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Transport of Dangerous Goods by Sea on Ro-Ro and Ro-Pax Vessels – Application of IMDG Regulations in Practice

Keywords: transport, maritime logistics, dangerous goods, legal regulations, safety

Introduction

The transport of dangerous goods (DG) is a key element of the global supply chain, regulated on land by the ADR (Accord Dangereux Routier) and at sea by the IMDG code (International Maritime Dangerous Goods Code). The IMDG Code adapts the ADR regulations to the specific requirements of maritime transport, ensuring safety and consistency in trade. This code contains guidelines regarding classification, packaging, labelling, documentation, and emergency procedures.[1] Transport of dangerous goods requires strict compliance with IMDG regulations, which encompass loading, unloading, packaging, and labelling.[2] Documentation must include details about the goods and procedures to be followed in the event of an emergency. This research aims to analyse the practical aspects of applying the IMDG regulations on Roll-on/Roll-off (Ro-Ro)

1 Meike Schröder, Gunnar Prause, "Transportation of Dangerous Goods in Green Transport Corridors – Conclusions from Baltic Sea Region," *Transport and Telecommunication* 17 (2016), 4: 322–334, DOI: 10.1515/ttj-2016-0029.

2 Jan Hołowiński, *Umowa o przewóz ładu nku drogą morską. Istota i charakter prawny* (Gdynia: Wydawnictwo Morskie, 1964).

and Roll-on/Roll-off[3] passenger (Ro-Pax)[4] vessels, in order to enhance the safety of transporting dangerous goods and to improve collaboration among the entities involved.[5] Legal regulation analysis methods, process modeling, as well as data from relevant literature, and cooperation with the shipowner, were utilized.[6] The findings are presented in descriptive, graphic, and tabular forms.[7]

Legal Framework for Transporting Dangerous Goods (DG)

Characteristics of International Legal Regulations

Transporting dangerous goods is governed by international agreements and regulations that ensure uniform safety standards.[8] The key regulations in this area depend on the mode of transport used:

- ADR, the European Agreement concerning the International Carriage of Dangerous Goods by Road,
- RID, the Regulations concerning the International Carriage of Dangerous Goods by Rail,
- ADN, the European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways. [9]

The history of legal regulations concerning the transport of dangerous goods dates back to the mid-twentieth century. The first step was the creation of the ADR Agreement, aimed at harmonising regulations related to the road transport of dangerous goods across Europe.[10] In subsequent years, with technological advancements and growth of international trade, it became necessary to regularly update these regulations.

3 Stefan Dahlbom et al.,"Fire Risk Model for Fires in Ro-Ro Ship Ro-Ro Spaces," *Journal of Risk Analysis and Crisis Response* 14 (2024), 3: 147–162, DOI: 10.54560/jracr.v14i3.503.

4 Edward Czermański, Żegluga promowa w regionie morza bałtyckiego w układzie północ – *Południe* (Gdańsk: Uniwersytet Gdański Wydział Ekonomiczny, 2010).

5 Francisco Rodero, and María Casal, ed. "Fire Hazard Reduction in Ro-Ro Spaces by Means of Using a Water Mist System," *Safety Science* 166 (2023): 106205, DOI: 10.1016/j.trpro.2023.11.092.

6 Baolin, Bian et al., "A Hybrid Approach for Quantitative Analysis of Fire Hazards in Enclosed Vehicle Spaces on Ro-Ro Passenger Ships," *Sustainability* 15, (2023), 17: 13059, DOI: 10.3390/su151713059.

7 Kihyun Kim and Hyunjoo Jeon, "The Causes and Responses to Cargo Hold Fire Accidents in Ro-Ro Ships Using AcciMap," *Journal of International Maritime Safety, Environmental Affairs, and Shipping* 7 (2023), 4: 214–227, DOI: 10.1080/25725084.2023.2274227.

8 Andrzej Salomon, *Spedycja w handlu morskim. Procedury i dokumenty* (Gdańsk: Wydawnictwo Uniwersytetu Gdańskiego, 2004), 87.

9 Agnieszka Skowrońska and Marek Suchecki, *Zarządzanie przewozami ładunków niebezpiecznych* (Wrocław: Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu, 2022), 12–20.

10 Eugeniusz Gostomski and Tomasz Nowosielski, *Międzynarodowy handel morski* (Gdańsk: Wydawnictwo Uniwersytetu Gdańskiego, 2020), 167.

New classifications of hazardous substances were introduced, along with detailed packaging and safety procedure requirements.

The ADR provisions specify detailed requirements for transport of dangerous goods, which include their classification. Goods are classified according to the types of hazards they pose, which is crucial for appropriate risk management. They set forth safety requirements and emergency procedures designed to minimise risk in the event of an accident or failure. The global transport of dangerous goods is regulated by a set of international regulations. In the context of maritime transport, such operations are regulated by the International Maritime Dangerous Goods Code (IMDG).[11] Although the two systems differ in their transport-specific details, they share a common objective: to ensure safety in the transport of hazardous materials.[12]

The IMDG Code was developed by the International Maritime Organization (IMO) and regulates the transport of dangerous goods by sea. The Code, like the ADR, covers the classification of dangerous goods, packaging, labelling, documentation, and emergency procedures.[13] The IMDG is a key document for shipowners, carriers, and all participants in maritime transport as it provides consistent safety standards on an international scale.[14]

European Union Regulations on the Transport of Dangerous Goods

The transport of dangerous goods within Europe is strictly regulated by a series of legal provisions to ensure the safety of people, the environment, and infrastructure. The main legal act governing the road transport of dangerous goods in Europe is the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR).[15] It is updated every two years to reflect new technologies, materials, and best practices in the transport of dangerous goods.

11 Grzegorz Nowacki, Cezary Krysiuk, Rafał Kopczewski, "Dangerous Goods Transport Problems in the European Union and Poland," *TransNav – International Journal on Marine Navigation and Safety of Sea Transportation* 10 (2016), 1: 37–42, DOI: 10.12716/1001.10.01.16.

12 Samuel C. Orzechowski, *Learning from Regulation in Air, Rail, Road and Sea Transport* (Springer: Marine Policy, 2025), 43–44.

13 Matej Renčelj, Andrej Zorić and Bojan Jakšić, "Assessment of Dangerous Goods Transport: Case Western Balkans," *Sustainability* 17 (2025), 3: 891.

14 Beata Janicka, "FIATA Documents," in: *Freight Forwarder's Handbook: Transport, Forwarding and Logistics*, ed. Danuta Marciniak-Neider and Janusz Neider, vol. 1 (Gdynia: Polish International Freight Forwarders Association, 2014), 153–168.

15 Grzegosz Nowacki and Marek Chmieliński, "Analiza transportu towarów niebezpiecznych w państwach członkowskich Unii Europejskiej," *Autobusy. Technika, Eksploatacja, Systemy Transportowe* 9 (2017): 104–111.

The most comprehensive EU legal act is Directive 2009/45/EC of the European Parliament and of the Council of 6 May 2009 on safety rules and standards for passenger ships, which covers passenger ships of 24 metres in length and above, constructed of steel or equivalent material, as well as high-speed craft, regardless of their length. The objective of this Directive is to establish a uniform level of safety rules for the protection of life and property on passenger ships and high-speed passenger craft, both new and existing, operating in domestic navigation, and to establish negotiation procedures at the international level to harmonise the rules applicable to passenger ships engaged in international navigation. In addition to the above, the following documents containing detailed provisions applicable to Ro-Ro passenger ships, including Ro-Pax vessels, high-speed craft, and the registration of persons on board are in force within the European Union:

- Directive 2003/25/EC of the European Parliament and of the Council on specific stability requirements for Ro-Ro passenger ships,
- Council Directive 1999/35/EC of 29 April 1999 on a system of mandatory surveys for the safe operation of regular Ro-Ro ferry and high-speed passenger craft services,
- Council Directive 98/41/EC of 18 June 1998 on the registration of persons sailing on board passenger ships operating to or from ports of the Member States of the Community.

In 2017, the European Commission published three directives regulating the safety of passenger ships, the rules for registering persons travelling on board passenger ships, and the safety of Ro-Ro and Ro-Pax passenger ships. The overarching goal was to create a clear legal framework that would be easier to apply, monitor, and enforce, thereby reducing the overall level of risk.

The safety of passenger ships in the EU is regulated at three levels: international, EU, and national. At the international level, the IMO has established regulations for passenger ships, which are included in, among others:

- The International Convention for the Safety of Life at Sea, 1974 (SOLAS Convention, 1974), concerns, among other things, requirements for damage stability of the Ro-Ro units, as well as common safety standards for stability, machinery, electrical installations, fire protection, and life-saving appliances on passenger ships, i.e., ships carrying more than twelve passengers,
- The International Convention on Load Lines, 1966, under which international conventions and some EU regulations apply to ships engaged in international voyages. For ships operating on domestic voyages, EU and national regulations apply.

Systematisation of the Content Directives and the Maritime Code in Relation to the Transport of Dangerous Goods

According to the Act of 1 December 1961 – the Maritime Code, the requirements ensuring the safety of maritime transport of dangerous goods are defined, in particular the packaging, marking, storage, transhipment, transport within the port, stowage, and sea carriage of these materials. Dangerous materials are goods that may, by themselves or under the influence of external factors, pose a threat to human life, health, or property. The Maritime Offices supervise the safety of maritime transport of dangerous goods. Dangerous materials are divided, according to the nature of the hazard, into the following classes and subclasses.. The classification is used in all cases where it is required to determine the properties of dangerous materials in maritime transport:

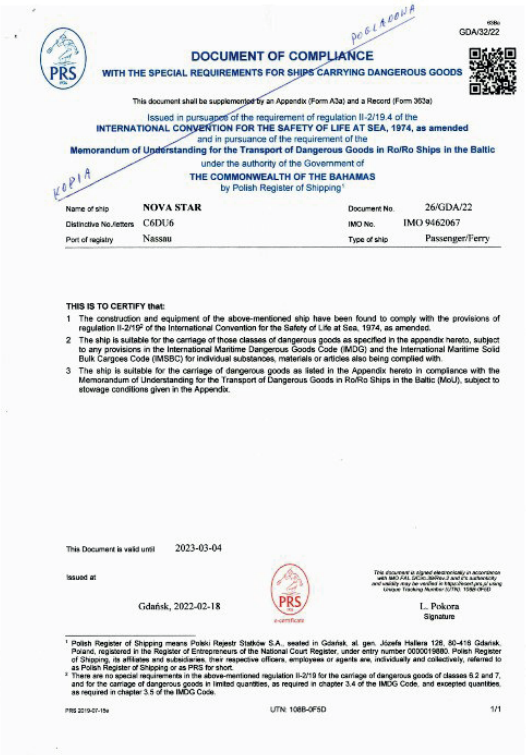
- class 1 – explosives,
- class 2 – flammable, non-flammable (non-toxic), toxic gases,
- class 3 – flammable liquids,
- class 4 – flammable materials: flammable solids, self-igniting materials, materials that emit easily flammable gases upon contact with water,
- class 5 – oxidizing materials and organic peroxides,
- class 6 – toxic and infectious materials,
- class 7 – radioactive materials,
- class 8 – corrosive materials,
- class 9 – miscellaneous other hazardous materials and articles not included in other classes but which display hazardous properties.

Each ship undergoes a classification process every year, which aims to confirm its compliance with safety requirements and its suitability to carry specific cargoes. In the case of vessels registered in Poland, classification is carried out by the Polish Register of Shipping S.A. (PRS).[16] As part of this assessment, PRS issues a classification certificate, which specifies what types of cargo can be carried on a given ship and identifies the decks for this purpose.[17] For the ship examined, the certificate indicates that the authorisation to carry dangerous goods covers only decks 3 and 5 (Fig. 1). This document contains a detailed list of the classes of dangerous goods per the IMDG Code, which may be carried on a given deck. In addition, it contains information on exceptions and limitations that may apply to specific cargoes or transport conditions.[18]

16 Stanisław Matysik, *Prawo morskie. Zarys systemu*, vol. 2 (Warszawa: Wydawnictwo Polskiej Akademii Nauk, 1973), 55.

17 Marek Chmieliński, "Requirements Regarding Safety Maritime Transport of Dangerous Goods Class 1," *TransNav – International Journal on Marine Navigation and Safety of Sea Transportation* 17 (2023), 2: 287–294, DOI: 10.12716/1001.14.01.13.

18 Jarosław Kabus, "Analiza operacji transportowej. Studium przypadku," *Zarządzanie i Jakość* 5 (2023), 1: 33–43.



KOPIA

GDA/32/22

DOCUMENT OF COMPLIANCE
WITH THE SPECIAL REQUIREMENTS FOR SHIPS CARRYING DANGEROUS GOODS

This document shall be supplemented by an Appendix (Form A3a) and a Record (Form 363a)

Issued in pursuance of the requirement of regulation II-2/19.4 of the
INTERNATIONAL CONVENTION FOR THE SAFETY OF LIFE AT SEA, 1974, as amended
and in pursuance of the requirement of the
Memorandum of Understanding for the Transport of Dangerous Goods in Ro/Ro Ships in the Baltic
under the authority of the Government of
THE COMMONWEALTH OF THE BAHAMAS
by Polish Register of Shipping[1]

Name of ship	**NOVA STAR**	Document No.	26/GDA/22
Distinctive No./letters	C6DU6	IMO No.	IMO 9462067
Port of registry	Nassau	Type of ship	Passenger/Ferry

THIS IS TO CERTIFY that:

1 The construction and equipment of the above-mentioned ship have been found to comply with the provisions of regulation II-2/15P of the International Convention for the Safety of Life at Sea, 1974, as amended.
2 The ship is suitable for the carriage of those classes of dangerous goods as specified in the appendix hereto, subject to any provisions in the International Maritime Dangerous Goods Code (IMDG) and the International Maritime Solid Bulk Cargoes Code (IMSBC) for individual substances, materials or articles also being complied with.
3 The ship is suitable for the carriage of dangerous goods as listed in the Appendix hereto in compliance with the Memorandum of Understanding for the Transport of Dangerous Goods in Ro/Ro Ships in the Baltic (MoU), subject to stowage conditions given in the Appendix.

This Document is valid until 2023-03-04

Issued at Gdańsk, 2022-02-18

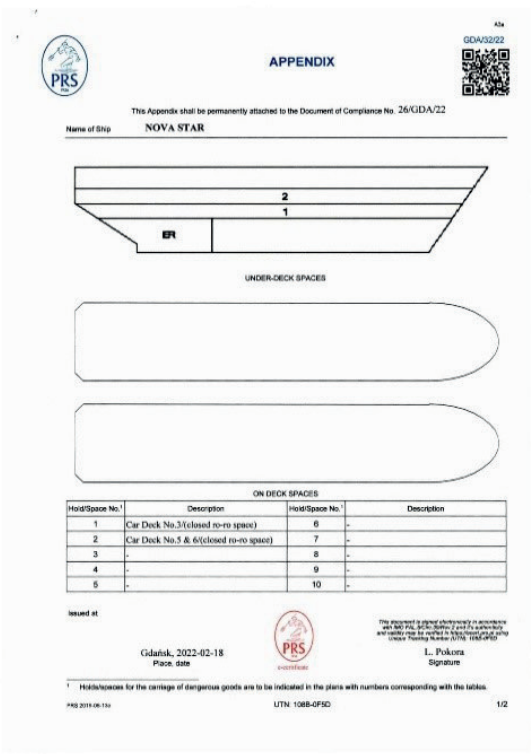
e-certificate

This document is signed electronically in accordance with IMO FAL.5/Circ.39/Rev.2 and it's authenticity and validity may be verified in https://eseal.prs.pl using Unique Tracking Number (UTN): 108B-0F5D

L. Pokora
Signature

[1] Polish Register of Shipping means Polski Rejestr Statków S.A., seated in Gdańsk, al. gen. Józefa Hallera 126, 80-416 Gdańsk, Poland, registered in the Register of Entrepreneurs of the National Court Register, under entry number 0000019880. Polish Register of Shipping, its affiliates and subsidiaries, their respective officers, employees or agents are, individually and collectively, referred to as Polish Register of Shipping or as PRS for short.
[2] There are no special requirements in the above-mentioned regulation II-2/19 for the carriage of dangerous goods of classes 6.2 and 7, and for the carriage of dangerous goods in limited quantities, as required in chapter 3.4 of the IMDG Code, and excepted quantities, as required in chapter 3.5 of the IMDG Code.

PRS 2219-07-15a UTN: 108B-0F5D 1/1



A3a

GDA/32/22

APPENDIX

This Appendix shall be permanently attached to the Document of Compliance No. 26/GDA/22

Name of Ship **NOVA STAR**

UNDER-DECK SPACES

ON DECK SPACES

Hold/Space No.[1]	Description	Hold/Space No.[1]	Description
1	Car Deck No.3/(closed ro-ro space)	6	-
2	Car Deck No.5 & 6/(closed ro-ro space)	7	-
3	-	8	-
4	-	9	-
5	-	10	-

Issued at Gdańsk, 2022-02-18
Place, date

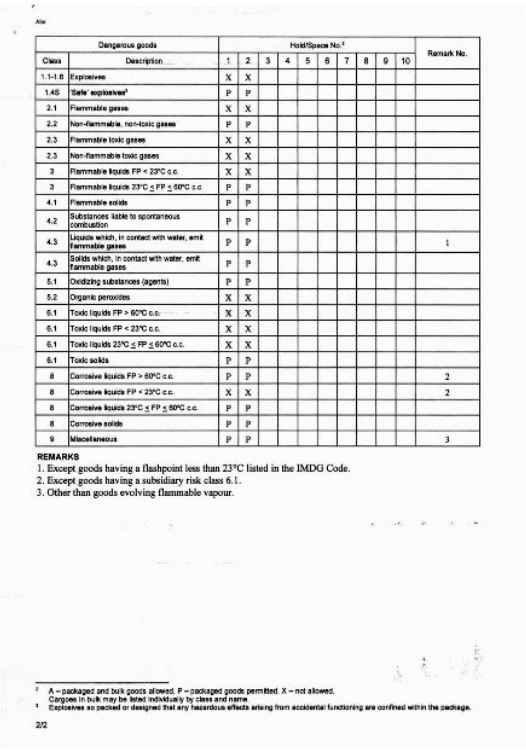
e-certificate

This document is signed electronically in accordance with IMO FAL.5/Circ.39/Rev.2 and it's authenticity and validity may be verified in https://eseal.prs.pl using Unique Tracking Number (UTN): 108B-0F5D

L. Pokora
Signature

[1] Holds/spaces for the carriage of dangerous goods are to be indicated in the plans with numbers corresponding with the tables.

PRS 2011-06-13a UTN: 108B-0F5D 1/2



A3a

Dangerous goods		Hold/Space No.[2]										Remark No.
Class	Description	1	2	3	4	5	6	7	8	9	10	
1.1-1.6	Explosives	X	X									
1.4S	Safe' explosives[3]	P	P									
2.1	Flammable gases	X	X									
2.2	Non-flammable, non-toxic gases	P	P									
2.3	Flammable toxic gases	X	X									
2.3	Non-flammable toxic gases	X	X									
3	Flammable liquids FP < 23°C c.c.	X	X									
3	Flammable liquids 23°C ≤ FP ≤ 60°C c.c.	P	P									
4.1	Flammable solids	P	P									
4.2	Substances liable to spontaneous combustion	P	P									
4.3	Liquids which, in contact with water, emit flammable gases	P	P									1
4.3	Solids which, in contact with water, emit flammable gases	P	P									
5.1	Oxidizing substances (agents)	P	P									
5.2	Organic peroxides	X	X									
6.1	Toxic liquids FP > 60°C c.c.	X	X									
6.1	Toxic liquids FP < 23°C c.c.	X	X									
6.1	Toxic liquids 23°C ≤ FP ≤ 60°C c.c.	X	X									
6.1	Toxic solids	P	P									
8	Corrosive liquids FP > 60°C c.c.	P	P									2
8	Corrosive liquids FP < 23°C c.c.	X	X									2
8	Corrosive liquids 23°C ≤ FP ≤ 60°C c.c.	P	P									
8	Corrosive solids	P	P									
9	Miscellaneous	P	P									3

REMARKS
1. Except goods having a flashpoint less than 23°C listed in the IMDG Code.
2. Except goods having a subsidiary risk class 6.1.
3. Other than goods evolving flammable vapour.

[2] A – packaged and bulk goods allowed. P – packaged goods permitted. X – not allowed.
Cargoes in bulk may be listed individually by class and name.
[3] Explosives so packed or designed that any hazardous effects arising from accidental functioning are confined within the package.

2/2

Figure 1. Compliance document certifying the carriage of dangerous goods

Source: Own elaboration based on materials obtained from the ship-owner, accessed 17.09.2025, https://prs.ms.gov.pl/.

This classification ensures that shipowners and the ship's crew have clear guidelines ensuring compliance with safety regulations and minimising the risks associated with the transport of dangerous goods.

Considering the regulations in force in Poland, in addition to the Maritime Code, they are supplemented by the Maritime Safety Act, introduced in 2011.[19] Its provisions complement the Maritime Code, ensuring a comprehensive approach to safety. The Act also imposes obligations on shipowners and captains to comply with safety regulations and international standards, particularly SOLAS and the IMDG Code. An important aspect is the origin of the vessel transporting dangerous goods. A ship operating in Polish waters may fly the flag of another country, in which case the regulations of that country apply; conversely, a ship flying the Polish flag in the Mediterranean Sea, is subject to Polish regulations. Another crucial legal consideration involves the internal regulations established by shipowners and carriers.

Documentation for Dangerous Goods

Dangerous Goods Declaration (DGN)

All documents related to the maritime transport of hazardous materials, such as bills of lading, waybills, manifests, cargo lists, mate's receipts, notices, storage receipts, orders, instructions, and Dangerous Goods Note (DGN), must include all necessary information to ensure transparency for each shipment. The classification of the material in the DGN (also referred to as Dangerous Goods Declaration) must correspond to its designated class and include the number assigned by the United Nations Committee of Experts on the Transport of Dangerous Goods, known as the UN number.

Cargo documentation, prepared by the shipper, must include a declaration confirming that the hazardous materials have been properly packaged and labelled. When loading takes place in a foreign port, the ship's captain is required to request the presentation of such a certificate. A manifest or a special dangerous goods list, detailing these materials and their stowage locations, must be kept on board. For hazardous materials that may be transported in limited quantities, all shipments must be reported to the carrier at least 24 hours in advance, and vehicles must be properly marked. Drivers are required to carry a physical copy of the DGN document at all times. Stowage operations may only be carried out under the supervision of the appropriate officers, depending on the category of materials. During cargo handling, it is recommended

19 Janusz Neider, *Transport międzynarodowy* (Warszawa: Polskie Wydawnictwo Ekonomiczne, 2018), 143–158.

that hazardous materials be unloaded first and loaded last. The ship's captain is also required to provide the crew with written instructions on handling dangerous goods before the voyage begins.

The requirement to hold a DGN extends beyond mere legal compliance. The document serves several key functions, such as informing logistics and freight forwarding companies about the proper handling, storage, and transport of dangerous goods. It also serves to inform port authorities, who must be aware of the hazardous nature of the cargo to ensure appropriate safety measures during unloading and storage. Apart from ships carrying dangerous goods, the DGN is also used by customs offices and emergency services. Customs officials and recipients rely on the DGN to process cargo properly and ensure regulatory compliance, while emergency responders use it to implement appropriate response measures in the event of an accident or spill.

Most Common Errors in Completing the DG Declaration for Dangerous Goods Transport on Ro-pax Vessels

In the context of analysing the accuracy of declarations for the transport of dangerous goods (DG) on Ro-Pax vessels operating between Poland and Sweden, the Delphi method was used to gather comprehensive knowledge from specialists across various areas of maritime transport. Data collected in October 2024, based on the authors' observations, source materials from onboard documentation, and in-depth interviews with representatives of the Cargo Departments in both Polish and Swedish ports, as well as with the Chief Officer and a Safety Specialist, served as the foundation for identifying the most common errors in DG transport documentation.[20]

Experts emphasise that maintaining the correct order and completeness of data in the Dangerous Goods Note (DGN) is crucial for ensuring regulatory compliance and transport safety. Observations and interview data from the Cargo Department indicate frequent omissions of critical information, such as the UN number, hazard class, proper shipping name, and packing group. Experts attribute this issue mainly to carelessness and insufficient familiarity with IMDG Code guidelines among personnel responsible for documentation. Additionally, specialists highlighted the importance of specifying the flashpoint for flammable materials (below 60°C). Interviews with port staff and the safety specialist revealed that failing to provide this information—often due to a lack of awareness of potential hazards—poses a risk to the entire maritime transport process. Furthermore, experts unanimously stressed the necessity of including the term

20 Edward Czermański, "Żegluga promowa w regionie Morza Bałtyckiego w układzie północ–południe," *Współczesna Gospodarka* 3 (2010): 68–81.

"marine pollutant" when declaring dangerous goods that pose a threat to the marine environment. Omitting this information, which is relatively common, can lead to serious legal and environmental consequences.

Interviews with Cargo Department employees and data analysis also revealed that shipments of waste often lack the required designation before the shipment name, as mandated by IMDG documentation. Experts consistently observed that the container packing certificate is frequently omitted or completed inadequately. This certificate confirms the proper loading of hazardous goods, and skipping this step increases the risk of accidents. Experts also confirmed that, for limited quantity goods, the absence of the "Limited Quantity" designation in documentation is a widespread issue, which complicates the work of loading personnel and constitutes a violation of IMDG regulations. Safety specialists recommend rigorously implementing this information in documentation to ensure proper cargo segregation and enhance operational compliance with regulations.

Transport Process Modelling

An example of the transport of dangerous goods in October 2024 on the Gdańsk–Nynäshamn route illustrates the process of shipping lithium batteries (UN3480) on a ferry. This type of cargo is classified under Class 9 of the IMDG Code, meaning it falls into the category of "miscellaneous dangerous substances and articles." The assigned EmS codes F-A and S-I correspond to emergency procedures in the event of fire (F-A) and spillage or substance release (S-I), which are crucial for the crew's emergency preparedness. The net weight of the cargo was 3,020 kg.

Based on PRS classification, this cargo was required to be placed on deck 3 or 5, as both decks meet the ventilation, security, and hazard control requirements essential for the safe transport of lithium batteries. Their transportation involves special precautions, as they can ignite or explode if damaged or overheated. The transport of dangerous goods, such as lithium batteries, on the Gdańsk–Nynäshamn Ro-Pax ferry is meticulously planned and carried out in strict accordance with safety procedures.

The transport process begins with the carrier booking a ticket for cargo shipment no earlier than 24 hours before the ferry's departure. During the booking process, detailed information must be provided, including cargo type, hazard classification, UN number, and packing group. The Cargo Department approves the reservation after consulting with the ship's crew to verify whether the transport of the specific dangerous goods is feasible. Once approved by this department, the reservation is finalised, and the carrier receives the final confirmation.

The driver must arrive at the port no later than three hours before the ferry departs. Upon arrival, the driver reports to the cargo department to verify their identity and receive a boarding pass. At this stage, they also complete the "Cargo Stowage and Securing Declaration" (Fig. 2), which confirms that the cargo has been properly secured for transport.

DEKLARACJA SZTAUOWANIA I MOCOWANIA ŁADUNKU
CARGO STOWAGE AND SECURING DECLARATION

NR REZERWACJI **RESERVATION NR**	

PORT DOCELOWY DESTINATION	YSTAD	COPENHAGEN	NYNASHAMN	ŚWINOUJŚCIE	GDAŃSK

NR CIĄGNIKA I NACZEPY TRUCK AND TRAILER NR				
DŁUGOŚĆ LENGHT				m
SZEROKOŚĆ WIDTH				m
WYSOKOŚĆ HEIGHT				m
RODZAJ NAPĘDU DRIVE TYPE	DIESEL	ELEKTRIC	HYBRID	GAS

RODZAJ ŁADUNKU TYPE OF CARGO			
WAGA ŁADUNKU WEIGHT OF CARGO			kg
ADR/IMDG	TAK YES	NIE NO	
PRZYŁĄCZE ELEKTRYCZNE 400V ELECTRICAL CONNECTION 400V	TAK YES	NIE NO	
KRAJ ZAŁADUNKU COUNTRY OF LOADING		KRAJ PRZEZNACZENIA COUNTRY OF DESTINATION	

Niniejszym deklaruję, że ładunek w w/w pojeździe/ kontenerze został właściwie zaszłauowany i zabezpieczony do transportu morskiego z uwzględnieniem Poradnika IMO/ILO dot.: Pakowania ładunku w pojazdach i kontenerach.
I hereby declare that the cargo on the above mentioned vehicle has been properly stowed and Secured for sea transport, by taking into account the IMO/ILO Guidelines for Packing Cargo In Freight Containers or Vehicle.

IMIĘ I NAZWISKO KIEROWCY NAME OF DRIVER		
IMIĘ I NAZWISKO 2 KIEROWCY NAME OF 2 DRIVER		
DATY URODZENIA DATES OF BIRTH		
NUMER TELEFONU PHONE NUMBER		
PODPIS SIGNATURE		
DATA DATE		

Figure 2. Sample Cargo Stowage and Securing Declaration

Source: Own elaboration based on shipowner's materials, accessed 17.09.2025, https://polferries.pl/.

Next, the vehicle transporting dangerous goods (DG) is marked accordingly. The driver places an ADR (IMDG) label on the front windscreen, completing it with the required information, including the UN number, cargo class, packing group, vehicle weight with cargo, and vehicle dimensions (Fig. 3). If the vehicle requires an external power connection (e.g. for refrigerated transport), the driver must also provide the transport temperature and vehicle weight using the Electric Connection label (Fig. 4).

Figure 3. Sample ADR (IMDG)

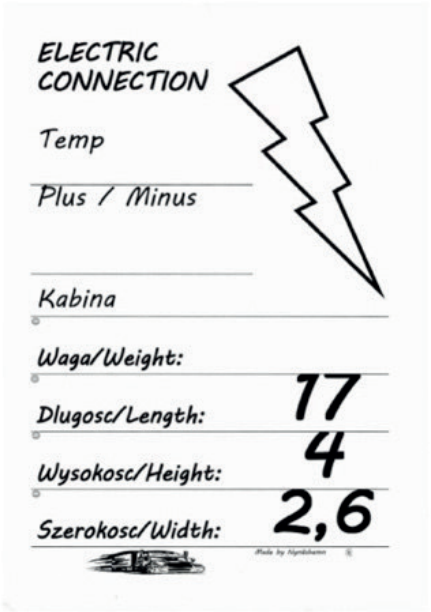


Figure 4. Sample Electric Connection Label

Source: Own elaboration on shipowner's materials, accessed 17.09.2025, https://polferries.pl/.

For the studied vessels, the loading and placement of cargo on the ferry are specific to each type of vehicle. On the M/F Wawel (operating on the Gdańsk–Nynäshamn route), dangerous goods are stowed on deck 4, specifically in sections AB, AC, AD, and AE (Fig. 5). This deck is semi-open, ensuring adequate ventilation and safety. Additionally, the deck is equipped with special chemical doors, which further isolate hazardous cargo from other shipments, minimising the risk of contact with substances that could pose a threat.

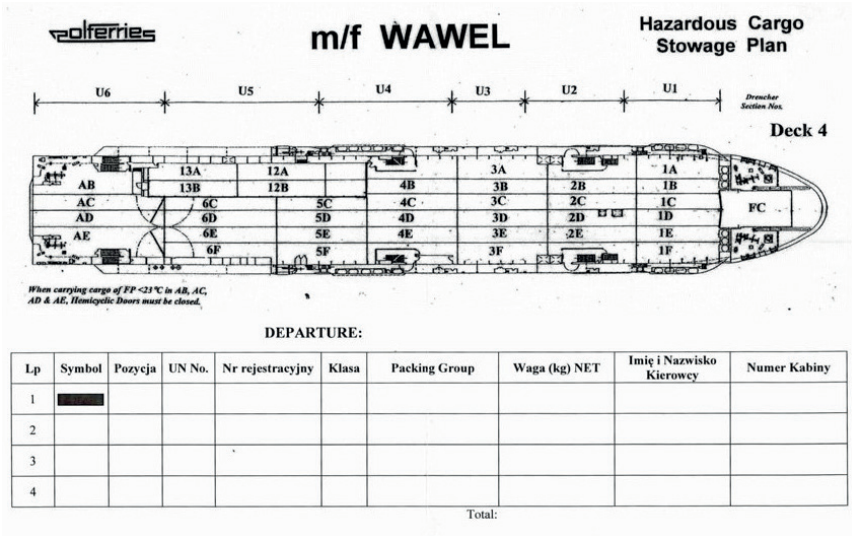


Figure 5. Dangerous Goods Placement on the Ship's Deck

Source: Own study based on shipowner's materials, accessed 17.09.2025, https://polferries.pl/.

Figure 6 illustrates the placement of dangerous goods (DG) on the M/F *Nova Star*, which operates on the same Gdańsk–Nynäshamn route. This vessel is equipped to transport hazardous cargo on decks 3 and 5, both of which are specifically designed and adapted for the safe carriage of such goods.

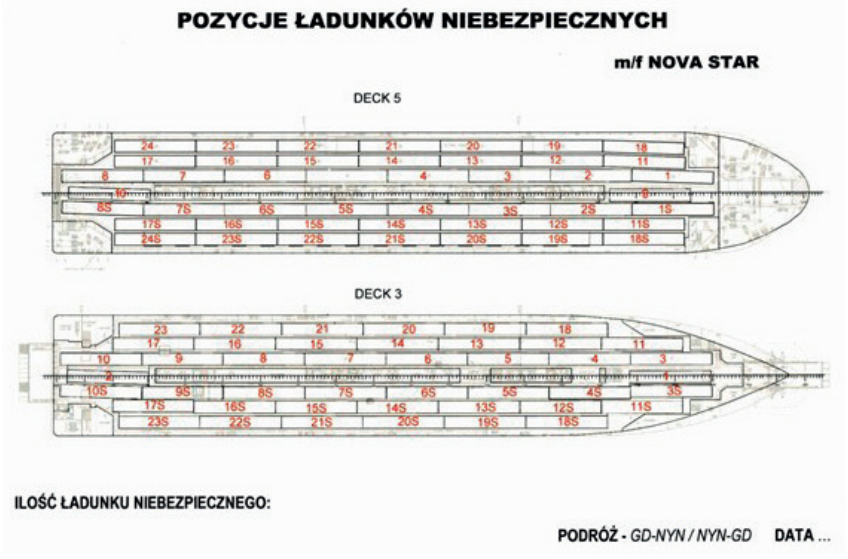


Figure 6. Dangerous Goods Placement on the Ship

Source: Own study based on shipowner's materials, accessed 17.09.2025, https://polferries.pl/.

The ship's documentation includes several key records provided by the carrier: the Dangerous Goods Note (DGN), the IMO FAL Form 7—completed by the ferry crew to report cargo details—and the Hazardous Cargo Stowage Plan. On ferries such as Nova Star, the safety officer is responsible for maintaining complete documentation and ensuring that information regarding hazardous cargo is available in two key locations: the bridge and the crew mess room. In these locations, an emergency response schedule is displayed, outlining procedures in the event of spillage or fire.

Key Data Analysis of Dangerous Goods Transport on Ro-Pax Vessels

To assess the activity and movement characteristics of dangerous goods (DG) transported on Ro-Pax ferries, a statistical analysis was conducted using voyage data collected between May to November 2024 (Table 1). During this period, 19 shipments of hazardous cargo were recorded.

Table 1. Summary of Dangerous Goods Transport Data on Ro-Pax Ferries (May–October 2024)

NO	ROUTE	DATE	DECK	LOCATION	DG CLASS	ADDIATIONAL INFORMATION	UN
1	GD-NYN	18.10.2024	3	23S	9	LITHIUM ION BATTERIES	3480
2	GD-NYN	14.10.2024	3	19S	9	–	
3	NYN-GD	12.10.2024	3	23S	3	–	
4	NYN-GD	10.10.2024	3	10	9	–	
5	NYN-GD	5.09.2024	3	9S	9	–	
6	NYN-GD	24.08.2024	3	23S	9	–	
7	GD-NYN	11.08.2024	3	–	9	ZINC SULPHATE	3082
8	NYN-GD	10.08.2024	3	–	9	LITHIUM ION BATTERIES	3480
9	GD-NYN	3.08.2024	5	–	3	FLAMMABLE LIQUID MATERIAL	1993
10	NYN-GD	31.07.2024	3	9S	9	POZYAMIDOAMINES	3082
11	NYN-GD	17.07.2024	3	23	9	POLYAMIDOAMINES /PG III	3082
12	GD-NYN	16.07.2024	3	18S	2.2(5.1)	NITROUS OXIDE 2.2/ 5.1	1070
13	GD-NYN	10.07.2024	3	3S	2.2(5.1)	NITROUS OXIDE 2.2/ 5.1	1070
14	GD-NYN	24.06.2024	3	23S	9	LITHIUM ION BATTERIES	3480
15	GD-NYN	20.06.2024	3	18	2.2(5.1)	NITROUS OXIDE 2.2/ 5.1	1070
16	NYN-GD	19.06.2024	3	10S	9	POLYAMIDOAMINES /PG III	3082
17	GD-NYN	12.06.2024	3	23	8	CAUSTIC ALKALI LIQUID/ PG III	1719
18	GD-NYN	10.06.2024	3	17S	9	LITHIUM ION BATTERIES	3480
19	NYN-GD	16.05.2024	3	10S	9	LITHIUM ION BATTERIES	3480

Source: Own study based on data collected on the M/S WAWEL and M/S NOVA STAR ferries on the Poland-Sweden route, operated by Polferries.

Analysis of the data presented in Table 1 shows that the most frequently transported goods were those of Class 9, classified as other dangerous goods. Due to the adaptation of deck number 3 for the transport of dangerous goods (DG), these goods were mostly placed on this deck. Considering the frequency of voyages in both directions, no deviations were observed, and the Gdańsk–Nynäshamn–Gdańsk routes were operated evenly during the studied period (Fig. 7). With one more shipment to Sweden than to Poland, the transportation of dangerous goods to Sweden exceeded that of consignments to Poland. No trends were observed regarding the popularity of this solution in either direction.

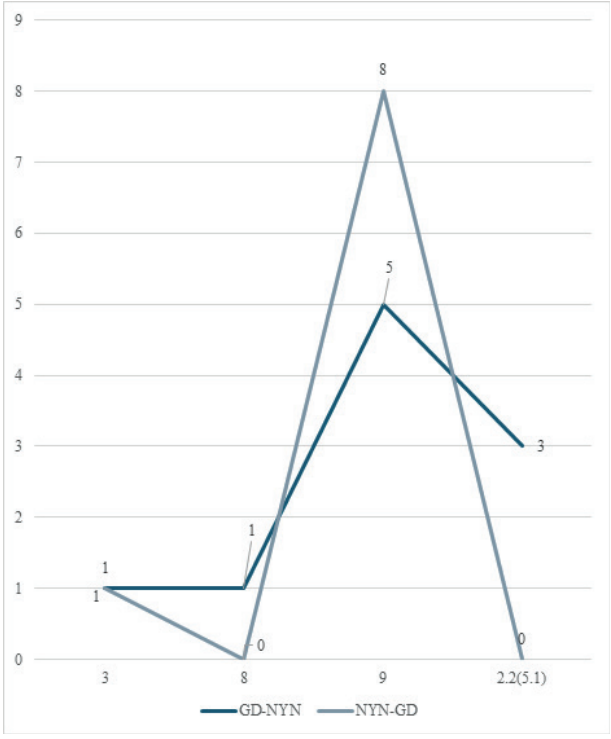


Figure 7. Distribution of Dangerous Goods Transport by Direction (GD-NYN-GD) and the Hazard Class of the Transported Goods.

Source: Own study based on data collected on the M/S WAWEL and M/S NOVA STAR ferries on the Poland-Sweden route, operated by Polferries.

Dangerous goods on Ro-Pax vessels were most frequently transported during the summer months which could be related to the demand for specific goods at that time (Fig. 8). Only one voyage was recorded in May and September, which significantly differs from the number of voyages in other months.

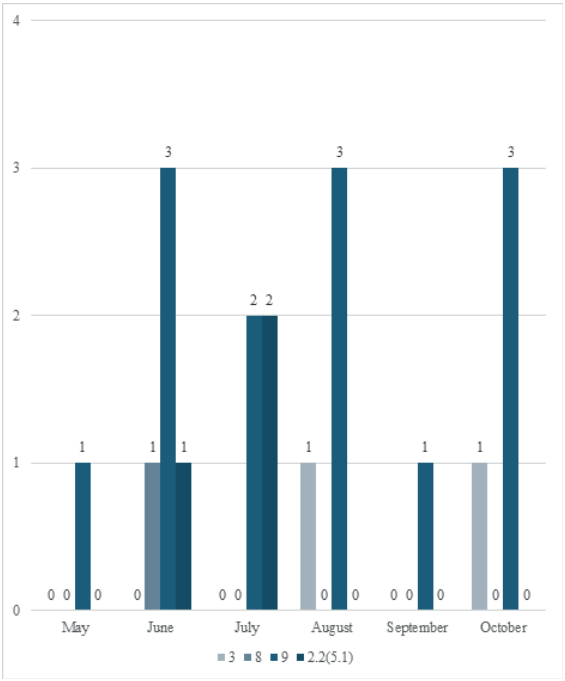


Figure 8. Frequency of Ship Voyages by Month, Categorised by the Hazard Class of Transported Goods.

Source: Own study based on data collected on the M/S WAWEL and M/S NOVA STAR ferries on the Poland-Sweden route, operated by Polferries.

The correlation of classes concerning the total number of shipments showed moderate dependencies for classes 8 and 2.2, while a very strong correlation of nearly 0.93 was recorded for class 9. The correlation results within individual classes are summarised in Table 2.

Table 2. The Correlation Coefficient for Individual Classes of Dangerous Goods.

DG Class	Correlation coefficient
3 to 8	–0,32
3 to 2.2	–0,46
9 to 2.2	0,12
8 to 2.2	0,29
8 to 9	0,42
3 to 9	0,66

Source: Own study based on data collected on the M/S WAWEL and M/S NOVA STAR ferries on the Poland-Sweden route, operated by Polferries.

It was observed that the strong correlation between Classes 3 and 9 (0.66) may suggest that these classes are often transported together. This could be due to similar transport requirements (e.g. similar types of vehicles, routes) or industrial demand. In this case, optimising logistical processes by focusing on joint transport of these classes may be beneficial, while also assessing whether combining these shipments increases the risk of failure or challenges in managing transportation.

The transport of classes 8 and 9 shows a moderate interdependence, which may indicate shared transport routes, albeit to a lesser extent than for classes 3 and 9. Potential logistical benefits may be gained by using shared routes for these classes, provided that the impact of combining them on cost savings is evaluated. Preventing regulatory conflicts, such as chemical reactions or different procedures for these classes, plays a key role in this process.

Class 3 tends to decrease when the transport of Classes 8 and 2.2 increases. This may result from different transport or infrastructural requirements, or the prioritisation of one class over others on specific routes or during certain seasons. Conversely, the weak positive correlations for class 2.2 with classes 8 (0.29) and 9 (0.12) suggest that it is transported independently of the other classes. Various classes may have specific seasons that influence these correlations. Classes 3 and 9 stand out, which may indicate that they play a crucial role in logistical operations, as confirmed by the number of shipments for these classes.

Recognition and response methods to threats resulting from the transport of hazardous goods

Procedures for crew action in emergencies

Safety on Ro-Ro (Roll-on/Roll-off) passenger ships is a crucial element of maritime operations due to the specific nature of these vessels and their intensive use. It requires specialised knowledge and skills, particularly in cargo operations, passenger safety management, and maintaining the integrity of the hull. For this reason, the International Maritime Organization (IMO) developed the IMO Model Course 1.29, which meets the requirements of Section A-V/2, paragraph 4 of the STCW Code, concerning training for the safety of passengers, cargo, and hull integrity on Ro-Ro vessels. Evacuation planning includes the designation of evacuation routes, the placement of life-saving appliances, and crew training in crowd management. Regular drills enable the crew to respond quickly to various emergency scenarios, such as fires, spills, or mechanical failures, which increases the chances of a successful evacuation and minimises losses.

The effectiveness of emergency procedures depends on the speed and accuracy of the crew's and passengers' responses. Managing these reactions requires not only the crew's knowledge of their duties but also the ability to communicate clearly and decisively with passengers. Ensuring calm and discipline among passengers is crucial to preventing panic and ensure a smooth evacuation. Optimal utilisation of resources on board requires coordinated management of both the crew and equipment. In daily operations, this includes regular inspections, maintenance, and crew training. In emergencies, effective management involves quick access to key resources such as life-saving appliances and precise coordination of the crew's actions to minimise the impact of the crisis. Optimizing safety and operational efficiency on board requires the implementation of, and adherence to, effective procedures that consider both the specifics of the vessel and the current sea conditions. Regular audits, risk analyses, and procedural updates are essential.

Technical and Operational Requirements Regarding the Transport of Dangerous Goods by Sea

International regulations for passenger ships require the installation of a fire detection system (FDS) in all areas where there is a risk of fire. The main FDS control panel is located on the navigation bridge, where it is constantly monitored by the crew. The fire detection system (FDS) not only identifies the location of the fire but also provides information on any preliminary hazards or faults related to specific fire detectors. The control panel is connected to detectors that detect smoke, temperature, and flame, as well as manual fire alarms. Additionally, the control panel is supported by sub-panels located in the passenger reception area, the engine room control centre, and the onboard office. This ensures that, even when the navigation bridge is unmanned, or when the ferry is docked, the hazard information can reach the appropriate personnel efficiently.

To increase the level of safety, constant monitoring of the situation is necessary, especially when the ferry is transporting trucks. Regular patrols are conducted—firefighting patrols—following a strictly planned route that covers all key areas. Additionally, the ship's CCTV system is helpful, allowing for monitoring of areas from the bridge and the engine room control centre.

The transport of dangerous goods on Ro-Pax vessels, which also carry passengers, comes with numerous additional safety requirements. Dangerous goods (DG) must be stowed in separate, secured areas, which necessitates the separation of cargo space from passenger areas. Detailed evacuation plans and emergency procedures must also be developed, considering the presence of passengers.

Conducting stability calculations to ensure the vessel's operational safety under various sea conditions. This requires precise determination of weight distribution on the deck, accounting for potential cargo shifts, and the impact of external factors such as waves and wind. Regularly conducting these calculations is essential to assess whether the vessel can safely undertake the planned voyage, minimising the risk of capsizing. Another important technical aspect regarding safety at sea is the watertight integrity of the Ro-Ro vessel's hull. Closing and securing doors, hatches, and access points must be done according to strictly defined procedures to prevent water from entering the ship's interior.

Application of the FMEA Method to Assess Potential Hazards Related to the Transport of Dangerous Goods

In the transportation of dangerous goods, the FMEA (Failure Modes and Effects Analysis) method allows for the identification of risks, such as package damage, accidents, or documentation errors, and the development of actions aimed at their elimination. These actions include training, audits, and improved and more efficient loading procedures. As a result, it becomes possible to minimise risks to people, the environment, and logistical processes while reducing costs associated with failures. Table 3 presents a sample risk analysis using the FMEA method, prepared based on discussions with the Ro-Pax vessel crew regarding potential hazards, their probability, impact, and detectability.

Table 3. FMEA Analysis for the Sea Transport of Dangerous Goods

No	Failure mode	Causes	Effects	Probability (P)	Severity (S)	Detection (D)	RPN (P × S × D)	Recommenations
1	2	3	4	5	6	7	8	9
1	Packaging Damage	Improper storage, vibrations during transport	Chemical leaks, fire hazard, loss of cargo	4	8	5	60	Regular quality checks of packaging, especially before transport
2	Incorrect documentation	Lack of employee training, data discrepancies	Transport delays, financial penalties, misclassification	3	6	7	126	Document management system, training, and documentation audits.

1	2	3	4	5	6	7	8	9
3	Improper storage	Overloading of containers, lack of cargo segregation	Cargo degradation, explosions, fires	5	9	4	180	Automation of processes, implementation of monitoring systems.
4	Transport damage	Improper cargo securing	Spillage of substances, environmental contamination, health hazards	3	9	6	162	Driver training, better cargo securing systems

Source: Own study based on data collected on the M/S WAWEL and M/S NOVA STAR ferries on the Poland-Sweden route, operated by Polferries.

- **P** – Probability (1–10, where 10 means very high probability),
- **S** – Severity (1–10, where 10 means very severe consequences),
- **D** – Detectability (1–10, where 10 means low possibility of detection).

The highest risk priority number (RPN) is associated with improper storage (180), highlighting the need for careful attention to loading and storage processes. The FMEA risk analysis for the transport of hazardous goods points to areas requiring improvement to minimise threats like cargo degradation, leaks, or fire, which could have severe environmental and financial consequences. Documentation errors also increase the risk of delays, fines, and incorrect classifications. To mitigate these risks, regular packaging inspections, crew training, stricter loading procedures, and systematic monitoring of transport are essential. These actions will enhance transport safety, protect the environment, and improve logistical efficiency.

Discussion

The transport of hazardous materials on Ro-Ro and Ro-Pax vessels requires special attention due to the high operational risks and potential threats to the environment and passenger safety. The conducted research and analyses highlight key aspects related to managing hazardous cargo, documentation, and emergency procedures. Despite the implemented safety measures, some areas require further exploration, which could contribute to improve transport efficiency and minimising the risk of incidents.

One of the crucial aspects requiring further research is the optimisation of the placement of hazardous materials on Ro-Pax vessels. Data analysis has shown that Class 9 materials are most commonly transported, suggesting the need for a thorough examination of their stowage methods on the vessel. There is a need to develop simulation

models for optimal cargo placement to minimise the risk of failure and improve operational efficiency. Future studies should consider the impact of dynamic factors, such as cargo shifting during voyages and the influence of waves on the vessel's stability. Simultaneously, it would be valuable to analyse the possibility of implementing modern monitoring systems for transport conditions, such as sensors that detect leaks or temperature increases in storage areas. Another important issue is the analysis of the seasonality effect on hazardous cargo transport. Moreover, it is essential to study the impact of weather conditions, such as storms and strong winds, on transport safety and develop solutions to enhance operational resilience under extreme maritime conditions. The use of modern technology for monitoring hazardous cargo is another area requiring attention. Current procedures comply with international standards but do not fully exploit the potential of advanced technologies like the Internet of Things (IoT) or artificial intelligence (AI). Additionally, it is worth exploring the potential of using AI algorithms for automatic anomaly detection and failure prediction, which can significantly enhance safety and reduce incident risk.

Conclusions

The article presents the key aspects of the transport of hazardous materials by sea on Ro-Ro and Ro-Pax vessels, with a particular focus on the application of the International Maritime Dangerous Goods Code (IMDG).

The paper reviewed the applicable legal regulations at the European Union and international levels governing the transport of hazardous materials. The basic differences and similarities between ADR and IMDG regulations were identified. The relationships between EU regulations and international regulations in the context of maritime transport were also characterised. The Dangerous Goods Note (DGN) was discussed in detail, along with the most common mistakes made when filling it out. The paper also outlined the procedures that the crew should follow in the event of an emergency. The article dealt with safety issues related to the transport of hazardous materials. Technical and operational requirements that must be met to ensure safe transport were discussed, with particular emphasis on fixed firefighting systems used on Ro-Pax ferries and procedures for handling emergency events.

The conducted analyses suggest that the effectiveness of rescue operations depends not only on the equipment aboard the vessels but also on the level of training of the crew and passengers. It would be beneficial to examine the effectiveness of current alarm and evacuation systems and the possibility of upgrading them by incorporating augmented reality (AR) and virtual reality (VR) technologies into crew training.

The last key research area is the analysis of the impact of international regulations on the safety of hazardous cargo transport. The existing regulations set detailed requirements for hazardous cargo transport, but the dynamic development of technology and the changing structure of transportation may require updates to these regulations. Further studies should focus on assessing the alignment of these regulations with modern transport methods and evaluating their effectiveness in risk mitigation. As a result, recommendations for potential regulatory changes can be developed to improve maritime transport safety.

In conclusion, the transport of hazardous materials by sea is an activity requiring a high level of safety. Compliance with IMDG regulations and proper crew preparation are key to minimising the risks associated with this type of transport. This article provides a comprehensive overview of the challenges and solutions related to this issue and serves as a good starting point for further research on the transport of hazardous materials. However, to gain a more comprehensive understanding, it is worth considering expanding the thematic scope, deepening the analysis, and including the latest trends and technologies.

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English version: Mark Atkinson

SUMMARY

The aim of the study was to examine the implications of the transport process of dangerous goods (DG) by sea on Ro-Ro and Ro-Pax vessels, with particular emphasis on the practical application of the International Maritime Dangerous Goods (IMDG) Code. The research focuses on legal frameworks, operational requirements, and safety procedures, addressing the problem of how effectively IMDG regulations are implemented in daily maritime practice.The study employs legal regulation analysis, process modelling on the Gdańsk–Nynäshamn route, statistical evaluation of 2024 voyage data, and qualitative data from shipowner documentation and expert interviews. Methods include the Delphi approach and FMEA risk analysis. The findings indicate recurring errors in Dangerous Goods Notes (DGNs), such as missing UN numbers, hazard classes, or "marine pollutant" designations. Statistical results show that Class 9 materials, especially lithium-ion batteries, dominate DG shipments, while correlation analysis highlights potential risks when certain classes are transported together. FMEA results point to improper storage and documentation deficiencies as the most significant hazards. The study concludes that compliance with IMDG standards ensures a high safety level, but continuous improvement is required. Enhancing documentation accuracy, crew training, and monitoring systems, along with adapting regulations to new technologies, is essential for safer and more efficient DG transport on Ro-Pax vessels.

Transport towarów niebezpiecznych drogą morską na statkach typu Ro-Ro i Ro-Pax – Zastosowanie przepisów IMDG w praktyce

Słowa kluczowe: transport, logistyka morska, towary niebezpieczne, regulacje prawne, bezpieczeństwo

STRESZCZENIE

Celem artykułu była identyfikacja implikacji związanych z procesem transportu towarów niebezpiecznych (TN) drogą morską na statkach typu Ro-Ro i Ro-Pax, ze szczególnym uwzględnieniem praktycznego zastosowania Międzynarodowego Morskiego Kodeksu Towarów Niebezpiecznych (IMDG). Badania koncentrują się na ramach prawnych, wymaganiach operacyjnych i procedurach bezpieczeństwa, podejmując problem skuteczności wdrażania przepisów IMDG w codziennej praktyce żeglugowej. W pracy dokonano analizy regulacji prawnych, modelowania procesu na trasie Gdańsk–Nynäshamn, statystycznej oceny rejsów z 2024 roku oraz danych jakościowych pochodzących z dokumentacji armatora i wywiadów z ekspertami. Wykorzystano metodę delficką oraz analizę ryzyka FMEA. Wyniki wskazują na powtarzające się błędy w deklaracjach towarów niebezpiecznych, takie jak brak numerów UN, klas zagrożeń czy oznaczenia „zanieczyszczenie morza". Wyniki analizy statystycznej wykazały, że w przewozach dominują towary klasy 9, szczególnie baterie litowo-jonowe, natomiast analiza korelacji uwidoczniła potencjalne ryzyka przy łączonym transporcie niektórych klas.

Wyniki FMEA wskazują na niewłaściwe składowanie i braki w dokumentacji jako najpoważniejsze zagrożenia. Wnioski z badań pozwoliły na podkreślenie, że zgodność z przepisami IMDG zapewnia wysoki poziom bezpieczeństwa, jednak konieczne są dalsze usprawnienia. Kluczowe jest zwiększenie dokładności sporządzonej dokumentacji, doskonalenie szkoleń załogi i systemów monitorowania oraz dostosowanie regulacji do nowych technologii, aby transport towarów niebezpiecznych na statkach Ro-Pax był jeszcze bezpieczniejszy i bardziej efektywny.

Citation

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