



STATISTICAL INVESTIGATION OF
ACCIDENTS WHERE
CAR-CARRYING VESSELS HAD
BEEN INVOLVED
Work Package 2.2

ALBERO Project

ALBERO – WP 2.2 Estimation of the occurrence probability of possible hazards during transport or charging processes of battery-powered vehicles on ferries

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Accidents of car-carrying vessels - Statistical investigation

The investigation of possible causes for fires on electric vehicles revealed the following main hazards triggering a thermal runaway of the vehicle battery (hereinafter also referred to as battery) in connection with a subsequent fire:

- mechanical damage to the vehicle battery (due to accident, driving over bumps, ...)
- inappropriate or defective electrical systems for charging
- overheating

Until today it is not possible to determine whether a damage or an overheating of the vehicle occurred prior to boarding a ro-pax or ro-ro vessel. The remaining question is to what extent such hazards also exist for a vehicle itself during the crossing and what is the probability.

Starting point for the study was the assumption that mechanical, thermal or electrical damage to vehicles on board may only occur if (collision) accidents occur on deck either during loading and unloading or if the ship itself gets into an accident situation, as a result of which the transported vehicles are damaged. Accordingly, the first step was to generally record accidents involving ships transporting vehicles in the years 2010 to 2019.

In this context, the following were understood to be car-carrying vessels:

- ro-ro ferries - vessels carrying rolling cargo, where the cargo is driven on and off the vessel by vehicle drivers themselves, mainly truck traffic, trailers.
- ro-pax vessels - vessels carrying rolling cargo, where the cargo is driven on and off the vessel by vehicle drivers themselves, car and truck traffic, significantly higher number of passengers than on ro-ro vessels.
- car carriers - cargo vessels carrying cars as cargo, the cars in this case do not have their own driver
- domestic ferries - smaller ferries that need more than 15 minutes to cross waters within a country or between two closely adjacent countries, also transporting vehicles. Depending on the route, the size of these ships varies significantly.

The analysis is limited to Europe. For the study period 2010 to 2019, approximately 700 ships were identified that belong to the above-mentioned group and are permanently underway in European waters. They are spread over as follows:

ferry company	vessels	source
Adria Ferries	3	https://www.adriaferries.com/it/navi-italia-albania-adria-ferries.html
Aegean Speed Lines	1	https://www.aegeanspeedlines.gr/site/eng/
Africa Morocco Link	3	https://www.aml.ma/de/uber-uns/flotte.html
Albania Ferries	1	http://www.albaniaferries.it/index.php?option=com_content&view=article&id=163&Itemid=1183&lang=en
Algerie Ferries	4	https://algerieferries.dz/index.php/flotte
Anek Lines	9	https://www.anek.gr/de/journey/fleet/
Anes Ferries	3	https://www.anes.gr/en/stolos
Aktien-Gesellsch. "EMS"	4	https://www.ag-ems.de/die-flotte
Akgünler	1	http://www.akgunlerdenizcilik.com/filomuz/
Balearia	21	https://www.balearia.com/de/flotte
Blu Navy	2	https://blunavytraghetti.com/de/die-flotte/
Blue Star Ferries	9	https://www.bluestarferries.com/en/about-us/the-fleet/our-ships.html
Bluvia/Bluferries	4	http://www.bluferries.it/laflootta.html
Bornholmslinjen	3	https://www.bornholmslinjen.de/unternehmen/faehren/
Brittany Ferries	12	https://www.brittany-ferries.co.uk/ships
Caronte & Tourist	10	https://carontetourist.it/en/caronte/fleet
Color Line	7	https://www.colorline.de/ueber-uns/ueber-color-line/unsere-schiffe
Condor Ferries	4	https://www.condorferries.co.uk/ships-onboard/our-fleet
Corsica Ferries	13	https://www.corsica-ferries.de/fahren/korsika.html
Corsica Linea	7	https://www.corsicalinea.com/eng
CTN Ferries	6	https://www.ctn.com.tn/
Destination Gotland	6	https://gotlandsbolaget.se/en/publikationer/m-s-visborg/
DFDS Seaways	38	https://www.dfds.com/en/about/media/media-library
Dodekanisos Seaways	3	http://www.12ne.gr/en/
Eckerö Line	2	https://www.eckeroline.com/cargo
European Seaways	2	http://www.europeanseaways.com/
Finnlines	20	https://www.finnlines.com/company/about-us/our-fleet
Fjord1	87	https://www.fjord1.no/eng/About-Fjord1-ASA/Our-vessels
Fjord Lines	4	https://www.fjordline.com/de/p/unsere-schiffe
Förde Reederei Seetouristik FRS	27	https://www.frs.world/de/frs-fleet
ForSea	5	https://www.forseaferry.com/about-forsea/ferries-and-port/
Fred Olsen Express	8	https://www.fredolsen.es/en/fred-olsen-experience/fleet
Golden Star Ferries	4	https://goldenstarferries.gr/en/our-fleet/
Grandi Navi Veloci	11	https://www.gnv.it/de/gnv/flotte.html
Grimaldi Lines	15	https://www.grimaldi-lines.com/de/page/die-flotte
Hellenic Seaways	10	https://hellenicseaways.gr/en/
Höegh Autoliners	47	https://www.hoeghautoliners.com/fleet
Hurtigruten ASA	10	https://www.hurtigruten.de/schiffe/#shipfacilities=17395
Irish Ferries	4	https://www.irishferries.com/de/to-ireland-from-france/
Jadrolinija	37	https://www.jadrolinija.hr/de/faehren-kroatien
Kefalonianlines	2	https://kefalonianlines.com/our-fleet/
La Meridionale	3	https://www.lameridionale.com/rubrique/our-ships-27.html
Laziomar	6	http://www.laziomar.it/viaggia-con-noi/la-flotta
Maestro Shipping	2	https://www.maestrosipping.com/service/ro-ro/
Mann Lines	2	https://www.mannlines.ee/ro-ro.html#239eng
Maregiglio	2	https://www.maregiglio.it/la-flotta.html#MG
Medmar	8	https://www.medmargroup.it/la-compagnia/la-flotta

Minoan Lines	6	https://www.minoan.gr/de/kreta
Moby Lines	15	https://www.mobylines.de/die-reederei/schiffe/
Molslinjen	3	https://www.molslinjen.dk/om-molslinjen/hurtigfaerger/
Montenegro Lines	3	http://www.montenegrolines.com/?sesslng=deu
Naviera Armas	15	https://www.navieraarmas.com/en/fleet
Neue Pellwormer Dampfschiffahrts-GmbH	1	https://www.fahre-pellworm.de/
Norled	44	https://www.norled.no/en/about-norled/contact-us/contact-ferries/
Nor Lines	4	https://norlines.no/en/who-we-are/operational-equipment/ships/
Northlink Ferries	3	https://www.northlinkferries.co.uk/shiplans/
P&O Ferries	20	https://www.pofreight.com/AboutUs
Pentland Ferries	1	https://www.pentlandferries.co.uk/the-pentalina/
Polferries	5	https://polferries.de/fahrschiffe/
Porto Santo Line	1	https://www.portosantoline.pt/index.php?option=com_content&view=category&layout=blog&id=5&Itemid=14&lang=de
Praamid	5	https://www.praamid.ee/wp/ferry-leiger/?lang=en
Rodne Fjord Cruise	3	https://rodne.no/en/our-fleet/
Reederei Baltrum-Linie	1	https://www.baltrum-linie.de/
Rømø-Sylt-Linie	2	https://www.syltfaehre.de/
Salamis Lines	3	http://www.salamisshipping.com/en/shipping-services-in-cyprus/guarantee291
Saronic Ferries	5	https://www.sf.gr/eng/fleet
Scandlines	8	https://www.scandlines.de/uber-scandlines/uber-scandlines-titelseite/fahren-und-hafen
Seajets	14	https://www.seajets.gr/learn-about-seajets/fleet
Siremar	15	https://carontetourist.it/en/siremar/fleet
St Peter Line	1	https://stpeterline.com/princess-anastasia/an-bord#interactive-ferries-anchor
Steam Packet Company	2	https://www.steam-packet.com/ourvessels? SPCoWinID=f22beb9a-c8d9-485c-990d-85024ccd5971
Stena Line	13	https://www.stenaline.de/skandinavien/unsere-schiffe
Superfast Ferries	3	https://www.superfast.com/adriatiki/de/the-fleet-de.html
Tallink Silja	12	https://www.tallinksilja.de/faehrreisen
Tirrenia	14	https://www.tirrenia.de/schiffe/
Toremar	7	https://www.toremar.it/de/toremar/die-flotte.html
Transmediterranea	19	https://www.trasmediterranea.es/en/fleet
TT Lines	6	https://www.ttline.com/de/passage/an-bord/tt-line-schiffe/
Unity Line	7	http://www.unityline.de/ferries
Ventouris Ferries	4	https://ventourisferries.com/en/fleet/
Viking Line	7	https://www.vikingline.de/reise-finden/unsere-schiffe/
Virtu Ferries	3	http://www.virtuferries.com/?page_id=42
Wasaline	1	https://www.wasaline.com/en/our-ferry/
Wightlink	6	https://www.wightlink.co.uk/go/meet-our-fleet/
Wyker Dampfschiffs-Reederei Föhr-Amrum	5	https://www.fahre.de/
Zante Ferries	2	https://zanteferries.gr/?lang=en
total	734	

Table 1: Car-carrying vessels in Europe, as of September 2019. In the list, the exact distinction between ro-ro and ro-pax has been omitted, as allocations cannot always be made unambiguously. However, the total number includes 47 car carriers and 127 domestic ferries.

Table 1 shows the distribution of car-carrying ships in Europe among the various shipping companies. The data is a snapshot (September 2019) and can change at any time given the quantity of shipping companies. However, the basic statement remains that there are approximately 700 car-carrying vessels in Europe at any given time. The European Maritime Safety Agency, EMSA assumes in its study [1] that there are 490 ships, but the car carriers and a part of the domestic ferries were not considered.

An extensive internet search was conducted on incidents involving vessels in the group under consideration over the last ten years (2010 to 2019). In the process, 915 incidents were identified and recorded in detail. According to the type of accident or damage, the following was found:

(rear end) accident <i>(Auffahr)Unfall</i>	3
blackout <i>Stromausfall</i>	28
fire <i>Brand</i>	37
fire on car deck <i>Brand auf dem Fahrzeugdeck</i>	36
leakage of hazardous substances <i>Gefahrstoffaustritt</i>	5
grounding <i>Grundberührung</i>	125
collision <i>Kollision</i>	323
unable to maneuver <i>manövrierunfähig</i>	55
fire inside engine room <i>Maschinenraumbrand</i>	54
damages to the engine <i>Maschinenschaden</i>	121
damages to the ramp <i>Rampenschaden</i>	29
smoke development <i>Rauchentwicklung</i>	14
crack in the hull <i>Riss im Rumpf</i>	2
list <i>Schlagseite</i>	3
technical problems <i>technische Probleme</i>	48
slipped cargo <i>verrutschte Ladung</i>	16
ingress of water <i>Wassereinbruch</i>	16

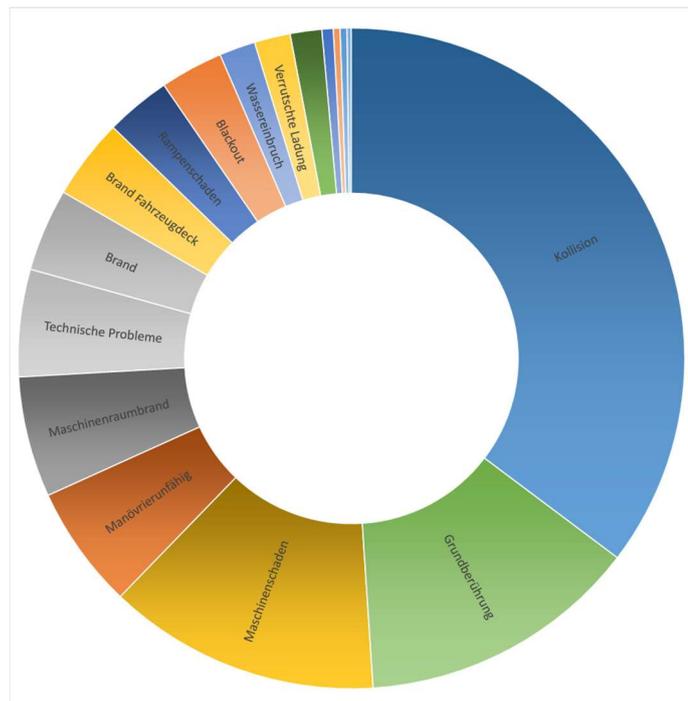


Table 2: Allocation of accidents causes of car-carrying vessels in Europe, 2010 to 2019 (915 incidents in total).

Considered by type of ship, statistics for the accidents recorded are as follows:

type of ship	total number of accidents	thereof collisions
ro-ro / ro-pax	281	103
domestic ferry	589	205
car carrier	45	15
	915	323

Table 3: Allocation by type of ship, share of collisions

Tables 2 and 3 show that collisions in particular are a frequent cause of accidents and that domestic ferries in particular have frequent accidents. Collisions mainly take place in port, as the following diagram shows:

collision with <i>Kollision</i>	
a boat <i>mit Boot</i>	7
pier <i>mit Pier</i>	212
a ship inside port <i>mit Schiff im Hafen</i>	70
a ship underway <i>mit Schiff in Fahrt</i>	16
a lock <i>mit Schleuse</i>	10
other <i>mit Sonstigen</i>	7
a buoy <i>mit Tonne</i>	1
	323

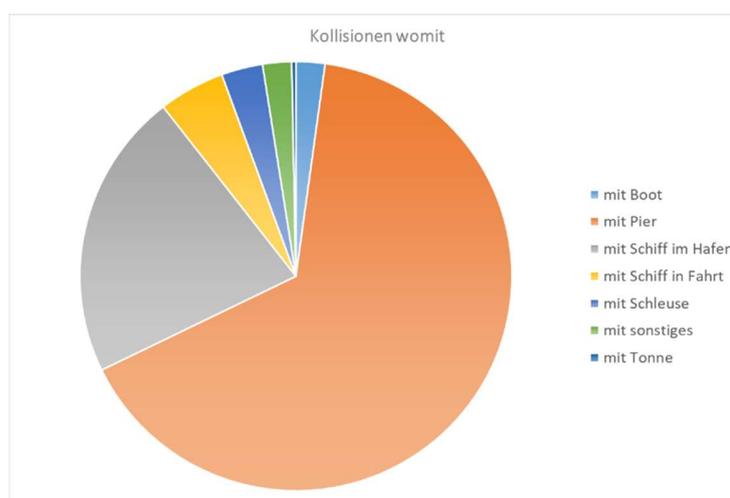


Table 4: Representation of the collision opponents

A particular relevance to the ALBERO project was the identification of accidents in which a damage of a vehicle occurred. In this regard, the investigation was able to identify 83 cases in which the media report explicitly referred to damages to vehicles. Table 5 shows that collisions, severe weather, and ramp damages are the main causes of mechanical damages to vehicles. Additionally, damage to vehicles is naturally expected when there is a fire on the car deck.

type of accident	total number	vehicles damaged (83)
(rear end) accident	3	2
vessel on fire	37	1
car deck on fire	36	36
collision	323	20
damages to the ramp	29	4
smoke development	14	3
slipped cargo	16	16
ingress of water	16	1

Table 5: Accidents with vehicle damage (according to media report), only those types of accidents were included in the table where vehicle damage was reported, for the remaining types of accidents listed in Table 2, no vehicle damage was reported.

However, a significantly higher number of incidents with vehicle damage must be assumed, as often only general statements such as "There was high property damage" could be found.

The following pictures show how badly vehicles can be damaged in accidents at sea:



Figure 1: European Causeway damaged by severe weather (December 2018)

Source: <https://www.irishexaminer.com/breakingnews/ireland/cars-crushed-after-lorries-overturn-on-ferry-sailing-from-the-north-to-scotland-892854.html>



Figure 2: Accident of the "Epsilon" due to heavy weather (February 2016)

Source: <https://www.thejournal.ie/irish-ferry-damage-storm-imogen-2596991-Feb2016/#slide-slideshow2>



Figure 3: Accident of the "St. Helen" due to ramp breakage (February 2016)

Sources:

<https://www.islandecho.co.uk/accident-report-into-wightlinks-deck-collapse-published/>

https://assets.publishing.service.gov.uk/media/56b0ded8e5274a2508000010/MAIBInvReport1_2016.pdf

In the event of such severe damage to vehicles, it can be assumed that the vehicle battery of an electric car will also be damaged and that fires may result. At the same time, however, the risk of damage in the event of such an accident is the same for all vehicle types, e.g. cars with diesel or gasoline engines can also be damaged accordingly and consequential damage can occur. The risk of damage due to accidents during the crossing is therefore definitely present, but it is no higher or lower for alternatively powered vehicles than for other vehicles.

Summary

Within the study, 915 accidents involving car-carrying vessels were recorded for the past ten years. These are spread over approximately 700 ships throughout Europe. In statistical terms, this results in a value of approximately 0.13 accidents per vessel and year. In 83 of the recorded accidents, a damage to transported vehicles was reported; a higher number can be assumed. The main causes of mechanical damage to vehicles were collisions and slipped cargo due to heavy weather. Other damage to vehicles occurred mainly due to fires on the car deck. Basically, the risk of damage is the same for all vehicle types.

Literature

- [1] Study investigating cost effective Measures for reducing the risk from fires on ro-ro passenger ships (FIRESAFE) EMSA OP 01/2016, Report 6P05070-1