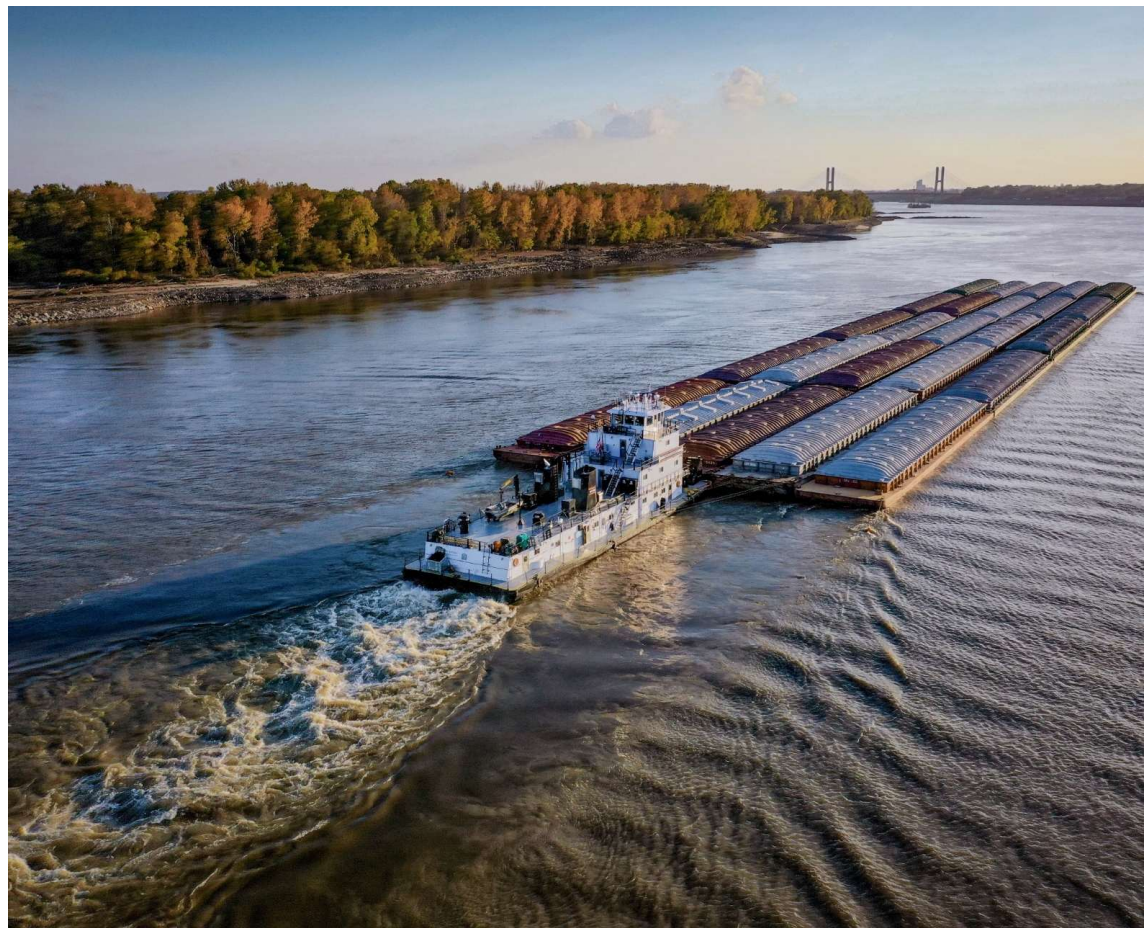




BAD GAS?

DEALING WITH A STINK
OVER SULFUR
AND COMING CHALLENGES
WITH ALTERNATIVE FUELS

Francisco A. Pecci & Lawrence D. Malizzi



June 19, 2026

For Planet & Progress

Your Presenters



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Agenda

Current & Proposed Frameworks 01

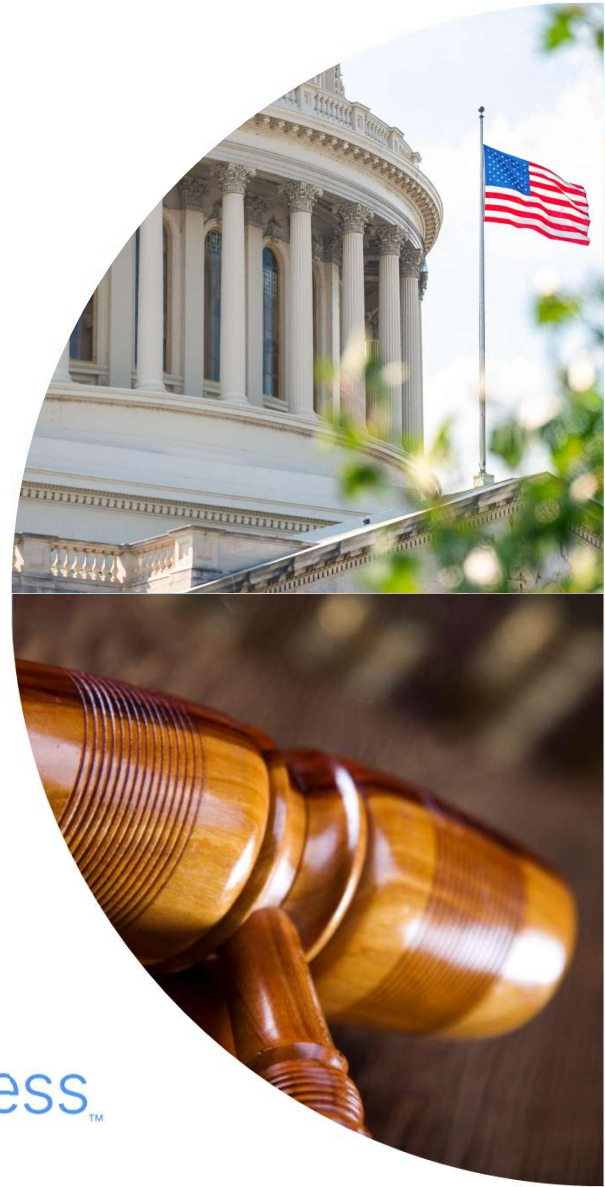
Vessel Considerations 02

Fuel Characteristics 03

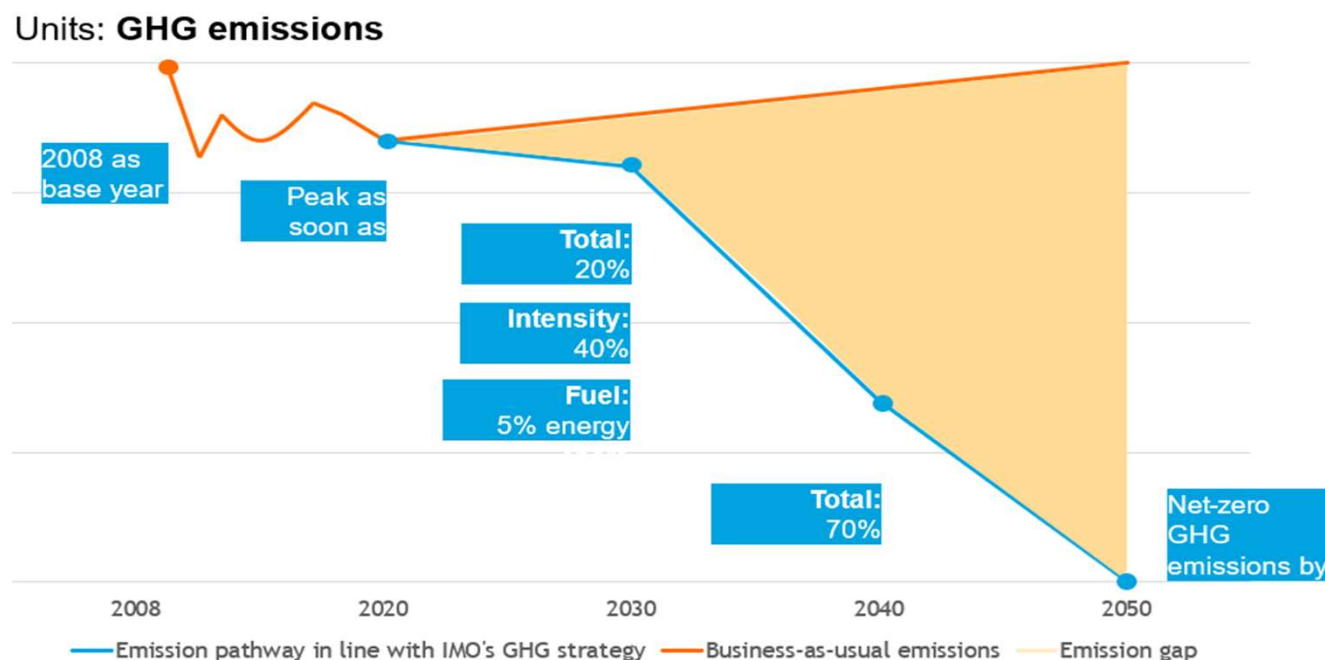
Legal Considerations 04

Current & Proposed Legal Frameworks

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Strengthened IMO strategy on GHG reductions



Total: Well-to-wake GHG emissions; Intensity: CO₂ emitted per transport work; Fuel: Uptake of zero or near-zero GHG technologies, fuels and/or energy sources

IMO – NET-ZERO/CARBON FEE APRIL 11, 2025, REGULATION

MEPC 83 / October 2025 Adoption / Spring 2026 Detailed implementation / 2027 Entry into force

- IMO Approval: Mandatory marine fuel standards and GHG emissions pricing for shipping on April 11, 2025. Vessels will be required to progressively reduce their annual GFI (emissions per unit of energy used)
- Implementation Timeline:
 - Formal adoption expected in October 2025.
 - Measures to enter into force by late 2027.
- Impact on Vessels:
 - Applies to large ocean-going vessels over 5,000 gross tonnage
 - (approx. 85% of CO₂ emissions from international shipping).
- New Regulations:
 - The IMO Net-Zero Framework will be added as a new Chapter 5 to Annex VI
 - Introduces emissions limits and a carbon pricing mechanism.
 - Fees range from \$100 to \$380 per ton of CO₂ emitted above the thresholds.
- Options for Compliance: Ships exceeding emissions caps can:
 - Purchase unused allowances from lower-emitting vessels.
 - Contribute to the IMO Net-Zero Fund, which supports low-carbon fuel development and climate resilience for vulnerable small island nations.
- Revenue Generation: The initiative could generate \$10 to \$13 billion annually
- Full Enforcement: Expected by 2028.

U.S. RESPONSE TO THE IMO's NET-ZERO/CARBON FEE

APRIL 11, 2025 - August 12, 2025

- “President Trump has made it clear that the United States will not accept any international environmental agreement that unduly or unfairly burdens the United States or harms the interests of the American people. This October, members of the International Maritime Organization (IMO) are poised to consider the adoption of a so-called “Net-Zero Framework,” aimed at reducing global greenhouse gas emissions from the international shipping sector.
- Whatever its stated goals, the proposed framework is effectively a global carbon tax on Americans levied by an unaccountable UN organization. These fuel standards would conveniently benefit China by requiring the use of expensive fuels unavailable at global scale. These standards would also preclude the use of proven technologies that fuel global shipping fleets, including lower emissions options where U.S. industry leads such as liquified natural gas (LNG) and biofuels. Under this framework, ships will have to pay fees for failing to meet unattainable fuel standards and emissions targets. These fees will drive up energy and transportation and leisure cruise costs. Even small vessels would incur millions of dollars in fees, directly driving up costs for American consumers.
- The Trump Administration unequivocally rejects this proposal before the IMO and will not tolerate any action that increases costs for our citizens, energy providers, shipping companies and their customers, or tourists. We will fight hard to protect the American people and their economic interests. Our fellow IMO members should be on notice that we will look for their support against this action and not hesitate to retaliate or explore remedies for our citizens should this endeavor fail.”

<https://www.state.gov/releases/office-of-the-spokesperson/2025/08/joint-statement-on-protecting-american-consumers-and-shipping-industries-by-defeating-the-international-maritime-organizations-net-zero-framework-aka-global-carbon-tax>

IMO Fails to Adopt and Adjourns for One Year the Net-Zero Framework



IMO at the end of a contentious week adjourned the vote on the Net-Zero Framework for one year (IMO)

PUBLISHED OCT 17, 2025 4:34 PM BY [THE MARITIME EXECUTIVE](#)

Regulations

- The Oil Pollution Act of 1990 (OPA 90)- Not applicable except for biofuels.
- Comprehensive Environmental Response, Compensation, and Liability Act) (CERCLA)- Reportable Quantities:
 - Ammonia- 100 lbs
 - Methanol- 5,000 lbs
 - LNG & Hydrogen- Exempt

US Coast Guard Guidance

- Bunkering for alternative fuels
- Covers:
 - Scope
 - Authority
 - Risk Assessment
 - Compliance and enforcement

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



Commandant
United States Coast Guard

U.S. Coast Guard Stop 7509
2703 Martin Luther King Jr. Ave SE
Washington, DC 20393-7509
Staff Symbol: CG-OES
Phone: (371) 613-1069
Email: Alt-Fuel-Bunkering@uscg.mil

16715
CG-OES Policy Letter
No. 01-25
24 Jul 2025

KOCH,STEVEN
A.1228580925
Digitally signed by
KOCH,STEVEN A.1228580925
DN: cn=STEVEN A. KOCH, o=USCG, ou=CGO, email=STEVEN.A.KOCH@uscg.mil

From: S. A. Koch, CAPT
COMDT (CG-OES)

To: Distribution

Subj: GUIDELINES FOR BUNKERING OF VESSELS USING LIQUEFIED NATURAL
GAS (LNG) AND OTHER ALTERNATIVE MARINE FUELS

Ref: (a) Navigation and Vessel Inspection Circular (NVIC) 01-25 – Guidance for
Improvement and Enhancement of Cooperative Relationships Through Local
Harbor Safety Committees
(b) CG-SP Policy Letter 01-24 – Guidelines for Facility Design Review and
Compliance Oversight of Waterfront Facilities Handling Alternative Marine Fuels

1. PURPOSE. This policy letter provides guidance to Coast Guard Captains of the Port (COTPs) regarding the bunkering of vessels using liquefied natural gas (LNG) and other alternative marine fuels at waterfront facilities and in waters subject to the jurisdiction of the United States. This policy letter defines the Coast Guard's expectations for bunkering operations not covered by existing regulations and establishes a streamlined procedure for the bunkering risk assessment process.
2. ACTION. COTPs assessing the safety of bunkering operations involving LNG and other alternative fuels should refer to this policy letter for guidance. It is recommended that owners and operators of vessels and waterfront facilities conducting alternative fuel bunkering operations be familiar with the contents of this policy letter.
3. AUTHORIZED RELEASE. Internet release is authorized.
4. DIRECTIVES AFFECTED. Commandant (CG-OES) Policy Letter 01-15, dated February 19, 2015, and Commandant (CG-OES) Policy Letter 02-15, dated February 19, 2015, are hereby canceled.
5. BACKGROUND.

ENVIRONMENT TRANSPORTATION

Alternative ship fuels make waves in Pacific Northwest ports

The global shipping industry is a major emitter of greenhouse gases.

BY: TOM BANDE • DECEMBER 21, 2023 9:45 AM



The new LNG bunkering vessel Seaspán Garibaldi claimed a number of firsts in 2023, including the first cruise ship refueled with LNG in Vancouver and the first container ship. This bunker vessel and its sister ship have also topped off oil tankers and automobile carriers this year. (Photo courtesy of Seaspán ULC)

Vessel Considerations



Vessel Design Impacts



Weight Impacts - stability/vessel size & arrangements



Fuel Storage Volume



Cargo capacity impacts



Operational Costs



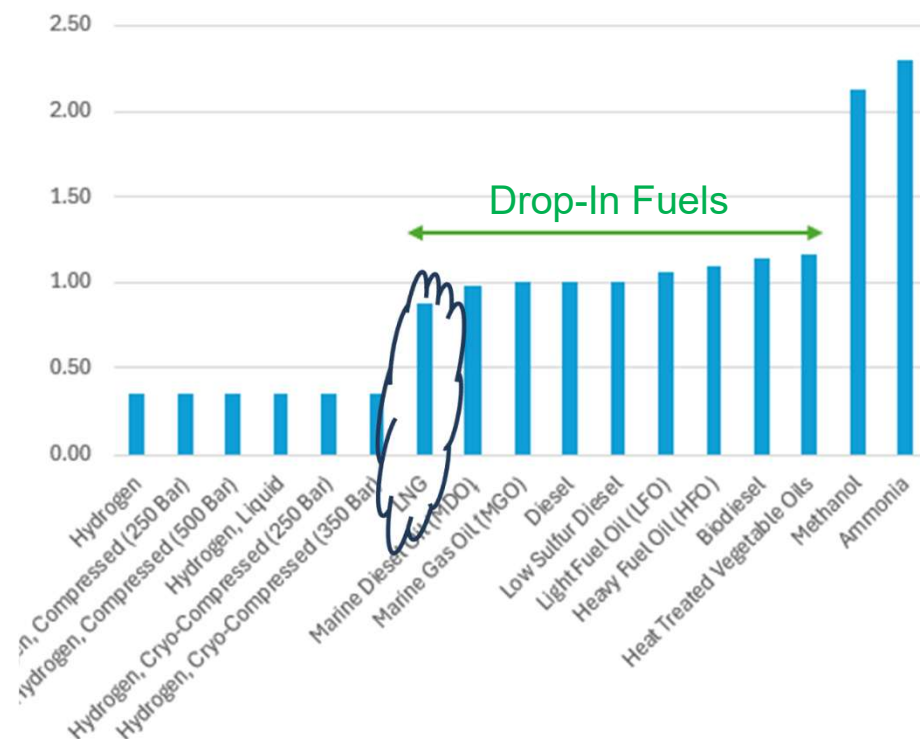
Personnel/Environmental Risk



Availability of Fuels

Fuel Weight Comparison

For Identical Energy Content



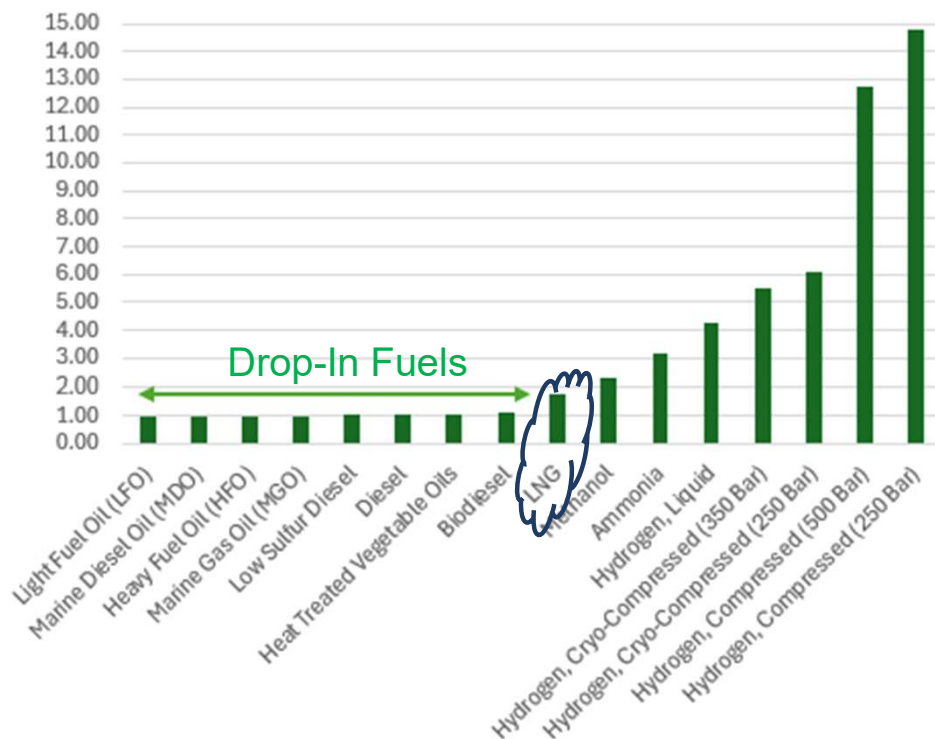
For the same range, fuel weight:

- LNG = 0.9 x diesel
- Methanol = 2.1 x diesel
- Ammonia = 2.3 x diesel
- Hydrogen = 0.4 x diesel

Not including additional space required for toxic, cryogenic, corrosive, flammable or explosive fuel.

Fuel Volume Comparison

For Identical Energy Content



For the same range, fuel volume:

- LNG = 1.7 x diesel
- Methanol = 2.2 x diesel
- Ammonia = 3.1 x diesel
- Hydrogen = 4.2 x diesel (or more)

Not including additional space required for toxic, cryogenic, corrosive, flammable or explosive fuel.

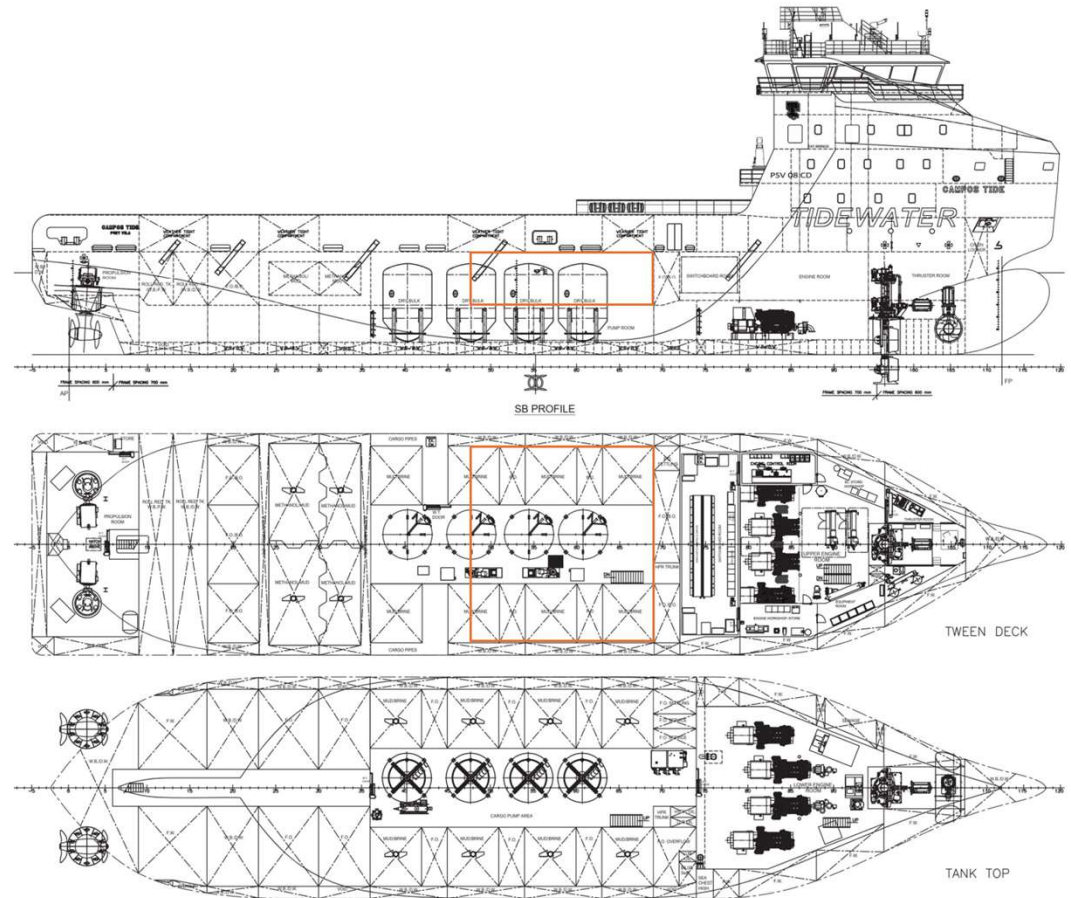
Platform Supply Vessel (PSV)

Diesel Volume in Single Tank

Fuel Tanks



Ref: Tidewater STX PSV 08



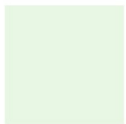
Platform Supply Vessel (PSV)

Equivalent LNG (CH_4 +) Tank/Hold Volume

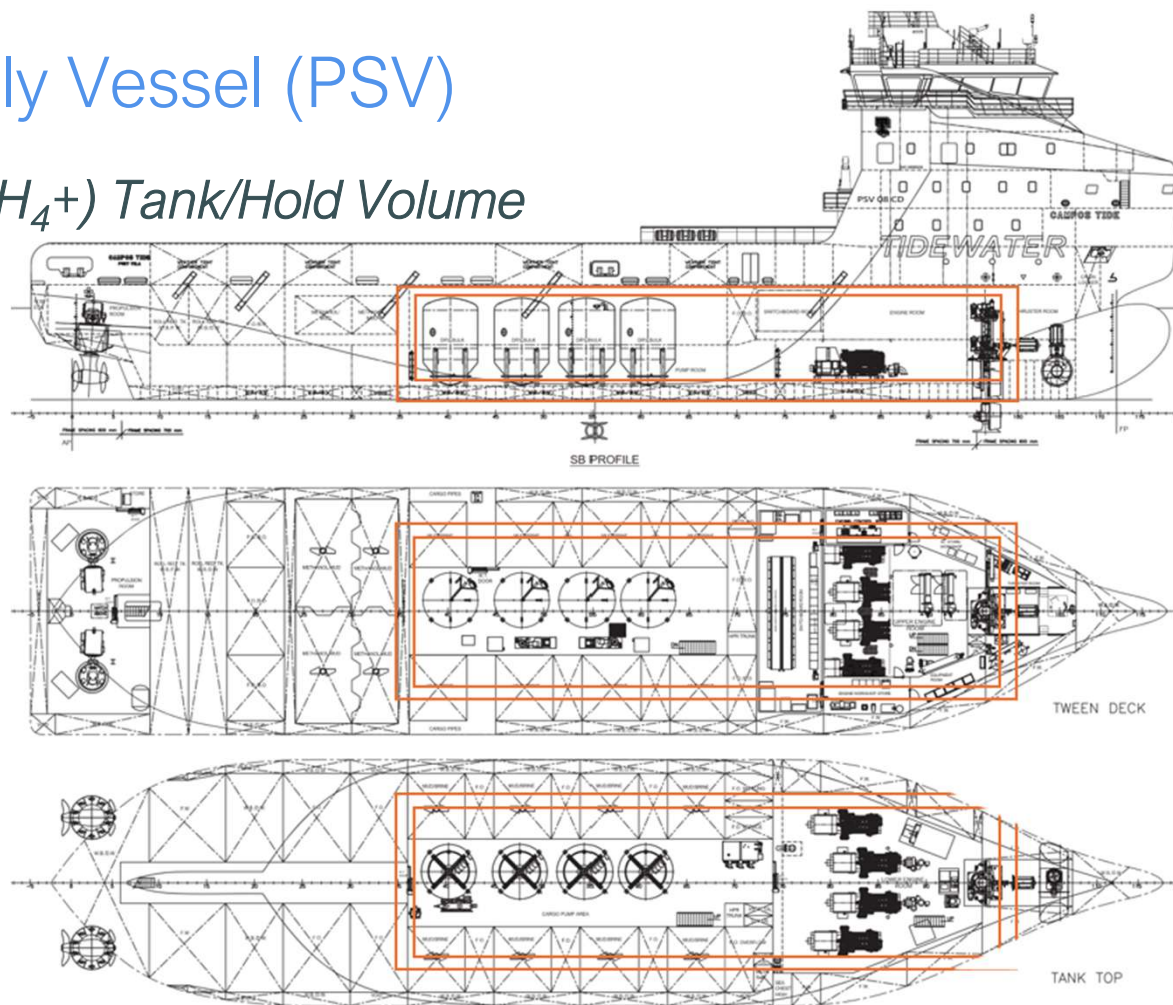
Fuel Tanks



Engine Room



Ref: Tidewater
STX PSV 08



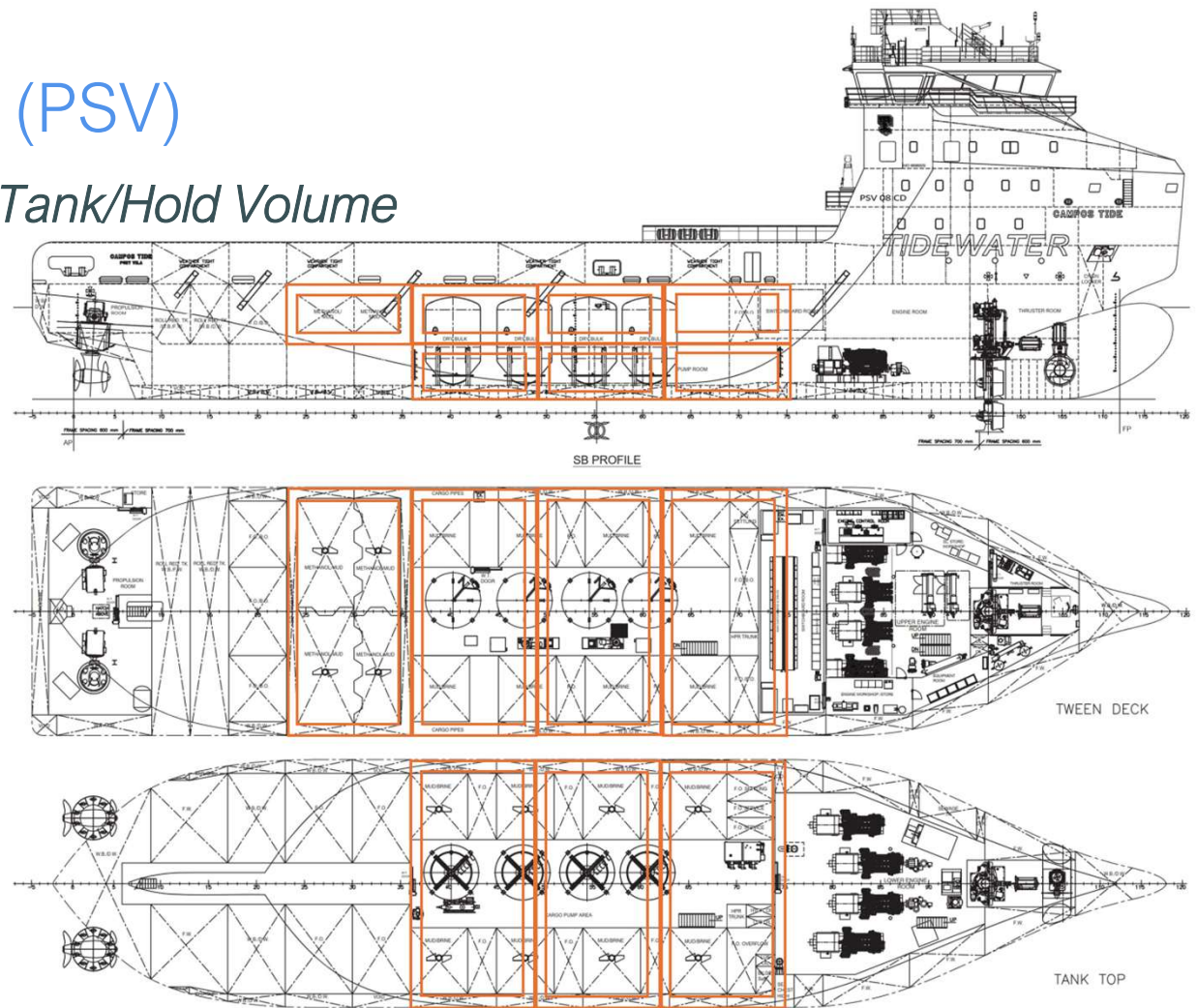
Platform Supply Vessel (PSV)

Equivalent Methanol (CH_3OH) Tank/Hold Volume

Ref: Tidewater STX PSV 08



Fuel Tanks



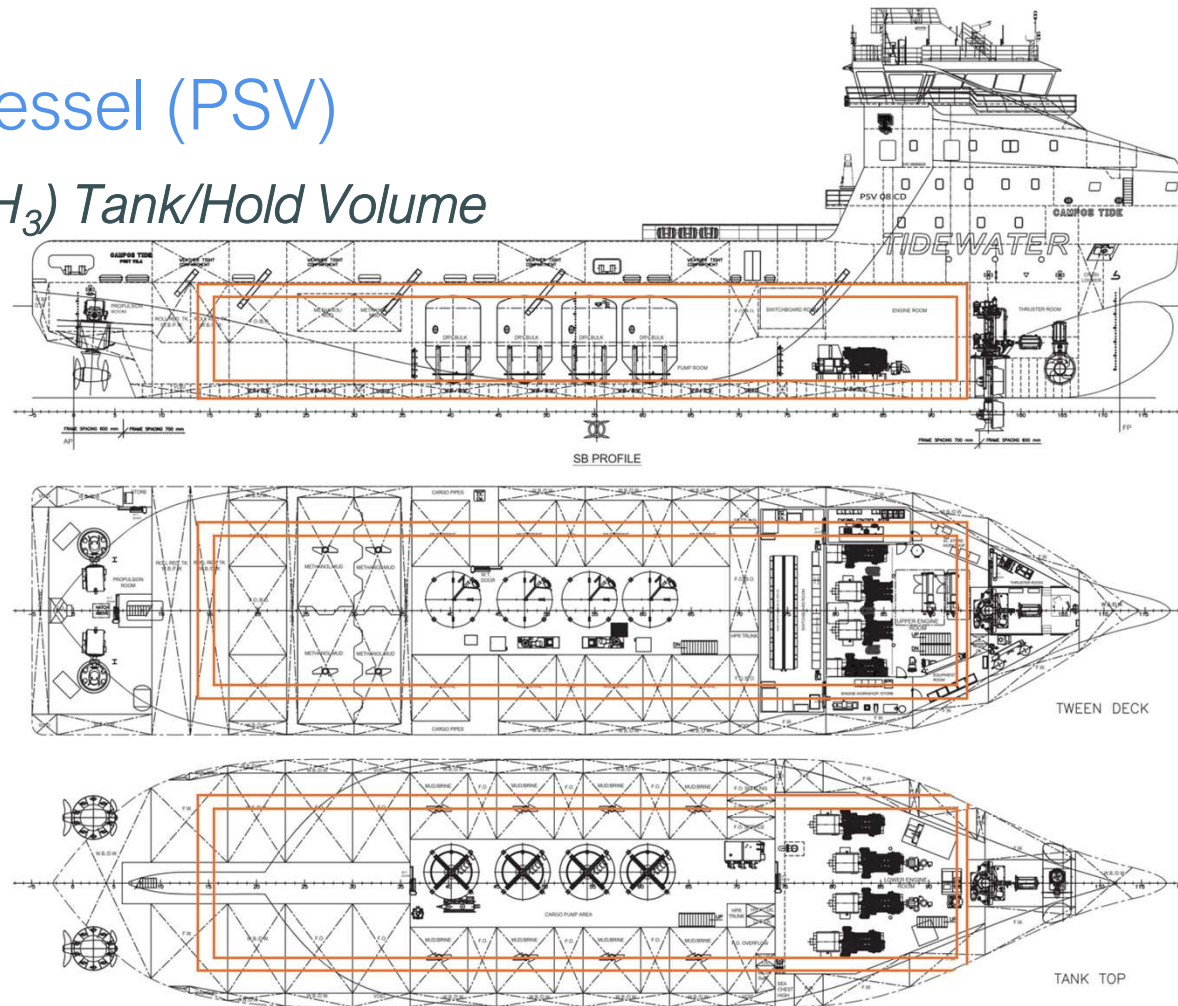
Platform Supply Vessel (PSV)

Equivalent Ammonia (NH_3) Tank/Hold Volume

Fuel Tanks



Ref: Tidewater STX PSV 08



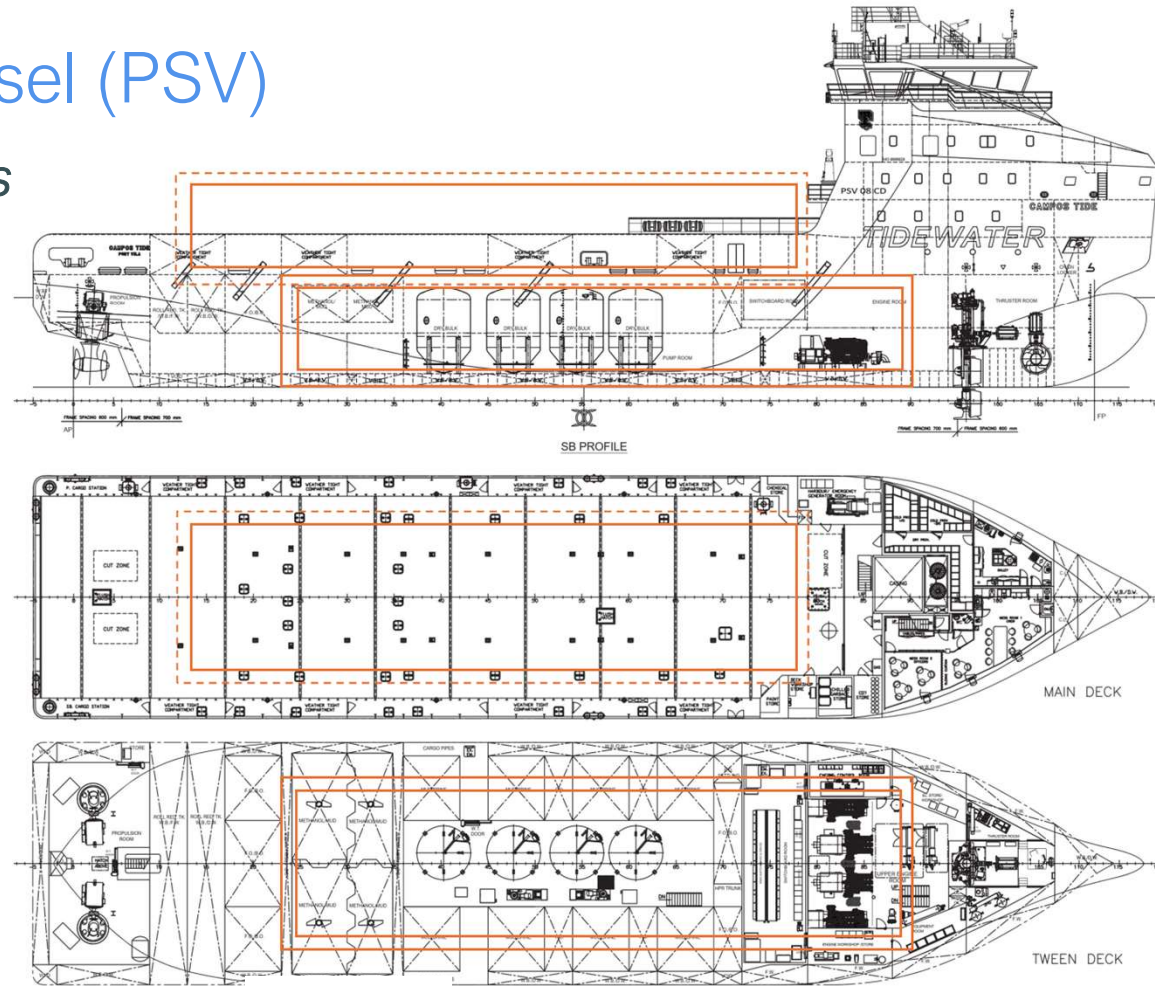
Platform Supply Vessel (PSV)

Liquid Hydrogen (H_2) Tanks

Fuel Tanks



Ref: Tidewater STX PSV 08

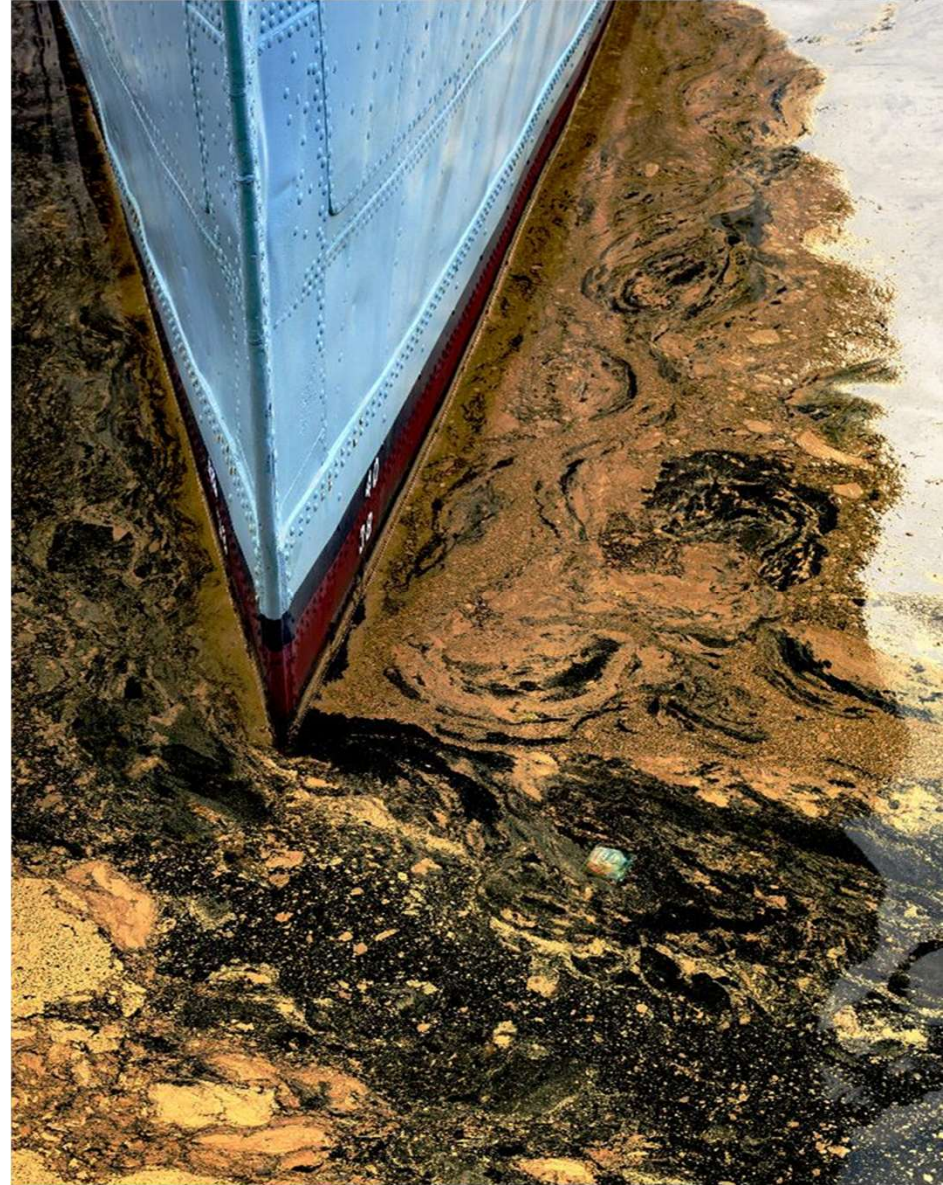


New Vessels – Characteristics of Alt fuels – risk identification & physical/operational changes to address

- Confined spaces...increased toxic / asphyxiation and explosion risks.

Fuel	Features	Toxic / Asphyx. Risk	Fire Risk	Explosion Risk
Liquid Hydrogen	Cryogenic liquid, low ignition energy, detonation potential, asphyxiation, invisible flame,	M	H	VH
LNG	Cryogenic liquid, flammable, explosion potential, asphyxiation	M	H	H
Methanol	Volatile liquid, flammable, highly toxic, explosion potential, invisible flame	H	H	M
Ammonia	Low volatility liquid, highly toxic, flammable	VH	L	L
Biodiesel	Low volatility liquid, flammable	L	M	L

■ Fuel Characteristics



Alternative fuels and their associated risks

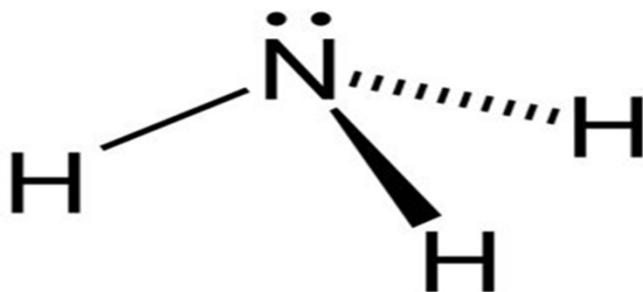
Fuel & associated risks from the four different fuels

Ammonia Hydrogen LNG Biofuels Methanol



<https://www.shimadzu.com/an/industries/new-energy/fuel-cells/index.html>
<https://www.energyintel.com/0000017f-1b41-d1ad-afff-bf77b78b0000>
<https://mykn.kuehne-nagel.com/news/article/cma-cgm-reports-exceptional-financial-year-de-06-Mar-2023>
<https://www.marinebusinessworld.com/news/248708/New-class-of-hydrogen-ship-design>

Ammonia



Public Health Considerations:

- Very irritating gas: coughing, throat irritation, skin and eye irritation
- Although it is colorless, its pungent odor provides early warning of its presence
- High concentrations can be fatal (pulmonary edema) and limit one's ability to escape a spill area
- Acute exposure 5,000–10,000 ppm is rapidly fatal in humans and exposure to 2,500–4,500 ppm is fatal in about 30 minutes (HEALTH EFFECTS -Toxicological Profile for Ammonia - NCBI Bookshelf (nih.gov))
- Flammable: gas presents an explosive hazard in confined spaces



Environmental Considerations:

- Highly soluble in water (70% of a surface spill volume will go into solution with water)
- Liquid ammonia that does not contact water will rapidly volatilize
- Toxic to aquatic life (formation of ammonium hydroxide generates heat, increases water pH)
- Fish kills have been reported even in smaller spills
- Can contaminate drinking water sources



April 08, 2023 | [News, Shipping](#)

U.S. East Coast green ammonia bunkering plan in the works

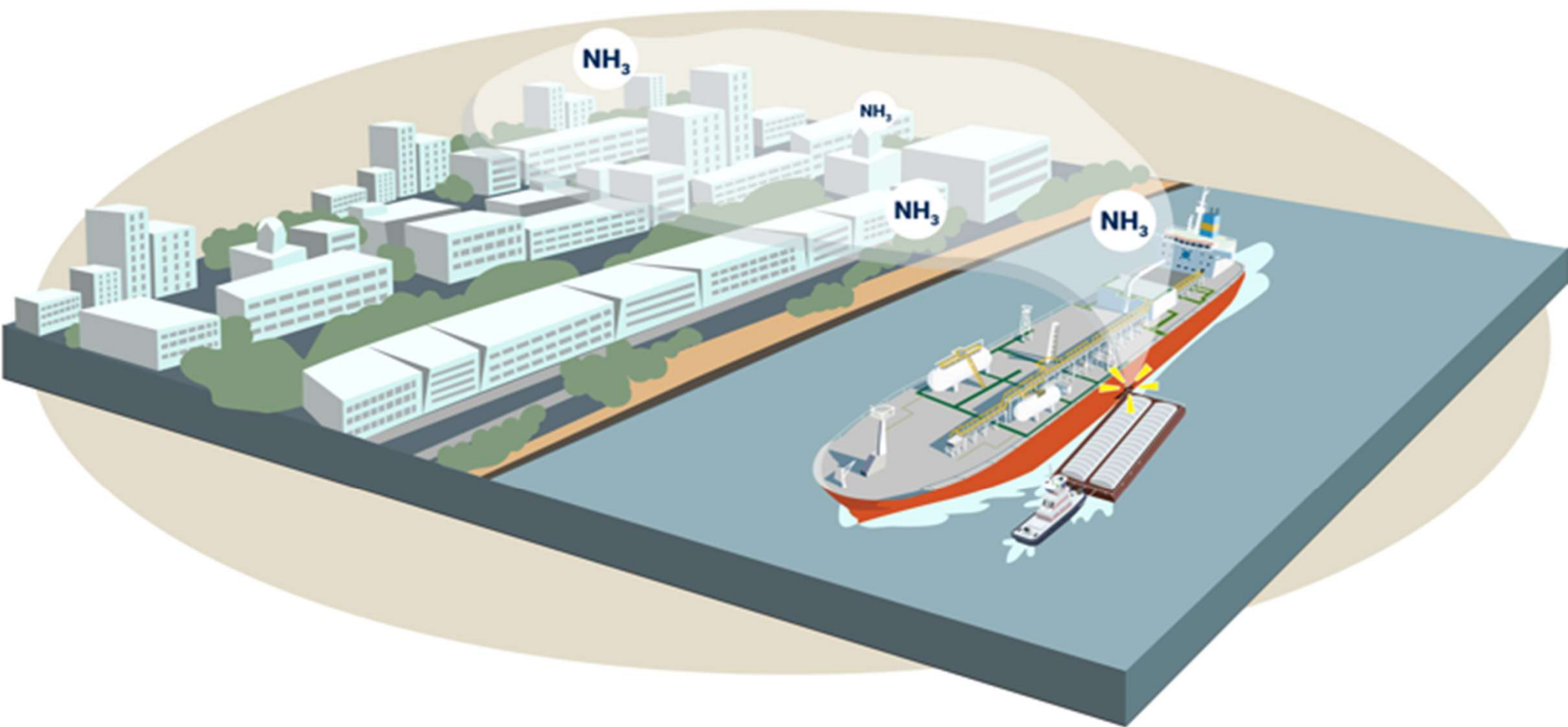
Written by [Nick Blenkey](#)



Savannah's proximity to the Ports of Brunswick and Jacksonville could help facilitate green ammonia bunkering of car carriers as well as containerships.

A group of eight U.S. and international marine industry leaders is looking to establish a supply chain to deliver ship-to-ship green ammonia bunkering on the U.S. East Coast.

U.S. East Coast green ammonia bunkering plan in the works - Marine Log





Methanol



Public Health Considerations:

- **Flammability (primary concern)**: highly flammable, denser than air (vapors accumulate close to the ground), and produces nearly invisible flames in daylight
- Acute effects: vapors can cause headache, dizziness, nausea, and central nervous system depression (hundreds of ppm)
- Methanol also metabolizes to formic acid - causes severe acidosis + organ/tissue damage
- Ingesting as little as 10 mL can cause permanent blindness by destruction of the optic nerve (ingestion of 30 - 100 mL is potentially fatal).
- Because of its toxic properties, methanol is frequently used as a denaturant additive for ethanol manufactured for industrial uses.

<https://www.pngegg.com/en/png-tmyis>

<https://www.offshore-energy.biz/japan-to-launch-first-ammonia-fueled-ammonia-gas-carrier-in-2026/>



Environmental Considerations:

- Relatively lower risk of environmental impact vs. other fuels
- Fully miscible with seawater and biodegradable; it spreads briefly on surface then dissolves into water column.
- Dissolved oxygen depletion from biodegradation is the main concern for fish / invertebrates
- Microbes break it down to CO₂ and H₂O, which consumes oxygen.
- Controlled dilution/dispersion + aeration to protect dissolved oxygen
- Vapor clouds can pool near the water surface and flash back. Manage ignition sources!
- Can contaminate drinking water sources

CMA CGM adds another methanol-powered vessel to its fleet as it continues to work towards the goal of reaching around 150 low-carbon vessels by 2029. Pictured: The naming ceremony of the CMA CGM Antigone, a 15,000-teu methanol-fueled container vessel, in China on 11 December.



LNG



Public Health Considerations:

- Liquefied natural gas (LNG) is natural gas that has been cooled to a liquid state (liquefied), to about -260° Fahrenheit, for shipping and storage
 - Liquid volume is 600 times smaller than gas volume, making it viable as a transportation fuel
- Direct contact with spilled LNG can cause frostbite/burns
- Inhalation of high concentrations of LNG vapors may cause CNS depression (nausea, headache, dizziness)
- As LNG evaporates, it can rapidly displace oxygen in low-lying areas or confined spaces (asphyxiation hazard!)
- Methane in LNG vapors can ignite

Environmental Considerations:

- Highly volatile (less persistent); visible dense vapor cloud forms on water
- When accidentally spilled to water, it is known to sometimes undergo a localized vapor explosion known as rapid phase transition (RFT).
- LNG is not particularly toxic, but its rapid volatilization from water could deplete oxygen and harm marine life.

Hydrogen



Public Health Considerations:

- Like LNG, direct contact with spilled liquid hydrogen can cause frostbite/burns
- Hydrogen gas is highly flammable and can ignite easily, even from small sparks or static electricity
 - Gas is colorless, odorless, tasteless
 - Readily forms an explosive mixture in air
- It can also rapidly displace oxygen in confined spaces (asphyxiation hazard!)



Environmental Considerations:

- Highly volatile (less persistent); visible dense vapor cloud forms on water
- Similar to LNG, when accidentally spilled to water, liquid hydrogen may undergo a localized vapor explosion (RFT).

<https://www.power-eng.com/gas/mcdermott-shell-nasa-working-together-on-liquid-h2-storage-demonstration/>
<https://energy-oil-gas.com/news/why-shipping-is-sink-or-swim-for-scope-3-in-oil-and-gas-by-kris-fumberger/>

Biofuels



Public Health Considerations:

- Human health hazards depend on the biofuel type
- e.g., Biodiesel is a paraffinic fuel with physical properties similar to petroleum distillates, but without the more toxic aromatic compounds.
- Pyrolysis oils (bio-oils) may have higher levels of PAHs (naphthalene, phenanthrene, anthracene) that present a long-term hazard.

<https://www.miadvancedbiofuels.com/2023/11/new-michigan-advanced-biofuels-coalition-stakeholders-represent-land-air-and-sea/>

Environmental Considerations:

- Less volatile – will remain in liquid form under ambient conditions and can be expected to persist relatively longer in environment
- Will form an oily slick on water surface, over time the slick can oxidize and sink.
 - Biodegradable (local dissolved oxygen depletion)
- Aquatic toxicity being studied, limited studies show low toxicity to marine organisms (bio-oils likely more toxic)

Lithium Batteries

- **Chemicals/mixtures of concern will depend on the battery type and state of charge**
- **General chemicals of concern for lithium-ion battery fires include:**
 - Hydrogen fluoride (HF)
 - Hydrogen chloride (HCl)
 - Hydrogen cyanide (HCN)
 - Metals (lithium, cobalt, manganese, nickel)
 - Smoke particulate matter
 - Combustion products (e.g., CO, NO_x)
 - Volatile organic compounds (VOCs)



Lithium Batteries

Source of these chemicals of concern?

- **Asphyxiant gases - CO, CO₂ – combustion, incomplete combustion**
- **Irritant gases:**
 - **HF** – electrolyte salt (LiPF₆) and binder (PVDF)
 - **NO_x** – N₂ and O₂ reacting during high temp combustion
 - **SO₂** – sulfur-based additive for solid electrolyte interphase
 - **HCl** – separator or flame-retardant additives in packaging



Alternative Fuels Spill Response

Traditional Oil Spill:

- Reporting
- USCG, OSRO, SMT, salvor, and environmental mobilization.
- Source control and containment
- Cleanup and salvage
- Environmental restoration



Alternative Fuel Spill:

- Potential mass casualty event
- Reporting
- USCG, OSRO, SMT, salvor, and environmental mobilization.
- Source control and containment
- Cleanup and salvage
- Environmental restoration



Current Leading US Alternative Fuel Candidates

- LNG
- Methanol
- Hydrogen
- Nuclear is **not** an option being proposed as in the EU

The Effect of Alternative Fuels on Existing Maritime Law Framework



Jones Act Waiver & Alternative Fuels – Impact



What it is:

Jones Act: Requires U.S.-built/flagged vessels for domestic shipping

Impacts fuel distribution + bunkering (incl. biofuels, ammonia, hydrogen)



2026 Waiver

Temporary (~60 days) waiver to ease wartime supply constraints

Allows **foreign vessels** in U.S. domestic energy transport



Impact on Alternative Fuels

Theoretical: More vessel availability → short-term flexibility

- Waiving Jones Act restrictions increases the pool of eligible vessels
- Could improve short-term optionality and routing flexibility for transporting energy and fuels between U.S. ports
- Potentially lowers friction in emergency repositioning of cargoes (including alternative fuels and feedstocks)

In practice: Minimal impact

- Impact is limited and short-lived
Flows driven by infrastructure & demand, not vessel limits
- Supply flows are primarily determined by infrastructure (terminals, storage, pipelines) and end-use demand, not shipping eligibility
- For alternative fuels specifically (biofuels, hydrogen, ammonia), constraints sit upstream in production scale, storage, and certification—not maritime transport



Key Reality

Early-stage fuels like hydrogen and ammonia are not yet distributed at scale via U.S. coastwise shipping routes
Waiver is temporary → reverts to status quo

Negligence Under General Maritime Law

- What constitutes “reasonable care” when operating vessels using alternative fuels?
- Mitigation of foreseeable hazards
- Regulatory compliance
- Importance of crew training



Unseaworthiness

- Potential seaworthiness concerns arising from alternative fuel systems
- Fuel-related equipment malfunction and defect
- Inadequacy of crew training and preparation
- Unseaworthiness versus operational errors



Marine Products Liability

- How claims may arise
- What constitutes a “product”?
- Relationship between alternative fuel system and vessel
- Non-maritime products
- “Failure to warn”



Commercial and Charter Party Disputes Arising From Alternative Marine Fuels



Fuel Availability and Deviation

- Limited bunkering infrastructure
- Unavailability at designated ports
- Reasonability and/or permissibility of deviation
- Adequacy of employment or provisioning for contemplated voyage



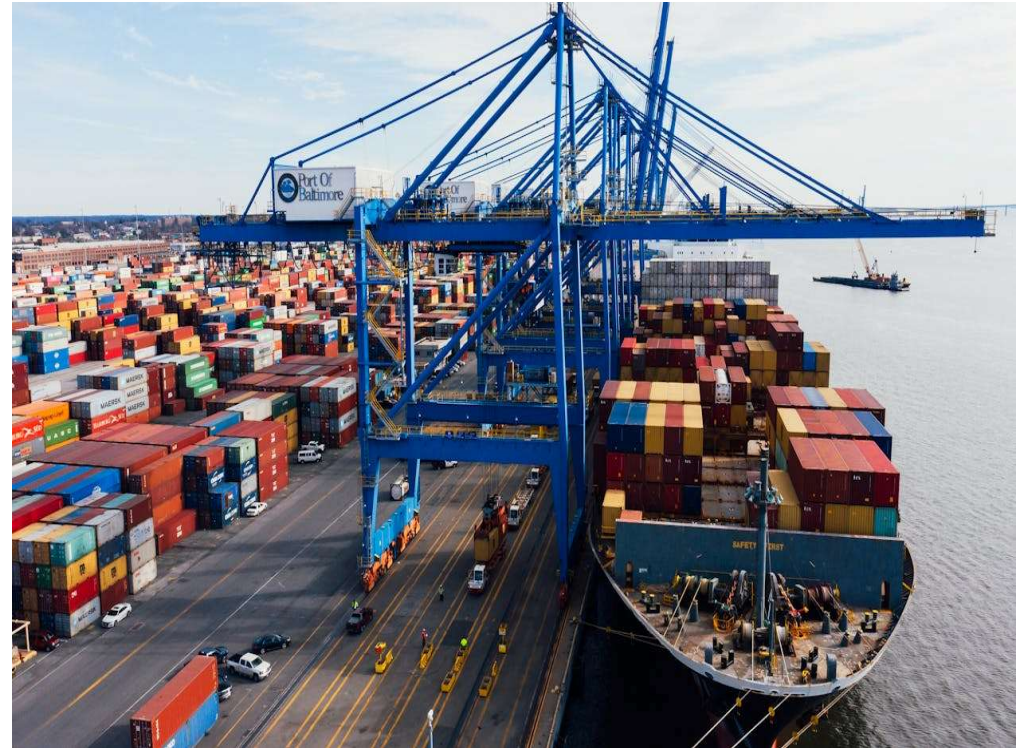
Off-Hire and Delay Claims

- Potential causes of delay
- Increased breakdown risk
- Fuel contamination
- Off-hire risk allocation
- Defect versus fuel handling



Cargo Issues

- Carriage of alternative fuels
- Specialization of containment systems
- Temperature management
- Leakage
- Mishandling
- Misdeclaration



Fuel Quality and Contamination

- Bunkering incidents
- Fuel quality control
- Allocation of responsibility
- Contractual considerations



Thank You

BAD GAS?

DEALING WITH A STINK OVER SULFUR
AND COMING CHALLENGES WITH
ALTERNATIVE FUELS

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