WHEN TRUST MATTERS

Providing a knowledge base and accelerating development of safety regulations for future fuels

Nordic Roadmap webinar

Linda Sigrid Hammer
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Safety is a prerequisite for the successful and timely introduction of carbon-neutral fuels

- Lack of international safety regulations is a barrier against their implementation
- Development of regulations in IMO is key to reduce this barrier
- The Nordic Countries may help accelerate the process in IMO

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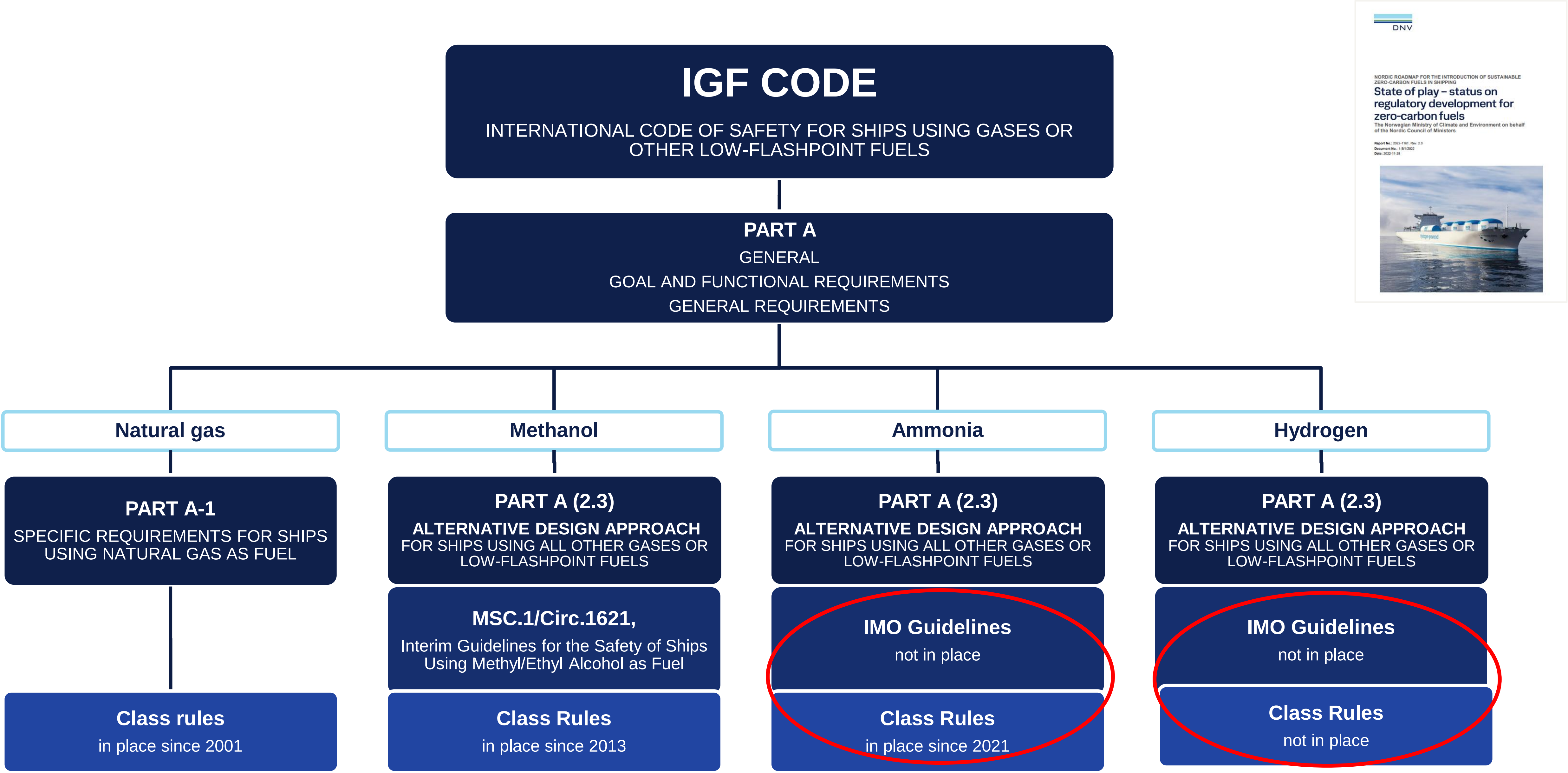


Figure 5-1 Regulatory status per fuel

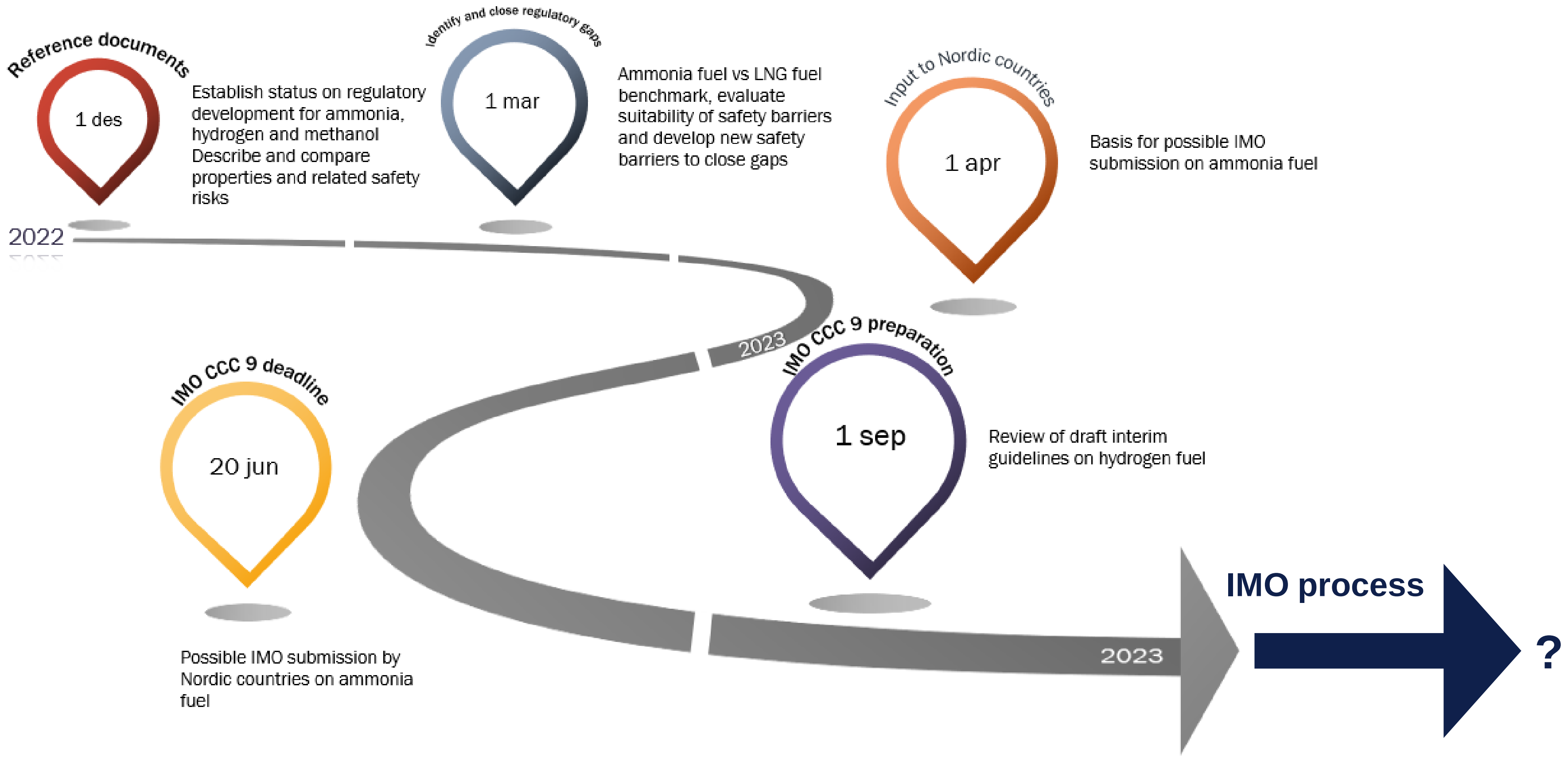
Work stream on safety to accelerate the process

Deliverables 2022

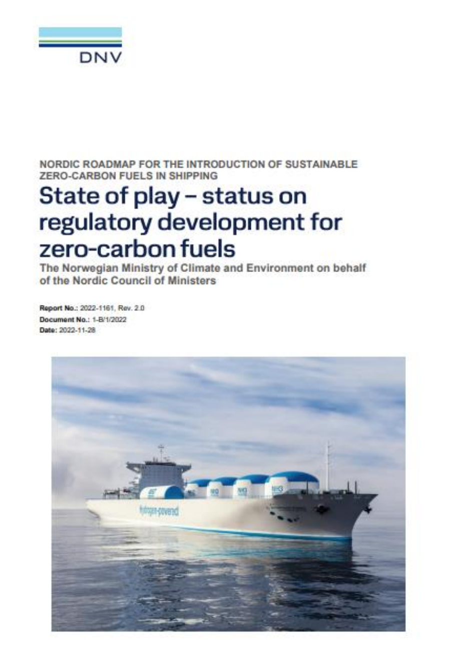
1. State of play – status on regulatory development for zero-carbon fuels
2. Fuel properties and their consequence for safety and operability

Deliverables 2023

1. Base document for draft interim guidelines for ships using ammonia as fuel
2. Review of draft interim guidelines for ships using hydrogen as fuel



Four technical deliverables from Task 1-B

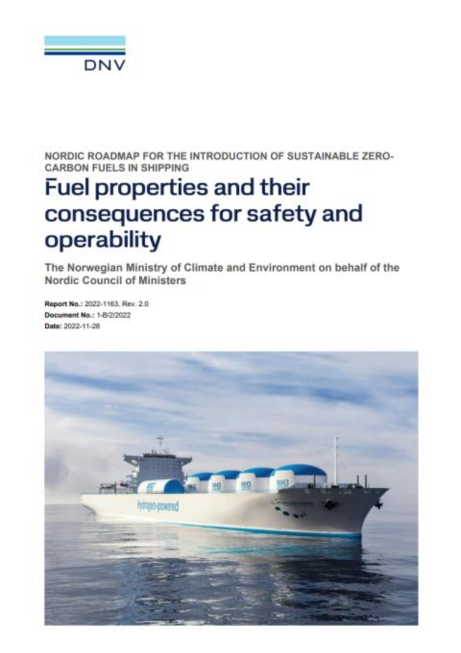


NORDIC ROADMAP FOR THE INTRODUCTION OF SUSTAINABLE ZERO-CARBON FUELS IN SHIPPING

State of play – status on regulatory development for zero-carbon fuels

The Norwegian Ministry of Climate and Environment on behalf of the Nordic Council of Ministers

Report No.: 2022-1161, Rev. 2.0
Document No.: 1-B/1/2022
Date: 2022-11-28



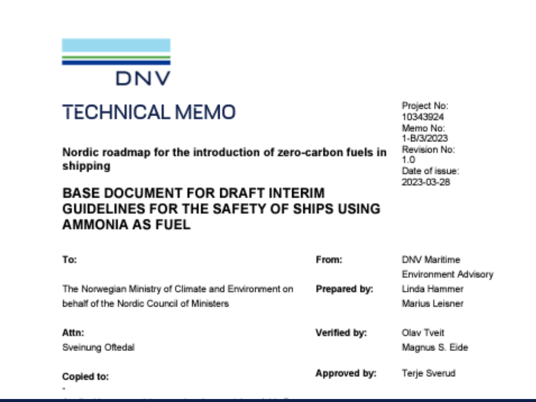
NORDIC ROADMAP FOR THE INTRODUCTION OF SUSTAINABLE ZERO-CARBON FUELS IN SHIPPING

Fuel properties and their consequences for safety and operability

The Norwegian Ministry of Climate and Environment on behalf of the Nordic Council of Ministers

Report No.: 2022-1163, Rev. 2.0
Document No.: 1-B/2/2022
Date: 2022-11-28

Available at: futurefuelsnordic.com



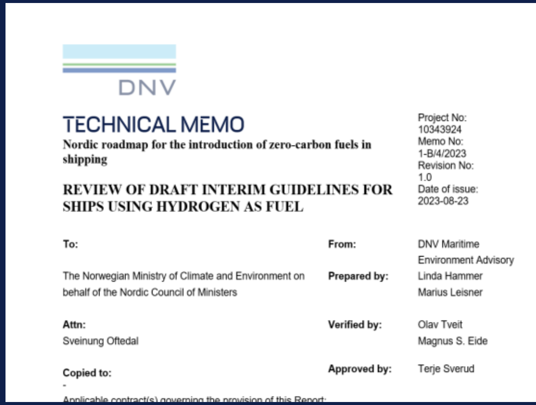
TECHNICAL MEMO

Nordic roadmap for the introduction of zero-carbon fuels in shipping

BASE DOCUMENT FOR DRAFT INTERIM GUIDELINES FOR THE SAFETY OF SHIPS USING AMMONIA AS FUEL

Project No: 10343924
Memo No: 1-B/3/2023
Revision No: 1.0
Date of issue: 2023-03-28

To:	**From:**	DNV Maritime Environment Advisory
The Norwegian Ministry of Climate and Environment on behalf of the Nordic Council of Ministers	**Prepared by:**	Linda Hammer Marius Leisner
Attn: Sveinung Oftedal	**Verified by:**	Olav Tveit Magnus S. Eide
Copied to: -	**Approved by:**	Terje Sverud



TECHNICAL MEMO

Nordic roadmap for the introduction of zero-carbon fuels in shipping

REVIEW OF DRAFT INTERIM GUIDELINES FOR SHIPS USING HYDROGEN AS FUEL

Project No: 10343924
Memo No: 1-B/4/2023
Revision No: 1.0
Date of issue: 2023-08-23

To:	**From:**	DNV Maritime Environment Advisory
The Norwegian Ministry of Climate and Environment on behalf of the Nordic Council of Ministers	**Prepared by:**	Linda Hammer Marius Leisner
Attn: Sveinung Oftedal	**Verified by:**	Olav Tveit Magnus S. Eide
Copied to: -	**Approved by:**	Terje Sverud

Applicable contract(s) governing the provision of this Report:

Work based on safety concept of the current regulations in the IGF Code for natural gas fuel

Segregation

Protect fuel installation from external events

System integrity

Minimize leakages from fuel installation

Double barriers

Protect ship against leakages

Leakage detection

Give warning and enable automatic safety actions

Automatic isolation of leakages

Reduce consequence of a leakage

Findings - Safety risks related to flammability properties

Relatively low	Medium	High	Very high

	Flashpoint (°C)	Flammability range (%vol. fraction)	Minimum ignition energy (mJ)	Auto-ignition temperature (°C)	Laminar burning velocity (m/s)
Methane	-*	5.3-17	0.274	537	0.37
Methanol	12	6-36.5	0.174	385	0.48
Ammonia	-*	15-28	40-170	650	0.07
Hydrogen	-*	4-77	0.017	585	2.7

*The gaseous fuels do not have a defined 'flashpoint' like the liquid fuels, but will instead transfer fully into gaseous form at ambient conditions, due to the low boiling temperatures.

Findings - Safety risks related to storage, release and dispersion properties

Relatively low	Medium	High	Very high

	Normal boiling point (°C)	Density (kg/m^3)		Expansion ratio liquid NBP/gas NTP	Toxicity IDLH (ppm)
		(G,NBP)	(G,NTP)		
Methane	-162	1.819	0.6594	600	Asphyxiation
Methanol	64.9	-	1.11*	-	6000
Ammonia	-33.4	0.89**	0.610**	850	300
Hydrogen	-253	1.312	0.0827	847	Asphyxiation

G – gas
L - liquid
NTP - normal temperature and pressure
NBP - normal boiling point
IDLH – Immediately Dangerous to Life or Health Concentrations specified by the United States National Institute for Occupational Safety and Health (NIOSH)
* Specific gravity of methanol vapour
**Due to hygroscopic properties ammonia vapours reacts with moisture in air resulting in a density that is heavier than air.

Findings – Is the IGF safety concept for natural gas also suitable for ammonia and hydrogen?

IGF can be used	IGF minor changes	IGF major changes	IGF questionable

	Segregation		System integrity		Double barriers				Leakage detection	Automatic isolation of leakages
	Mechanical damage	External fire	System design	Operational and emergency discharges	Piping	ESD machinery space	Double barrier spaces	Ventilation	LEL	ESD valves
Ammonia			corrosivity pressure toxicity	toxicity	toxicity	toxicity	toxicity	toxicity	toxicity	toxicity
Hydrogen			leakage, embrittlement, flammability	flammability	flammability	flammability	flammability	flammability	density, flammability range	flammability

Resulting IMO submissions to CCC 9

AMENDMENTS TO THE IGF CODE AND DEVELOPMENT OF GUIDELINES FOR ALTERNATIVE FUELS AND RELATED TECHNOLOGIES

CCC 9/3/Add.1	Report of the Correspondence Group (Germany) Annex 6 – Base Document for Draft Interim Guidelines for the Safety of Ships Using Ammonia as Fuel
CCC 9/INF.7	Supporting information to the draft interim guidelines for the safety of ships using ammonia as fuel Submitted by Denmark, Finland, Norway and Sweden

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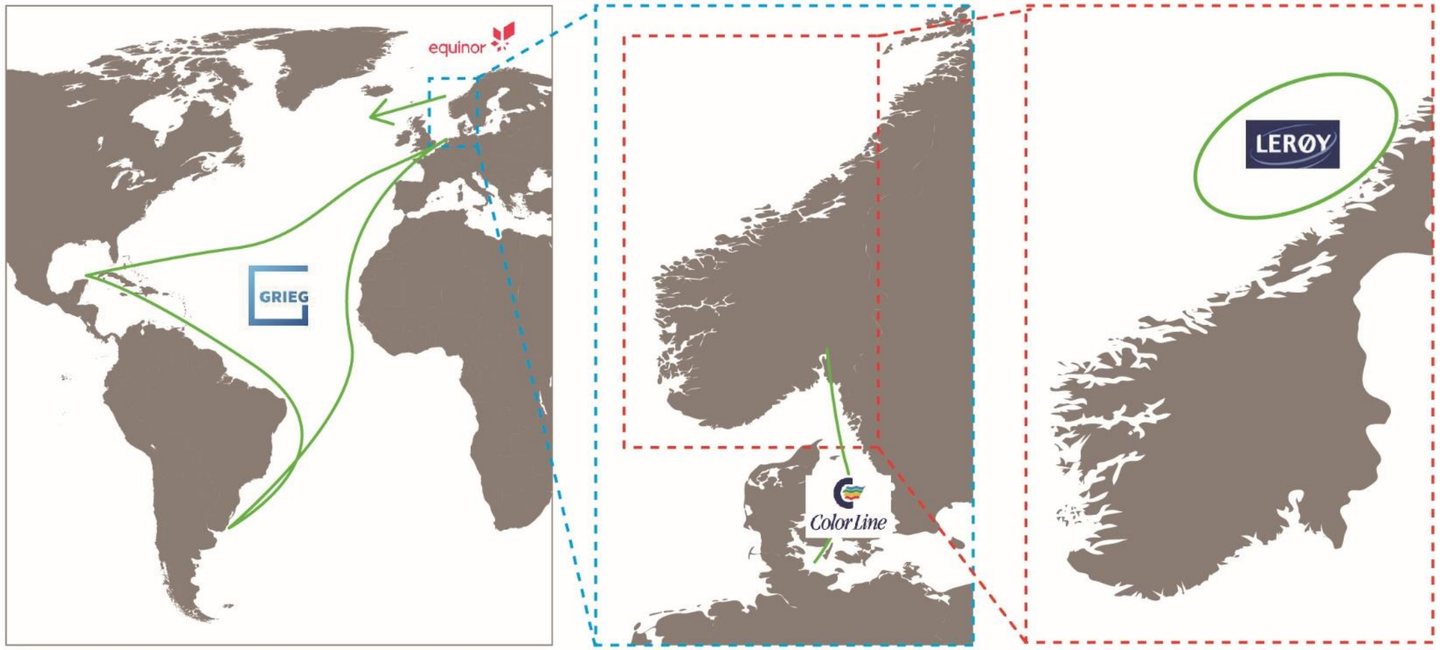
Green Shipping Programme

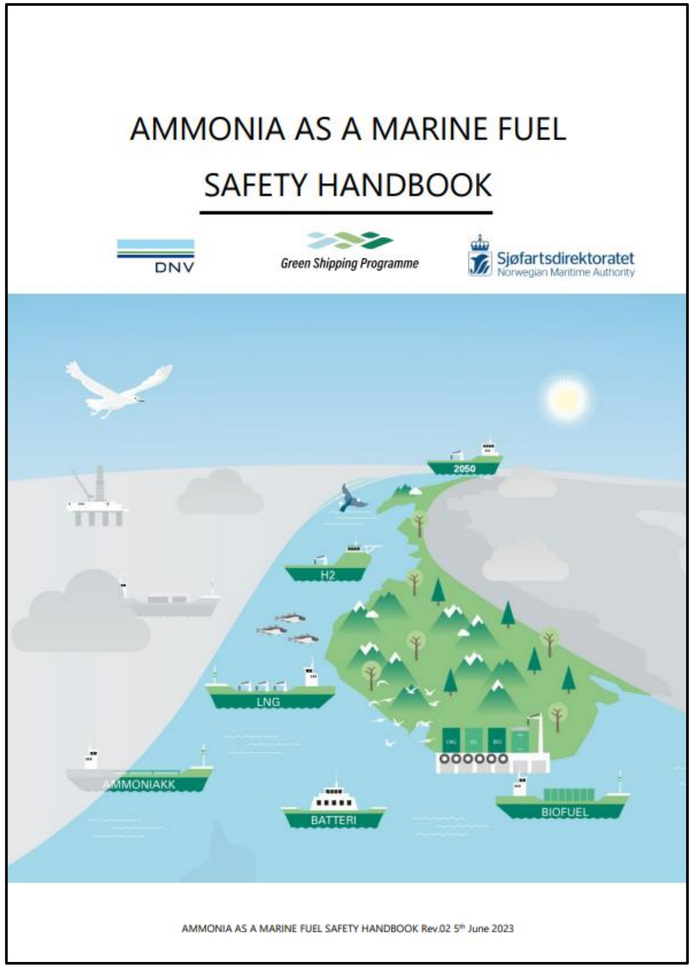
A revised Ammonia Safety Handbook from the Green Shipping programme (GSP)

To provide **practical guidance on safety aspects of ship design** in the development of ammonia fuelled ships for ship owners, yards and designers



Based on four ammonia fuel pilots in GSP and

The Nordic Roadmap for Future Fuels project



Available at: https://greenshippingprogramme.com/reports/

DNV

Green Shipping Programme

Possible safety barriers addressing toxicity of ammonia

Toxic exposure protection - definitions of toxic zones

Ammonia release mitigation system (ARMS) collecting and handling operational releases of ammonia

Revise alarm levels to provide warnings of toxic levels of ammonia

Arrange mustering stations and LSA away from toxic hazards

Toxicity hazards

Performing risk assessment specific for ammonia

Arrange Safe Haven where personnel onboard can take refuge

Sufficient personal protective equipment (PPE)

Apply water spray systems to reduce extent of toxic vapours

Avoid portable tanks for ammonia

No ESD protected machinery spaces

Indefinite holding time for ammonia storage tanks

Extensive and ship-specific fuel handling manual

WHEN TRUST MATTERS

futurefuelsnordic.com

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