# Alternative Fuels

The Past, The Present & The Future

**FOR THE OPA-90 FORUM**

Wednesday, 20 August 2026
Presenter: Guillermo Hernandez

DONJON SMIT SALVAGE

OPA 90 FORUM

# Alternative Fuels

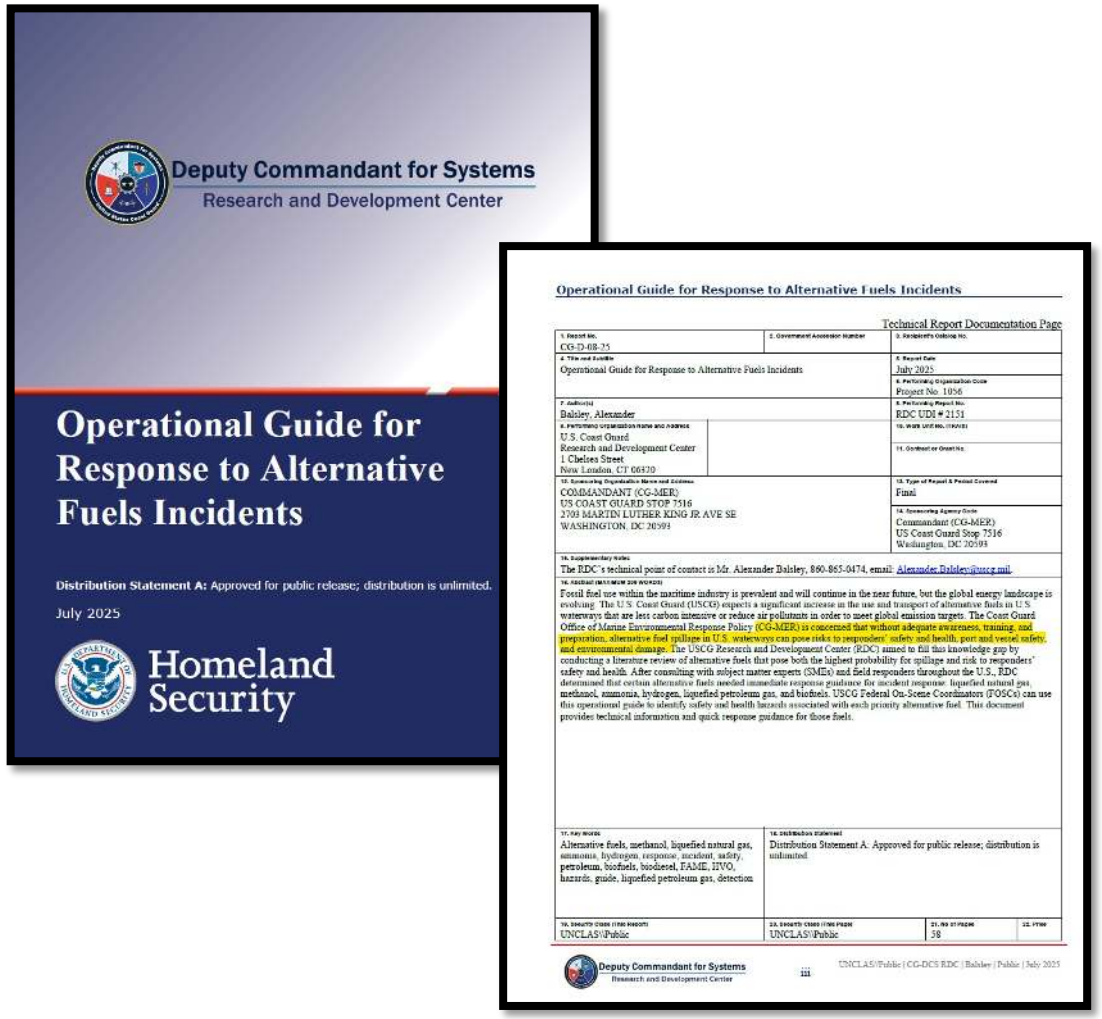
## Contents




Image from NAMEPA's 2025 Calendar,
***"Unsung Heroes of Sustainable Development"*** – Jacob K.,
Grade 6, Twin Peaks Middle School, Poway, CA USA

# Alternative Fuels

## 1. Why are we here today?




The Coast Guard Office of Marine Environmental Response Policy (CG-MER) has ***concern*** that without adequate awareness, training, and preparation, alternative fuel spillage in U.S. waterways can pose risks to responders' safety and health, port and vessel safety, and environmental damage.

***Alternative Fuels: Not Covered Under OPA-90:***

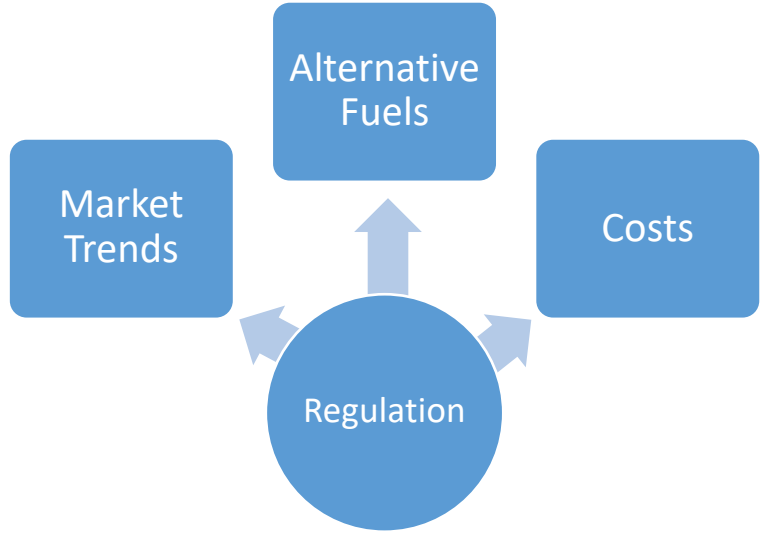
***OPA-90 applicability is for all vessels carrying Group I-IV oils as primary cargo and that are required by 155.1015 to have a vessel response plan. CFR 155.4015***

**… To have an open dialogue and cross-sharing knowledge between Donjon-SMIT and OPA-90 FORUM members regarding Alternative Fuels**

# Alternative Fuels

## 2. Four Steps for Introducing Alternative Fuels

| | | |
|---|---|---|
| A | Understanding Regulations |  |
| B | Understanding Trends |  |
| C | Understanding Alternative Fuels<br>[the alt. fuel property composition and existing vessels] |  |
| D | Understanding Costs<br>[Shipbuilding, Fuel Costs & Regulations] |  |




**OPA-90 REGULATION**

The OPA-90 regulations have been in existence for over 35-years and proven itself time-and-time again. This could be a great foundation for adopting **Alternative Fuels** and **All Hazards** responses in the maritime response community.

# Alternative Fuels

## 2 (A): Understanding Regulations

### IMO & EU-ETS

- International Maritime Organization (**IMO**): is the United Nations specialized agency with responsibility for the safety and security of shipping and the prevention of marine and atmospheric pollution by ships. The goal to Net-Zero GHG emissions from international shipping by or around, i.e. close to 2050. ***(The USCG has been a key participant at the IMO for all policy development since the IMO Convention entered into force over 50 years ago.)***

- European Union Emissions Trading System (**EU-ETS**): is a carbon emission trading scheme (or cap and trade scheme) that began in 2005 and is intended to lower greenhouse gas emissions in the EU.


### IMO Net-Zero Framework

**July 2023**:The IMO's 2023 Strategy is adopted at Marine Environment Protection Committee (MEPC) 80 – work begins on development of the 'mid-term measures'

**Apr. 2025**: The IMO Net-Zero Framework is approved at MEPC 83

**Oct. 2026**: IMO net-zero shipping talks to resume post the extraordinary session (14-17 Oct 2025) were not positive. The next critical decision point is the adoption vote at **MEPC 85** in late 2026.

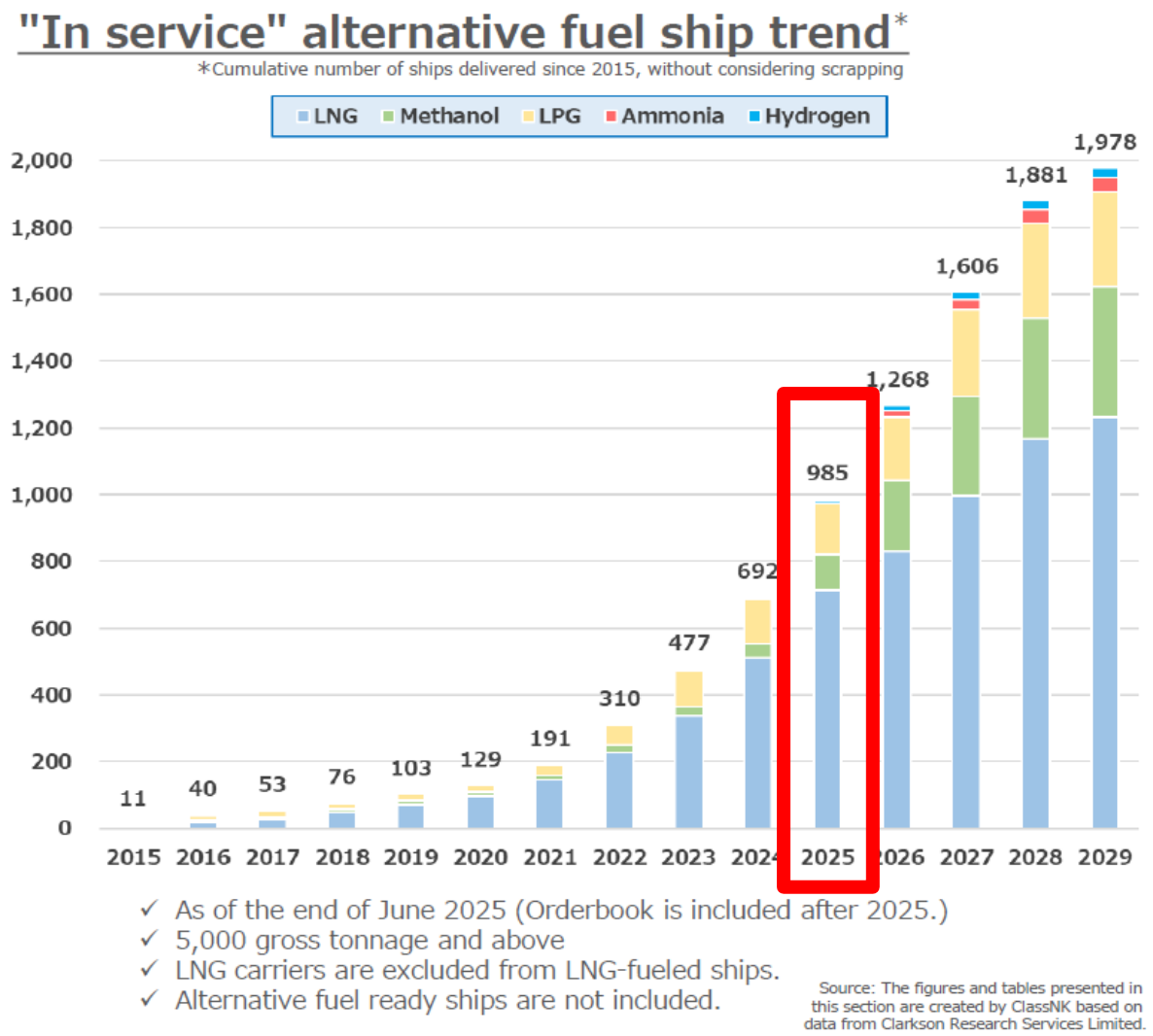
**Spring 2027**: 3Entry into force (6-mths after the 10-mth acceptance period)

**2028:** Actual functioning of the IMO Net-Zero Framework (data collection begins)

# Alternative Fuels

## 2 (B): Understanding Trends

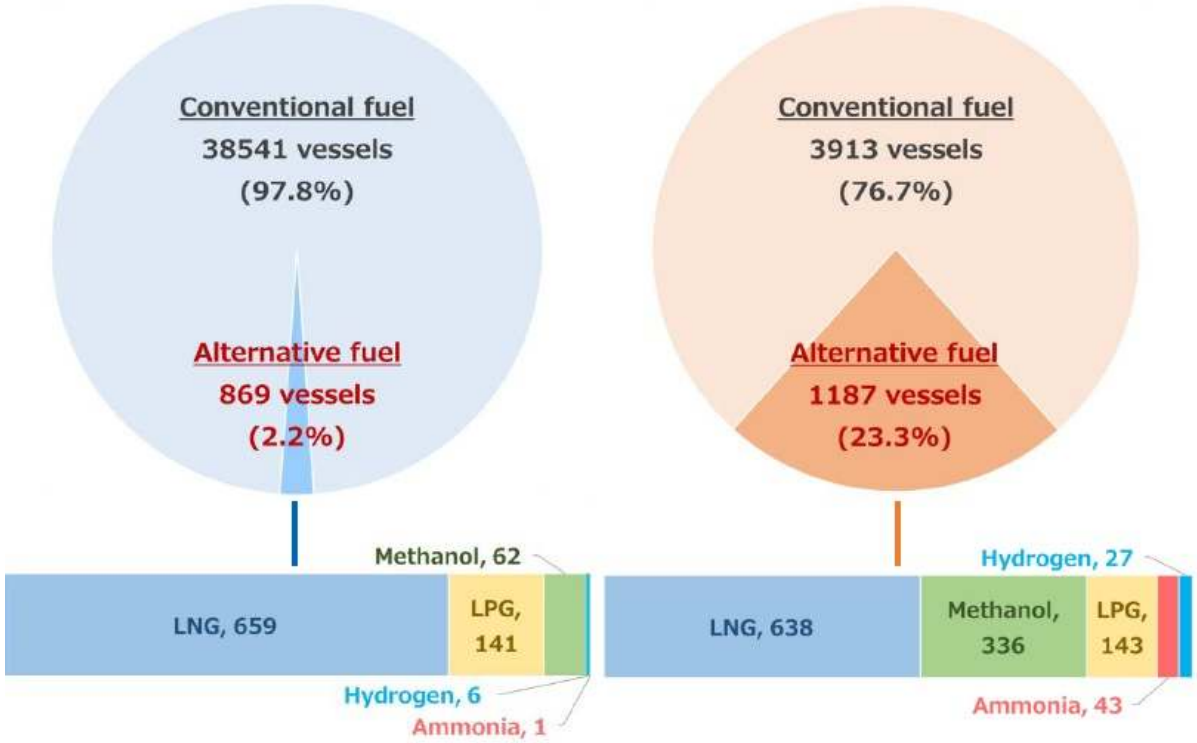
- Currently there are seven alternative fuel types and energy systems available to the shipping industry:
  - **LNG, Methanol, LPG, Ammonia, Ethane, Hydrogen and Nuclear**
- Adaptation rate of alternative fuels ships remains high for ship types such as RORO, LPG vessels and containerships but these share of vessel types are starting to plateau.
- Adaptation of alternative fuel ships for the other vessel types are not progressing significantly as a “wait-and-see” attitude due to the adoption of the IMO’s mid-term measures.



# Alternative Fuels

## 2 (B): Understanding Trends, continue

### In service —




### On order —




- ✓ As of the end of June 2025
- ✓ 5,000 gross tonnage and above
- ✓ LNG carriers are excluded from LNG-fueled ships.
- ✓ Alternative fuel ready ships are not included.

## Details of alternative fuel ships (Dec. 2024 → Jun. 2025)

### In service —

| | As of Dec. 31, 2024 | As of Jun. 30, 2025 |
|---|---|---|
| Number of vessels | 742 vessels (1.9%) | 869 vessels (2.2%) |
| Total GT | 50,810,660 GT (3.2%) | 62,147,411 GT (3.8%) |

There was an increase of 127 vessels totaling 11.3 million GT over the last six months. LNG-fueled ships accounted for 99 ships (79%), followed by 19 methanol-fueled ships (15%), and 7 LPG-fueled ships (6%). Deliveries of methanol-fueled ships were seen not only in the containerships but also for product/chemical tankers and bulk carriers.

### On order —

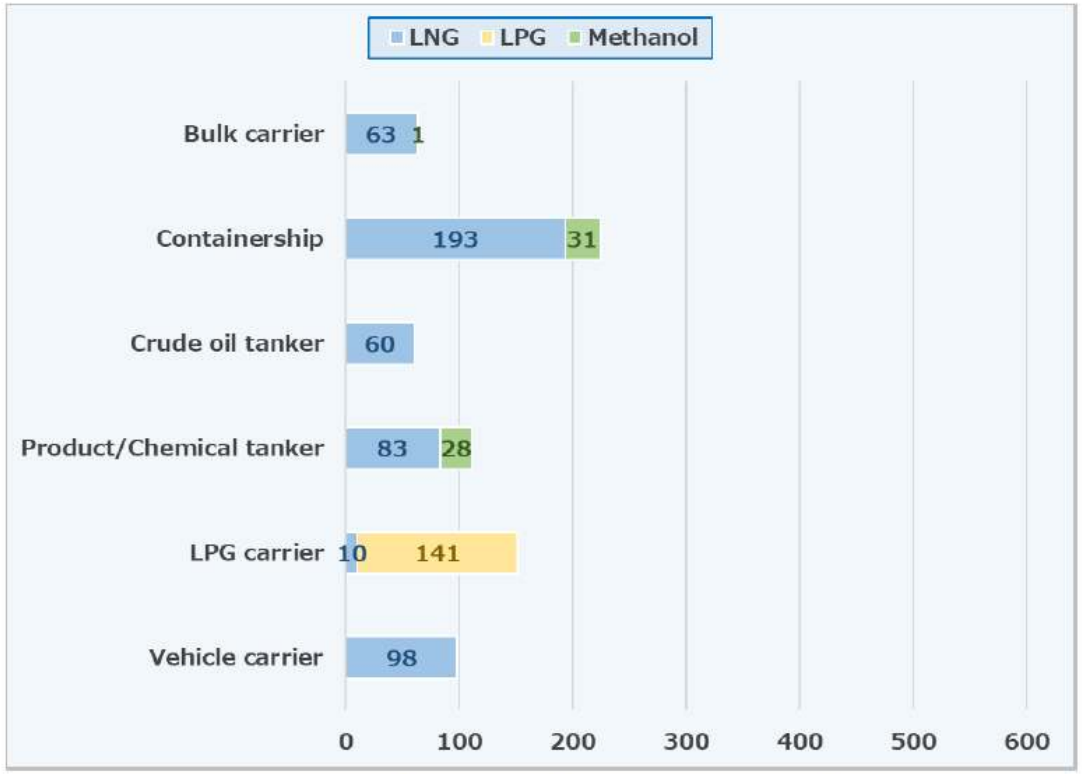
| | As of Dec. 31, 2024 | As of Jun. 30, 2025 |
|---|---|---|
| Number of vessels | 1,152 vessels (23.8%) | 1,187 vessels (23.3%) |
| Total GT | 102,557,464 GT (36.9%) | 112,588,899 GT (38.5%) |

There was an increase of 35 vessels totaling 10.0 million GT over the last six months. The increase in GT significantly outpaced the increase in the number of vessels. By fuel type, while LNG-fueled ships accounted for 49% of the total, methanol-fueled ships also captured a substantial 36% share and are gathering renewed attention.

# Alternative Fuels

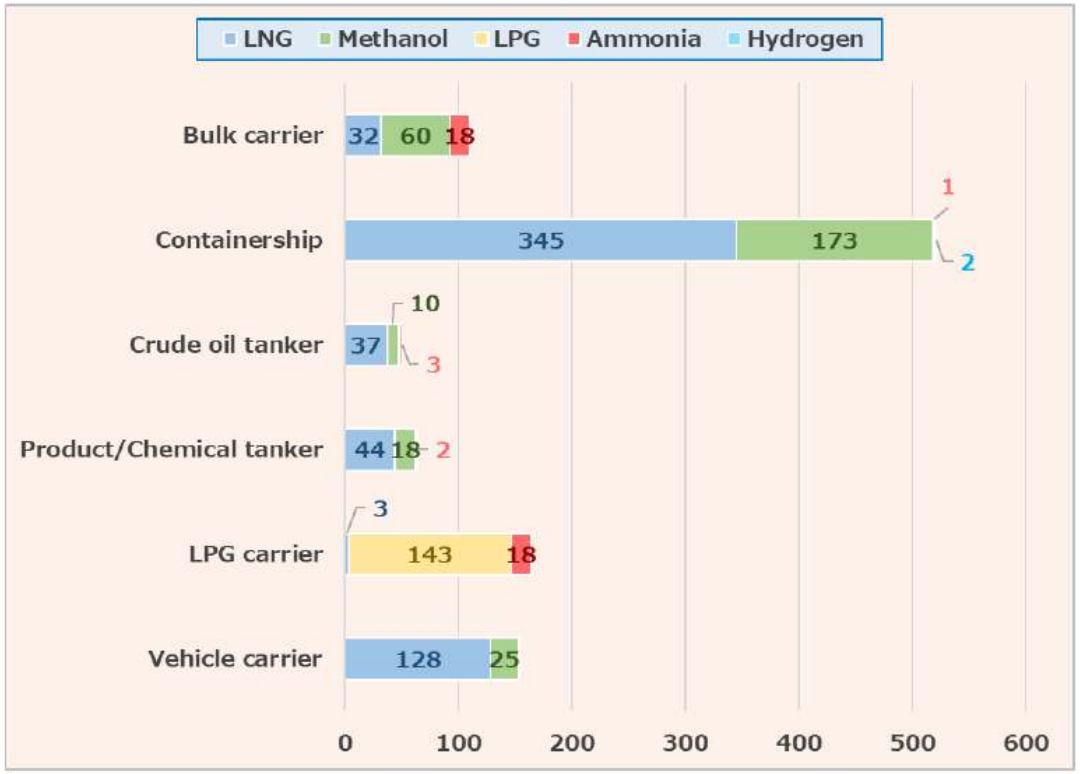
## 2 (B): Understanding Trends, continue

### In service —




- ✓ As of the end of June 2025 / 5,000 gross tonnage and above / Alternative fuel ready ships are not included.
- ➢ While LNG-fueled ships dominate most ship types, excluding LPG carriers, methanol-fueled ships have a notable presence, especially in containerships.

### On order —




- ✓ As of the end of June 2025 / 5,000 gross tonnage and above / Alternative fuel ready ships are not included.
- ➢ Unlike the situation of “in service”, methanol-fueled ships account for a larger share. The adoption of ammonia-fueled ships has begun in some ship types.

# Alternative Fuels

## 2 (C): Understanding Alternative Fuels, a few properties

- **1. LNG > ZIM MOUNT EVEREST**

Boiling point -162°C (-259.6°F), flammable/explosive, lighter than air when T>-100°C (-148°F)

- **2. Methanol > STENA GERMANICA**

Boiling point +64.7°C (+147.2°F), flammable/explosive, toxic. Can be handled at room temp.

- **3. LPG > CALLUNA GAS**

Boiling point -42°C (-43.6°F), flammable/explosive, lighter than air

- **4. Ammonia > OSV FFI GREEN PIONEER**

Boiling point -33°C (-27.4°F), flammable/explosive, toxic, lighter than air

- **5. Ethane > JS INEOS INTREPID**

Boiling point -89°C (-128.2°F), flammable/explosive, lighter than air

- **6. Hydrogen > SUISO FRONTIER**

Boiling point -253°C (-423.4°F), flammable/explosive, lighter than air

- **7. Nuclear > USS Theodore Roosevelt (CVN-71)**

Boiling point N/A, toxic, contamination concerns, specialized training, port visits concerns, coolant chemistry concerns (hydrogen, hydrazine, Ammonia, etc.)





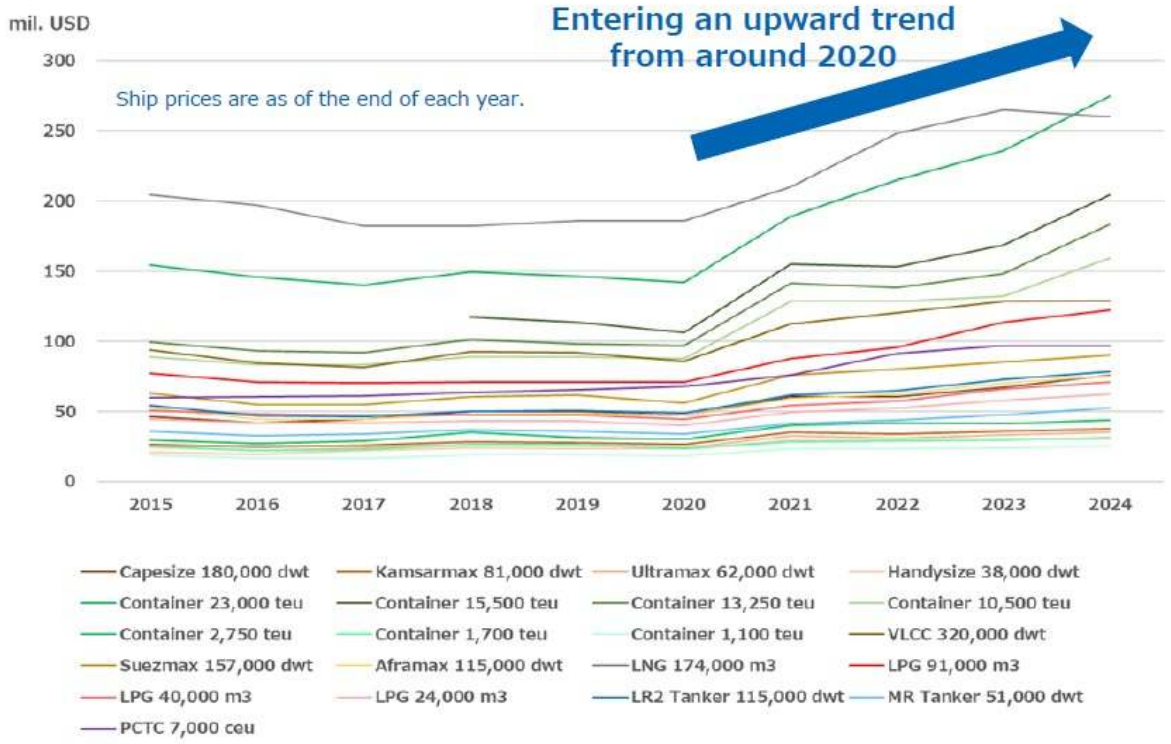


# Alternative Fuels

## 2 (D): Understanding Costs, Shipbuilding

- Costs are key factor when considering the adoption of alternative fuels. The primary main costs ClassNK associates the adoption of alternative fuels are **shipbuilding** costs, **fuel** costs, and **regulatory** costs.

### The historical trend of shipbuilding costs (ship prices) and the shipbuilding costs of alternative fuel ships




Source: Prepared by ClassNK based on data from Clarkson Research Services Limited

### Shipbuilding costs of alternative fuel ships (relative to conventional fuel ships)

| | |
|---|---|
| LNG | +30% - +40% |
| LPG | +30% - +40% |
| Methanol | +20% - +30% |
| Ammonia | +30% - +40% |

Source: ClassNK

✓ The shipbuilding cost of alternative fuel ships is typically 20% to 40% higher compared to conventional fuel ships, depending on the ship types and sizes.

# Alternative Fuels

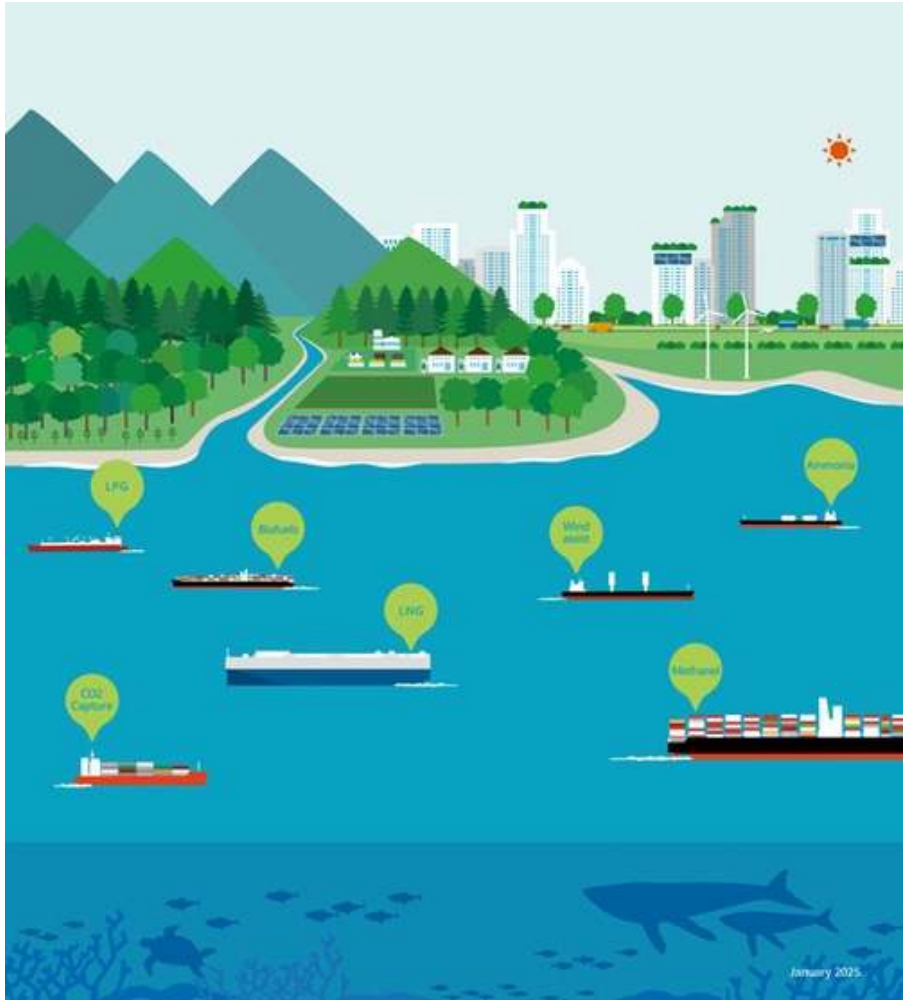
## 2 (D): Understanding Costs, Fuel Costs

- **Fuel** burning rates and **Daily Operational Costs** for a 60 MW ship (80,500 hp)

| Fuel Type | Cost ($/ton) | Daily Cost ($/day) |
|---|---|---|
| **LNG** | 3,500-6,000 | 94,00-188,000 |
| **Methanol** | 350-550 | 165,000-259,000 |
| **Ammonia** | 400-800 | 203,000-406,000 |
| **B30 Blend** | 720-800 | 216-000-250,000 |
| **Hydrogen** | 3,500-6,000 | 275,000-471,600 |
| **Electricity *** | $0.10 per kWh | 151,584 |

***Additional considerations***

- Infrastructure and Bunkering
- Supply Chain and Global Availability
- Regulatory Compliance and Incentives
- Safety and Risk Management
- Environmental Impact beyond CO2
- Economic Viability and Long-Term Sustainability
- Comparison of fuel volume (green circles on the right)

# Alternative Fuels

## 2 (D): Understanding Costs, Fuel Costs, continue

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### Marine fuel comparison

| | | Technology and safety | | | Economic | | Availability | | GHG |
|---|---|---|---|---|---|---|---|---|---|
| **Fuel substance** | | **Volumetric energy density*** | **Maturity indicator (ICE)** | **Safety regulations (IMO)** | **Onboard CAPEX** | **Fuel cost*** ** | **Fuel production** (Mtoe per year)** | **Bunkering infrastructure** | **WtW GHG intensity**** ($gCO_2$-eq./MJ)** |
| Fuel oil | Fossil | ~36 GJ/m³ | Mature | Mature | No additional cost | MGO: ~700 USD/tonne VLSFO-eq. | | Well-established | ~91 |
| | Low GHG intensity | | Mature, but bio-based diesel compatibility should be checked on a case-by-case basis | | | B100 biodiesel: ~1500 USD/tonne VLSFO-eq. | Sustainable biodiesel: ~25 | | <34 |
| LNG (methane) | Fossil | ~21 GJ/m³ (~58% of fuel oil) | Mature | Mature | ~15-30% additional cost | LNG: ~500 USD/tonne VLSFO-eq. | | >80 ports 63 bunkering vessels (29 on order) | ~76-91 |
| | Low GHG intensity | | | | | High | Bio-methane: ~6 Biogas: ~40 | | <51 |
| Methanol | Fossil | ~16 GJ/m³ (~44% of fuel oil) | Limited engine models available, boilers under development | Alternative design approval process required, but interim IMO guidelines in place | ~10-20% additional cost | ~700 USD/tonne VLSFO-eq. | | 10 bunkering vessels (5 on order) | ~101 |
| | Low GHG intensity | | | | | ~2200 USD/tonne VLSFO-eq. | Bio/e-methanol: <4 (announced projects: ~50) | | <35 |
| Ammonia | Fossil | ~12 GJ/m³ (~33% of fuel oil) | Engines and boilers under development | Alternative design approval process required | ~15-25% additional cost | ~1000 USD/tonne VLSFO-eq. | | No dedicated bunkering infrastructure | ~124 |
| | Low GHG intensity | | | | | ~2800 USD/tonne VLSFO-eq. | Blue/e-ammonia: <1 (announced projects: ~200) | | <36 |
| Hydrogen (liquefied) | Fossil | ~9 GJ/m³ (~25% of fuel oil) | Engines under development | Alternative design approval process required | >30% additional cost | High | | Infrastructure for marine transport and bunkering to be developed | ~133 |
| | Low GHG intensity | | | | | Very high | Bio/e-hydrogen: ~1 (announced projects: ~50) | | <34 |

*not including fuel storage system
**based on current annual production capacity (by end of 2030) from DNV's Alternative Fuels Insights platform
***based on estimated recent prices, 2024-04, in Rotterdam by Argus Media (if available)
****for all low GHG intensity fuels, we assume production with GHG saving of at least 65%

High score | Medium score | Low score | Very low score



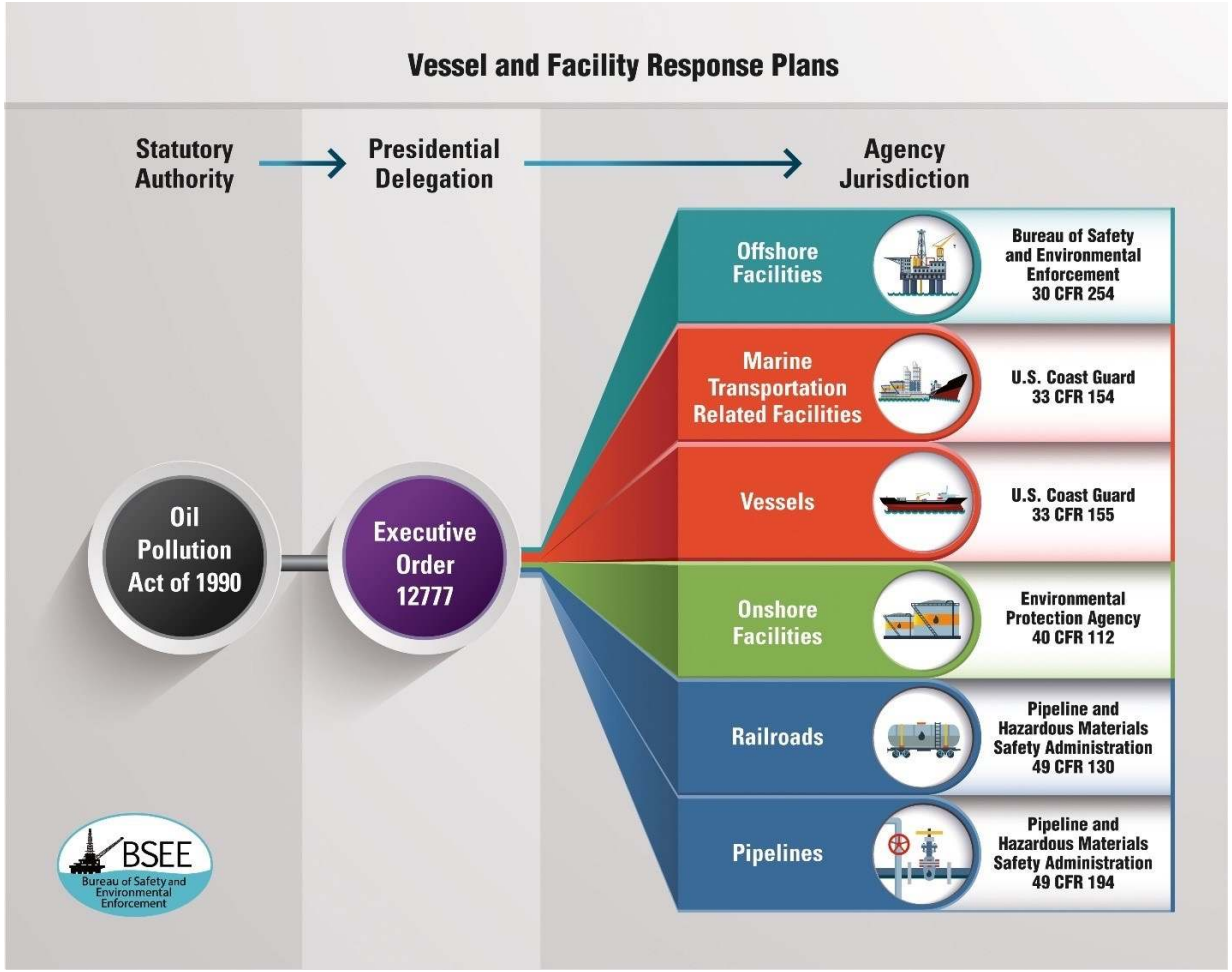
Mtoe: Million tonne oil equivalents ICE: Internal Combustion Engine WtW: Well-to-wake

DNV

# Alternative Fuels

## 2 (D): Understanding Costs, Regulations

- USCG considerations regarding regulations




- Emergency responders and the salvage industry should be involved in the maritime industry's "**safety by design**" process.
- Responders (*not just Salvors*) must be properly trained, equipped and prepared to respond to alternative fueled vessels.
- National and Area Contingency Plans should include response procedures for alternative fueled vessels.
- Government agencies, ports, municipal firefighters, and the maritime industry should work together to conduct risk assessments, gap analyses, and develop tactical response plans.
- SMFF regulations should be revised to apply to alternative fueled vessels (*we spoke about OPA90 focus is "oil"*).
- National legal frameworks to address alternative fueled vessels should promote the safety of life and the environment.

# Alternative Fuels

## 3. U.S. OPA-90 Legal Framework

### The Oil Pollution Act of 1990 (OPA-90)

The Oil Pollution Act of 1990 (OPA-90) was signed into law largely in response to the rising U.S. public concern over the potential environmental impacts of oil spills. The OPA-90 regulations, which apply to all tank vessels and non-tank vessels 400gt and greater operating the U.S., improved the nation's ability to prevent and respond to oil spills by establishing provisions that expanded the federal government's ability, and provide the money and resources necessary, to respond to oil spills.

**The law includes numerous measures targeted at reducing the risk of oil pollution, such as:**

- Double Hull Tanker Requirement
- Development of unique Vessel Response Plans (VRP)
- Oil Spill Response Organization (OSRO) readiness
- **Salvage & Marine Firefighting (SMFF) readiness**
  - **2008: Final Rule for Tank Vessels**
  - **2013: Final Rule for Nontank Vessels**

# Alternative Fuels

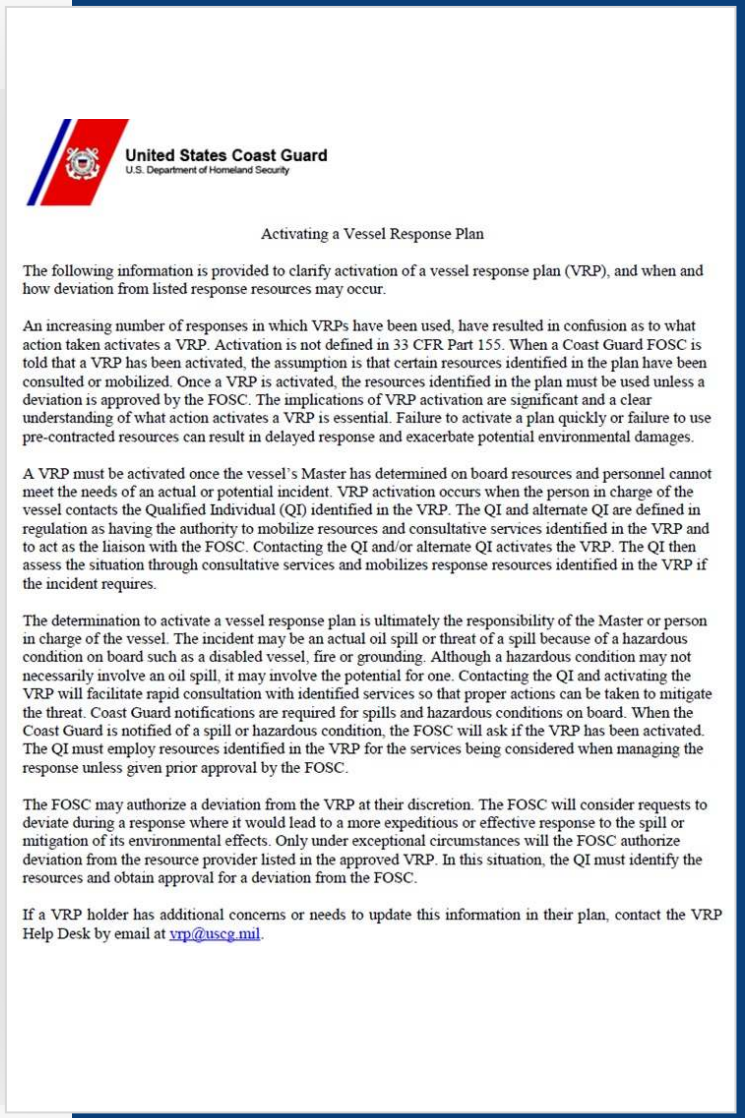
## 3. U.S. OPA-90 Legal Framework

- The VRP must be activated for an <u>oil spill or threat of a spill</u> (*pollution*) and/or Vessel Master has determined on board resources and personnel cannot meet the needs of an actual positional incident.
- However, a hazardous condition or threat thereof, may also trigger activation of response resources. Hazardous conditions include the following:

| | | | | |
|---|---|---|---|---|
| ○ COLLISION | ○ ALLISION | ○ FIRE | ○ EXPLOSION | ○ GROUNDING |
| ○ LEAKAGE/ LEAKING | ○ SINKING | ○ CAPSIZING | ○ LOSS OF PROPULSION | ○ LOST/ OVERBOARD VESSEL APPARATUS |

And who can activate the VRP?

The Vessel Master, the Vessel Owner/Operator, the Qualified Individual, and/or the USCG (in form of an Admin Order) have the authority to activate the VRP.



United States Coast Guard
U.S. Department of Homeland Security

Activating a Vessel Response Plan

The following information is provided to clarify activation of a vessel response plan (VRP), and when and how deviation from listed response resources may occur.

An increasing number of responses in which VRPs have been used, have resulted in confusion as to what action taken activates a VRP. Activation is not defined in 33 CFR Part 155. When a Coast Guard FOSC is told that a VRP has been activated, the assumption is that certain resources identified in the plan have been consulted or mobilized. Once a VRP is activated, the resources identified in the plan must be used unless a deviation is approved by the FOSC. The implications of VRP activation are significant and a clear understanding of what action activates a VRP is essential. Failure to activate a plan quickly or failure to use pre-contracted resources can result in delayed response and exacerbate potential environmental damages.

A VRP must be activated once the vessel's Master has determined on board resources and personnel cannot meet the needs of an actual or potential incident. VRP activation occurs when the person in charge of the vessel contacts the Qualified Individual (QI) identified in the VRP. The QI and alternate QI are defined in regulation as having the authority to mobilize resources and consultative services identified in the VRP and to act as the liaison with the FOSC. Contacting the QI and/or alternate QI activates the VRP. The QI then assess the situation through consultative services and mobilizes response resources identified in the VRP if the incident requires.

The determination to activate a vessel response plan is ultimately the responsibility of the Master or person in charge of the vessel. The incident may be an actual oil spill or threat of a spill because of a hazardous condition on board such as a disabled vessel, fire or grounding. Although a hazardous condition may not necessarily involve an oil spill, it may involve the potential for one. Contacting the QI and activating the VRP will facilitate rapid consultation with identified services so that proper actions can be taken to mitigate the threat. Coast Guard notifications are required for spills and hazardous conditions on board. When the Coast Guard is notified of a spill or hazardous condition, the FOSC will ask if the VRP has been activated. The QI must employ resources identified in the VRP for the services being considered when managing the response unless given prior approval by the FOSC.

The FOSC may authorize a deviation from the VRP at their discretion. The FOSC will consider requests to deviate during a response where it would lead to a more expeditious or effective response to the spill or mitigation of its environmental effects. Only under exceptional circumstances will the FOSC authorize deviation from the resource provider listed in the approved VRP. In this situation, the QI must identify the resources and obtain approval for a deviation from the FOSC.

If a VRP holder has additional concerns or needs to update this information in their plan, contact the VRP Help Desk by email at vrp@uscg.mil.

# Alternative Fuels

## 4. Preparedness, Responses & Case Studies

**Salvage Experience in LNG**

- Several successful LNG emergency STS cases
- LNG lightering equipment SMIT Houston
- Keppel-SMIT Towage operating LNG dual-fueled harbor tugs
- SMIT is co-author SGMF Guideline – Salvage Principles
- SMIT is part of SIGTTO working group on “Gas Carrier Emergency Preparedness” publication
- 2020-2021: Extensive study Emergency STS for LNG fueled (container) vessels

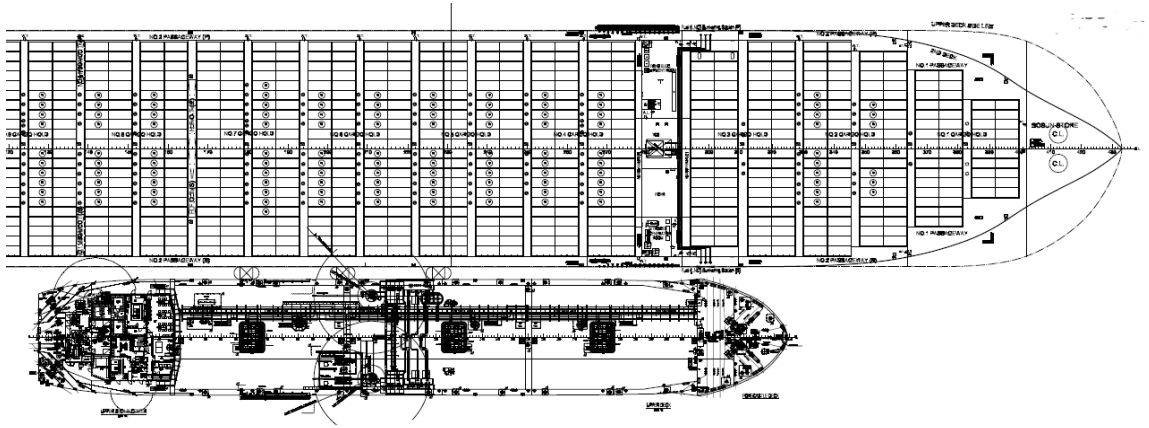

SIGTTO

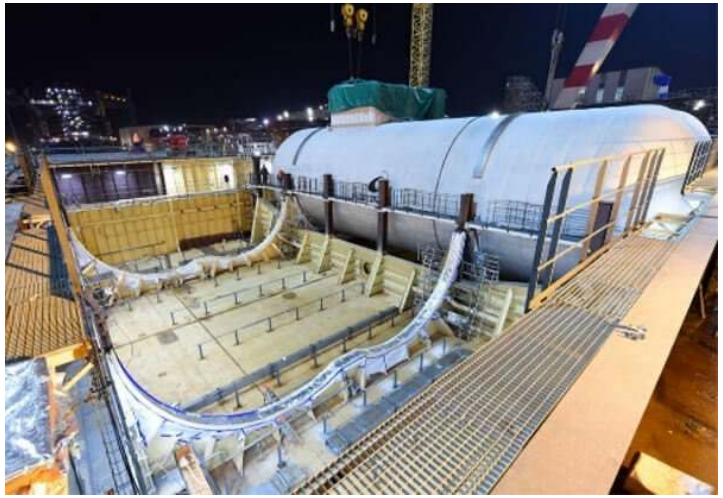
# Alternative Fuels

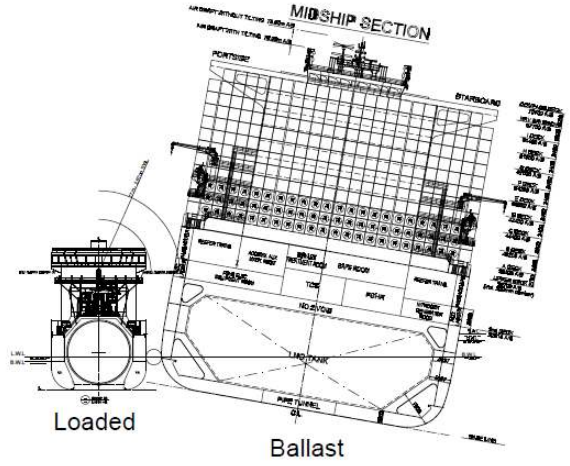
## 4. Preparedness, Responses & Case Studies

**2020-2021: Extensive study Emergency STS for LNG fueled (container) vessels**

- Salvage scenarios
- Mooring arrangements
- LNG assets and partners
- STS equipment set design
- Developing LNG infrastructure







# Alternative Fuels

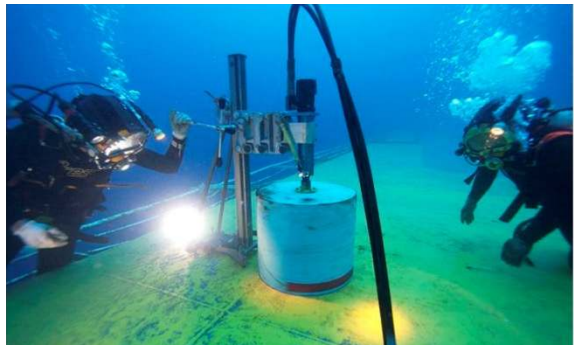
## 4. Preparedness, Responses & Case Studies

### LNG Emergency STS Equipment

- Proper PPE
- Cryogenic specialists
- Cryogenic STS equipment like hoses, saddles, tee pieces, connections, lines, valves, etc.
- Portable flares (BOG handling)
- Zone management
- Water current barriers
- Generators
- Gas detection
- Universal safety link
- Inerting and purging capabilities (on board lightening tonnage)
- Lightening tonnage, suitable receiving tanks in trucks or barges, tugs with fifi and towing capacity








# Alternative Fuels

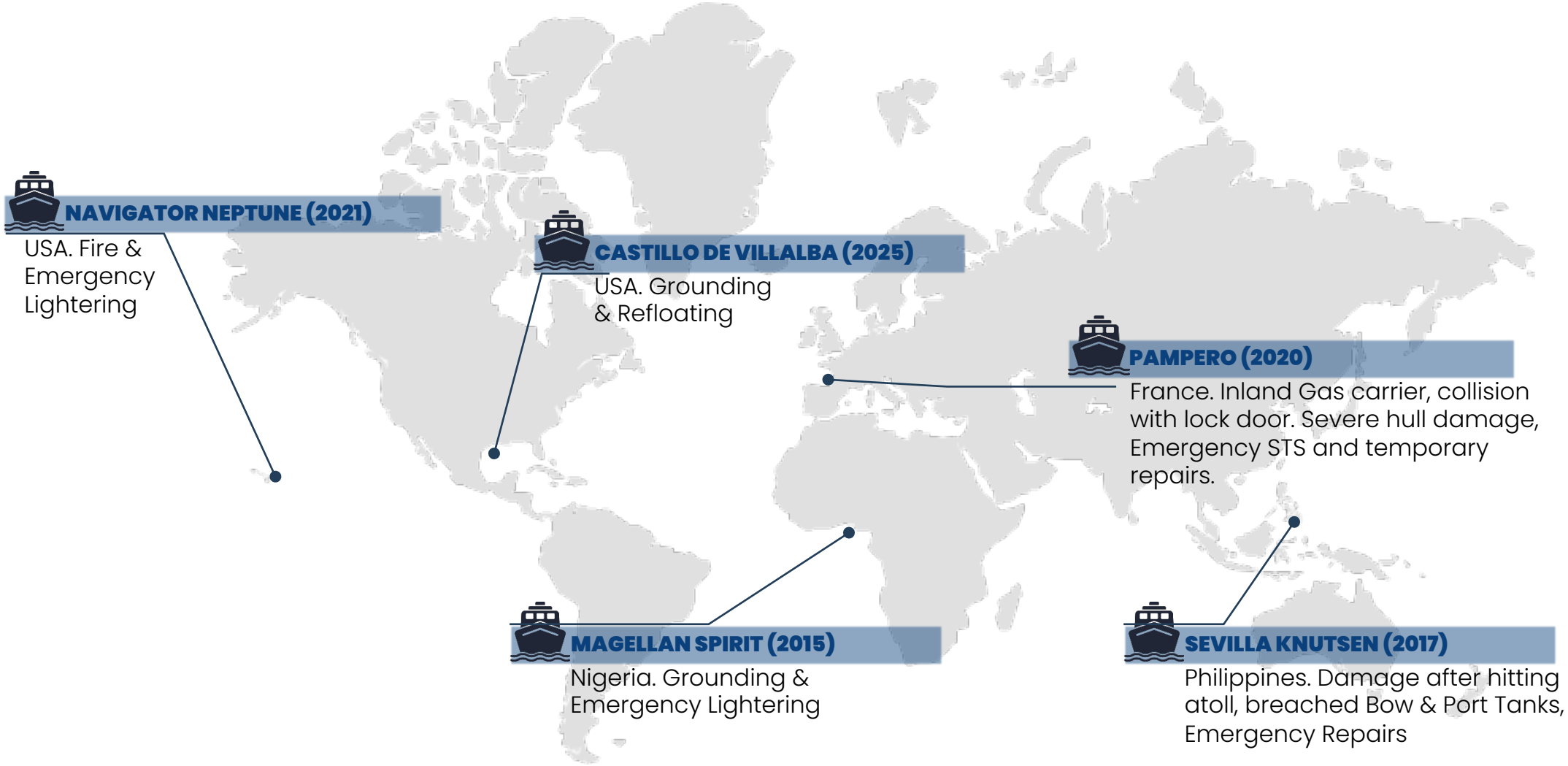
## 4. Preparedness, Responses & Case Studies

**Ongoing Preparedness Efforts**

- SMIT continues to work on solutions for salvage cases with alternative fuels
- Further R&D and exchange of information in SGMF
- In-house training of personnel
- For 30-years, 62nd edition of in-house 4-day training course, "**Managing Marine Emergencies**", dates for next year are*:*
    - April 14-17, 2026
    - November 10-13, 2026
- Close cooperation SPT and salvors
- More fundamental research required, preferably in cooperation with stakeholders
- Open for discussions with owners/operators/consortia regarding equipment storage, readiness, preparedness and exercises

# Alternative Fuels

## 4. Preparedness, Responses & Case Studies



# Alternative Fuels

## 4. Preparedness, Responses & Case Studies

**“MAGELLAN SPIRIT” – Nigeria (2015)**

- 82,000 DWT, 290-meter LOA, LNG tanker aground along channel, Bonny Island, Nigeria
- Failed pulling attempts > lightering of cargo required for refloating
- Complexity surrounding factors:
  - Piracy threat & Close proximity to channel
  - Planning & regulations LNG Transfer (Teekay + Shell procedures)
  - On-site & In-Office manning requirements, 24/7
- Lightering LNG vessel ‘Excellence’ (including equipment)
- SMIT Salvage coordination team offshore + onshore + LNG expert team
- SMIT Lamnalco tug assistance
- 45,000 m3 offloaded
- Controlled (de-)ballasting and refloating
- Backloading at safe anchorage Lome, Togo

# Alternative Fuels

## 4. Preparedness, Responses & Case Studies

**“SEVILLA KNUTSEN” – Philippines (2017)**

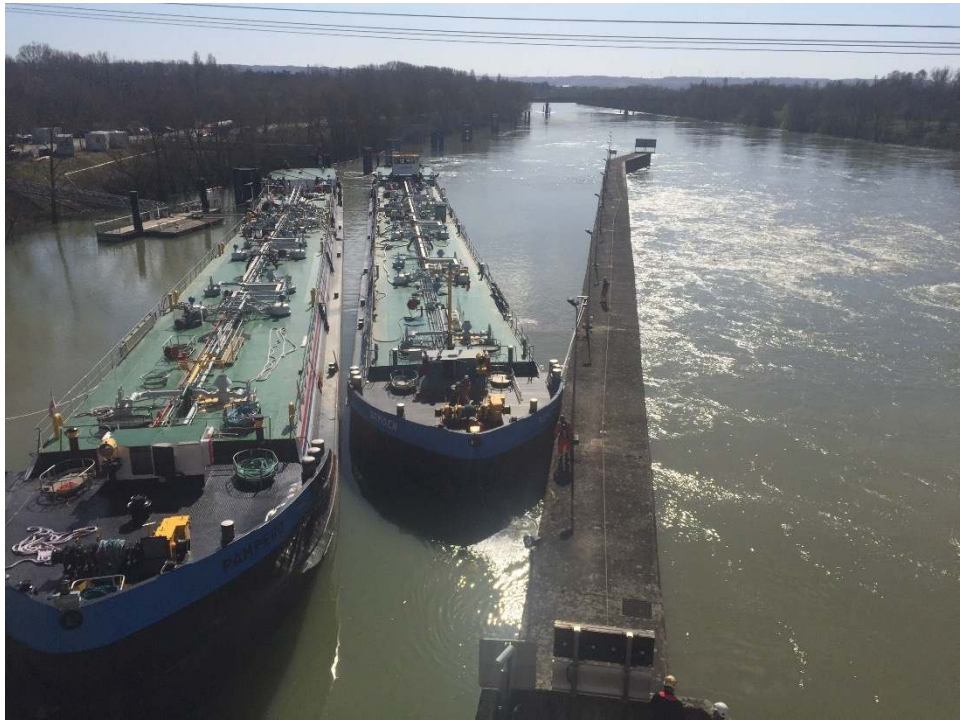
- LNG carrier (in ballast), hit atoll in open ocean.
- Damage from bow to stern over the full length on port side
- Breached ballast tanks and engine room
- Emergency repairs


# Alternative Fuels

## 4. Preparedness, Responses & Case Studies

**“PAMPERO” – France (2020)**

- Inland Gas carrier, collision with lock door
- Loaded with 2200 m3 of VCM
- Severe hull damage, broken vessel
- Emergency STS and temporary repairs



# Alternative Fuels

## 4. Preparedness, Responses & Case Studies

**“NAVIGATOR NEPTUNE” – Hawaii, USA (2021)**

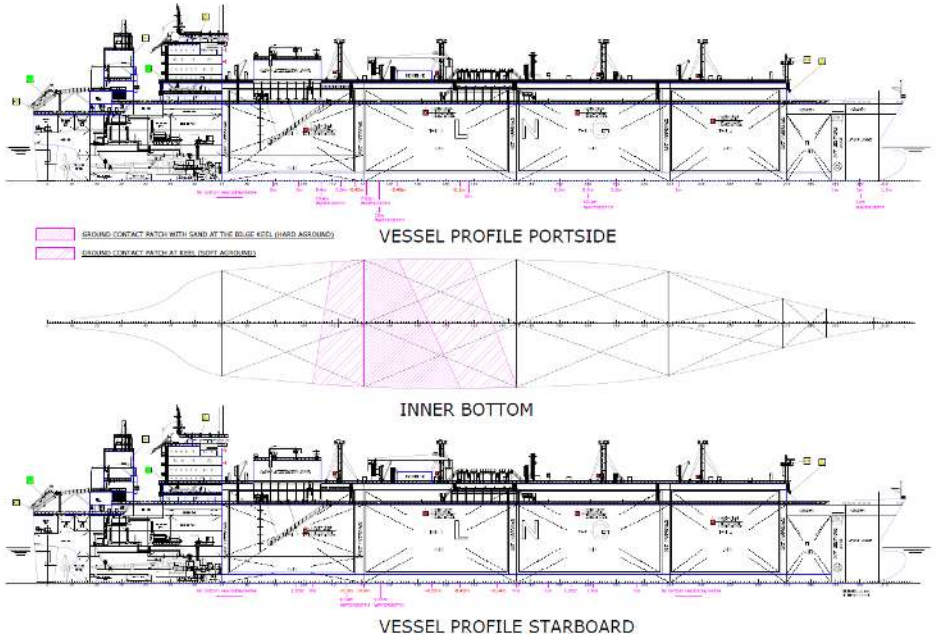
- LPG tanker, fire in engine room. Loaded with 22,000 m3 Ethylene.
- Engine room fire. Fire was extinguished by crew, but ME not operational and cargo could not be cooled.
- Mobilization of team, STS equipment, powerpack, tugs and STS lightering vessel was client provided.
- External power was established to the casualty and emergency STS performed at a remote and challenging location.

# Alternative Fuels

## 4. Preparedness, Responses & Case Studies

**“CASTILLO DE VILLALBA” – GOA, USA (April 2025)**

- LNG tanker ran hard aground 25-nm off Sabine Pass. Loaded with 136,000 m3 of LNG cargo.
- Mobilization of RSA and 2x Naval Architects as well as 2x Ocean going tugs and Dive Team.
- Conventional salvage methods such as internal ballast transfer, scouring and pulling were utilized to refloat the casualty within 96-hours of the event.

# Alternative Fuels

## 5. Challenges & Opportunities within the Salvage Community

### Challenges

- More Complex Operations
  - Mix and/or Undeclare Cargos
  - Larger ships
  - Casualty location wrt Alt. Fuel type (due to infrastructure / logistics)
- Shrinking Talent Pool
  - Less jobs to train personnel
  - 84-hr work week is not appealing to new generation
- Higher Risks
  - More regulatory/ legal risk (*and other unknow risks*)
  - More stakeholder's involvement
  - More expectations around environment mitigation
- Higher Expenses
  - Personnel
  - Craft, Equipment and Assets
  - Fuel & Energy

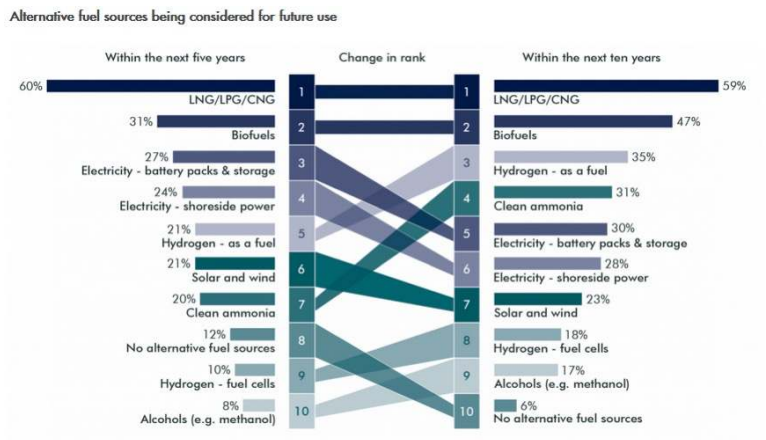
### Opportunities

- More Literature & Info
  - Online reports and databases
  - AI, BI and models via real-time platforms
  - Many industry events regarding Alt. Fuels
- Internship Opportunities
  - SECNAV, Tours with Industry
  - Work-Life balance initiatives
- Bridging the Gap within Regulators
  - Greter interest from all stakeholders within the entire supply chain including the regulators > capitalize today's engagement in our Preparedness & Response posture
- Greater R&D capabilities
  - For tools for the trade & PPE measures
- Albeit not OPA90 covered > Salvors will continue to respond as these marine casualties (Alt. Fueled or not) disrupt the Maritime Transportation System

# Alternative Fuels

## 6. The Future regarding Alternative Fuels and Salvage Operations

### Alternative Fuels: who's in the lead




### Salvage Operations success are because of People & Equipment


Recent developments in both maritime regulations and the global energy market have led to an increased interest in the use of LNG as a marine fuel. IGF Code is out to facilitate its safe use and is ultimately supporting the drive toward lower emissions. As more LNG fuelled vessels enter into operation, salvage companies will have to be prepared to offer their services to the LNG marine fuelled fleet. The physical properties of LNG are very different from conventional fuel oils, which means that a different approach to salvage will be required.

Presence of a cryogenic liquid brings new challenges to any salvage operation, whether it is as a fuel or a cargo. For a general assessment there are three types of salvage scenarios, ranging from floating upright, partially submerged to fully submerged. For a salvage operation involving LNG in any way the priority must be safety. Full risk assessments are required to fully evaluate any operation involving cryogenic materials.

The success of a salvage operation will largely depend on the people involved and the equipment used. Salvage crews competent in handling cryogenic liquids in combination with LNG specialists are necessary for a safe and efficient operation. All equipment used on site will have to be designed to function in cryogenic temperatures.

This paper is offered as a starting point for the industry to understand the issues involved when encountering a salvage operation involving LNG as a fuel. It is envisaged that as the industry evolves the understandings initiated here will be built upon towards a comprehensive guide as to what would need to be done.

# Alternative Fuels

## 7. Bibliography / Credit