, refugee boats.

It used both statistical risk assessment methods and a risk assessment workshop that was attended by nine maritime experts from various stakeholders. In accordance with contemporary safety thinking, risk assessments cannot be supported by statistical methods alone, as statistics cannot provide anywhere near the whole picture – the world is forever changing and surprises occur.

In order to reach a conclusion, the analysis studied the following research questions:

- How great a risk do ship fires pose in relation to other maritime accidents when the risk is loss of human life or serious injury?
- On which type of vessel does fire pose the greatest threat when the risk is loss of life or serious injury?
- What is the most significant factor that will have a negative influence on the threat posed by ship fires in the future?

1Lloyd’s List Intelligence uses the term ‘operator’ – their tasks are usually comparable to those of a shipping company.

The final assessment of the threat posed by ship fires has been reached by combining the results from the statistical risk assessment and the risk assessment workshop. The reliability of the assessments was also defined on a scale of good-moderate-weak, depending on whether the workshop participants agreed on their assessments and whether the statistical risk assessments supported their assessments.

APPENDIX 2: MATERIALS

1. Trends in commercial maritime traffic
   - UNCTAD: Review of Maritime Transport 2014

2. Ship fires and Port State Control inspections in Europe

3. The threat posed by ship fires in Europe

4. Previous studies
   - Germanischer Lloyd: Study on fire safety in connection with the transport of vehicles with electric generators or electrically powered vehicles on ro-ro and ro-pax ships (2013)
   - Faros: Risk models for aboard fires on cargo and passenger ships (2014)
   - Lund University: Safety Assessment for Oil Tankers and Container Vessels Focused on Fire and Explosion In the Machinery Space (2009)
   - VTT: Survivability for ships in case of fire (2009)