LNG as Fuel- safe bunkering procedures

Background and Scope

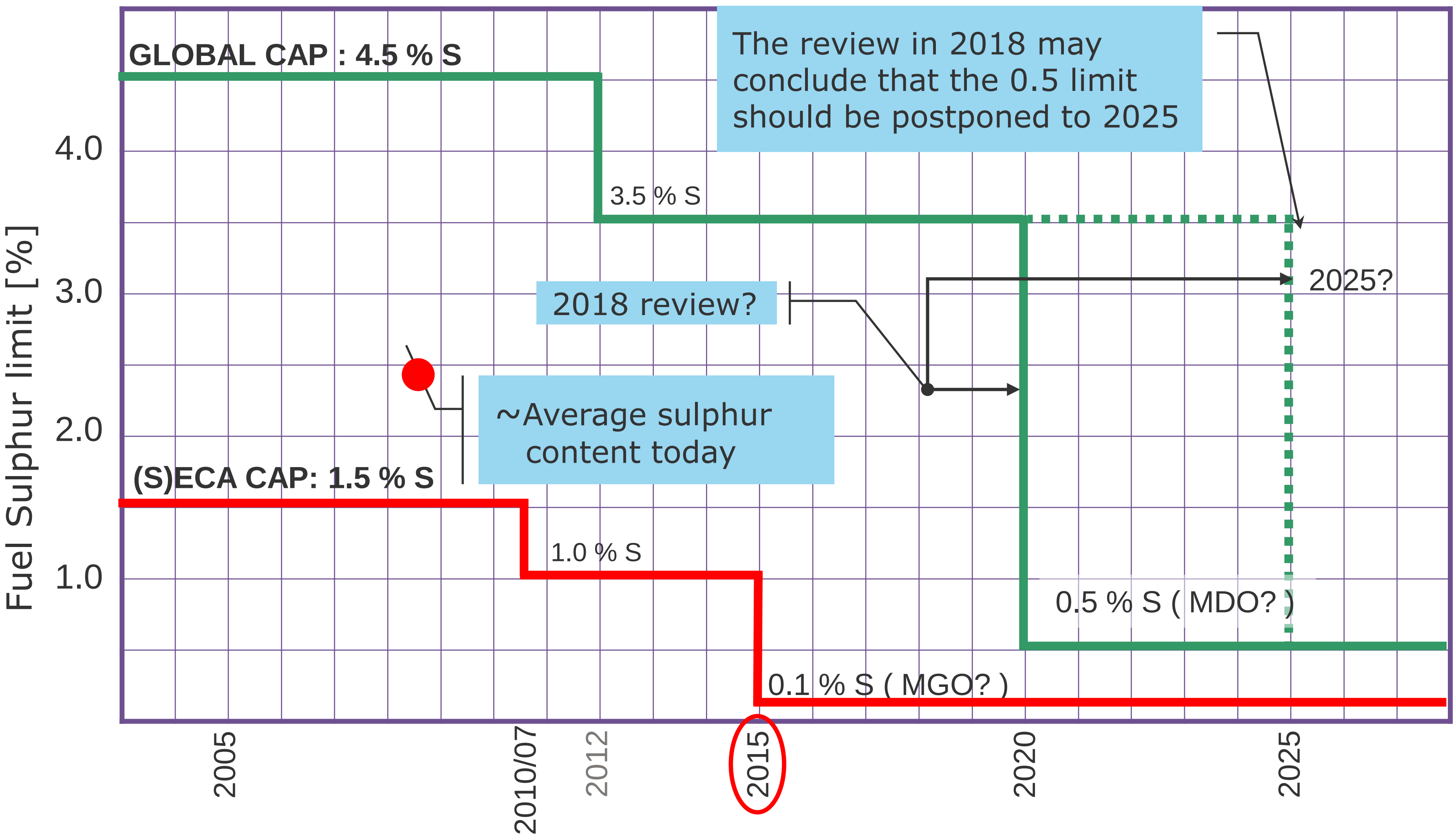
AGENDA

1. Background
2. LNG Basics
3. Shipping & ports
4. Status of LNG fuelled ships
5. ECA options
6. Regulatory

DNV·GL

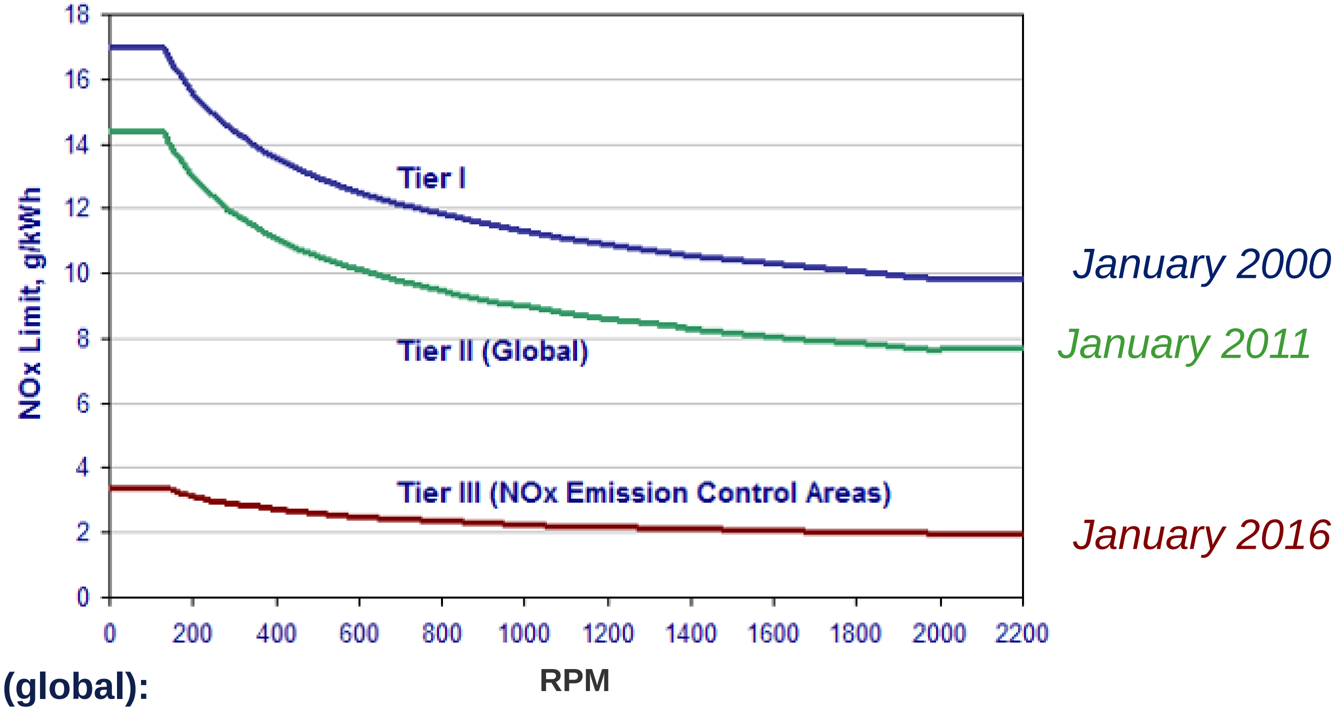
Current & Future ECAs

MARPOL Annex VI SOx



DNV·GL

....Not only SOx; NOx-in ECAs by 2016!

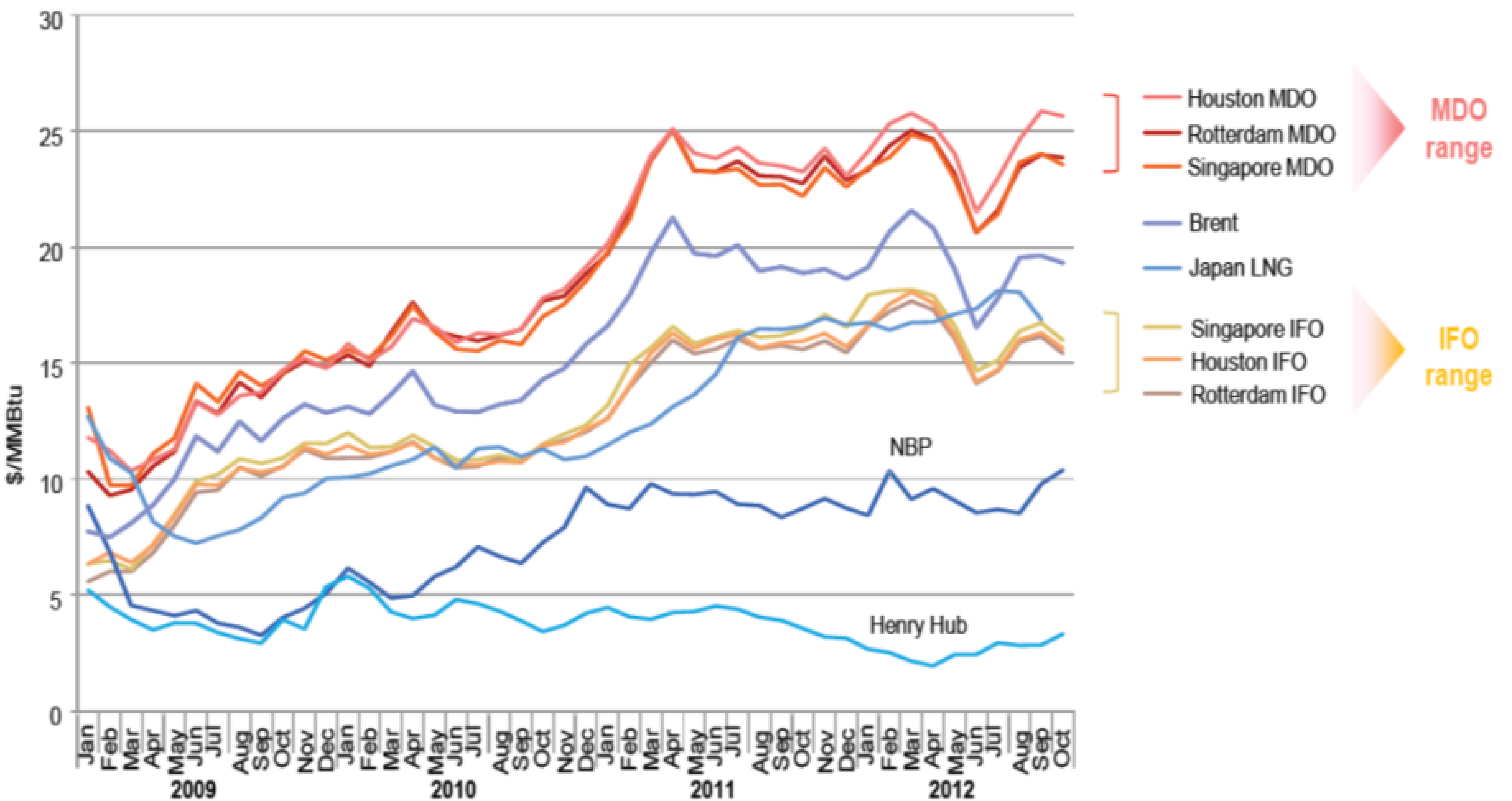


Tier I (global):
engines in new ships with keel laid between 01.01.2000 – 01.01.2011

Tier II (global): engines in new ships with keel laid after 01.01.2011

Tier III (in NOx ECAs):
Applicable for engines in new ships with keel laid after 01.01.2016. No current engine on conventional fuel meets Tier III, hence need additional post treatment (e.g. SCR).
LNG fuelled engines will likely be approved as Tier-III equivalent measure

NG Cost vs Marine diesel



What to do?

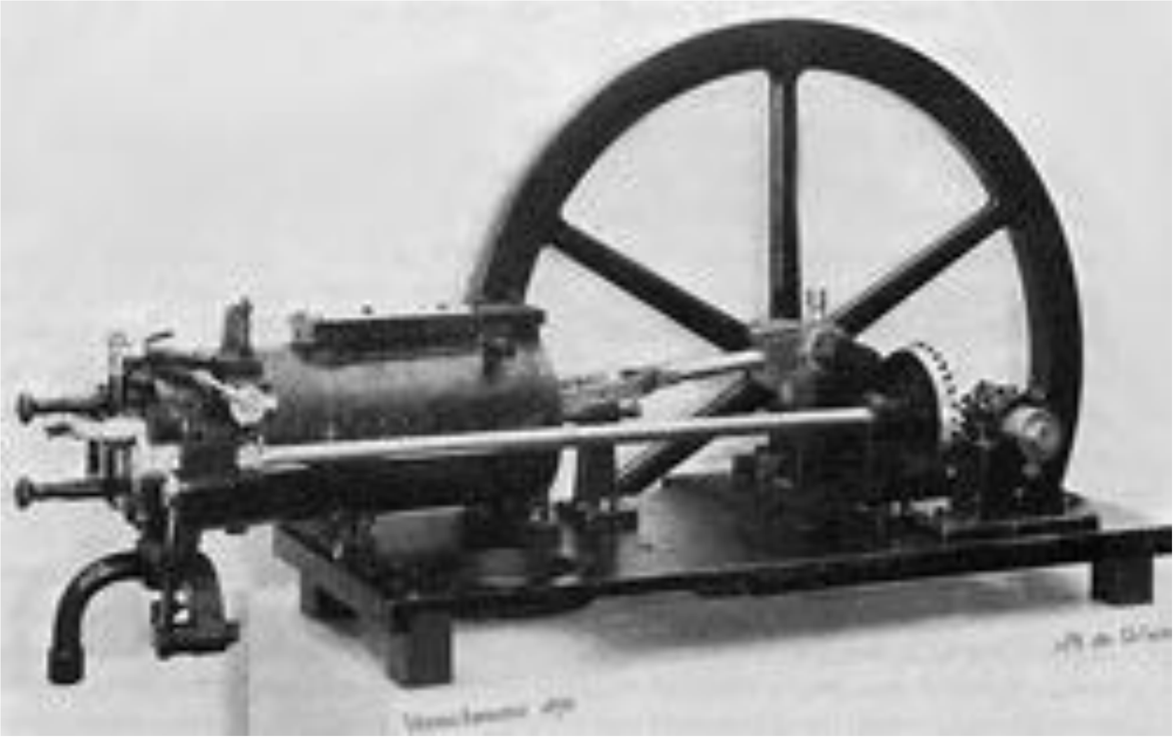
1 LNG as fuel

2 Scrubbers for exhaust gas cleaning

3 Low sulphur fuel

…or fleet redeployment, i.e. give up trading in ECAs…

Gas is not new as fuel for the Internal Combustion Engine !!



Nikolaus Otto's engine from 1876

Why is natural gas better?

- Sulphur free
  - SO_x emissions 100 % reduction
- Burned in lean mixture in combustion engine
  - Low temperature → NO_x emissions substantially reduced (~ 90% reduction)
  - Lean burn engine- efficient engine without “engine knocking” (uncontrolled self-ignition)
  - Gas diesel: Also some reduction in NO_x
- Clean combustion – particles almost eliminated
- Methane, CH_4 , has less carbon to hydrogen than oils
  - CO_2 emissions reduced compared to oil combustion (~ 20% reduction)

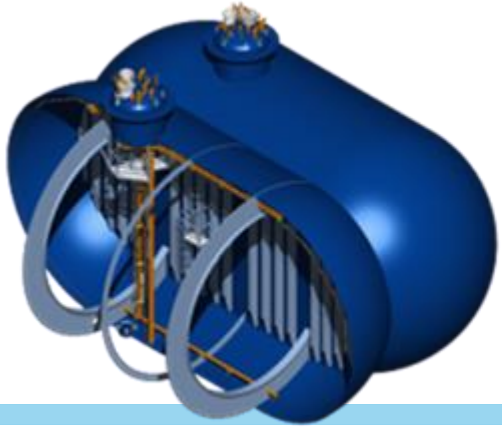
VS

DNV·GL

Main safety challenges using natural gas as fuel

- Fire/ explosion risk

- Low temperature

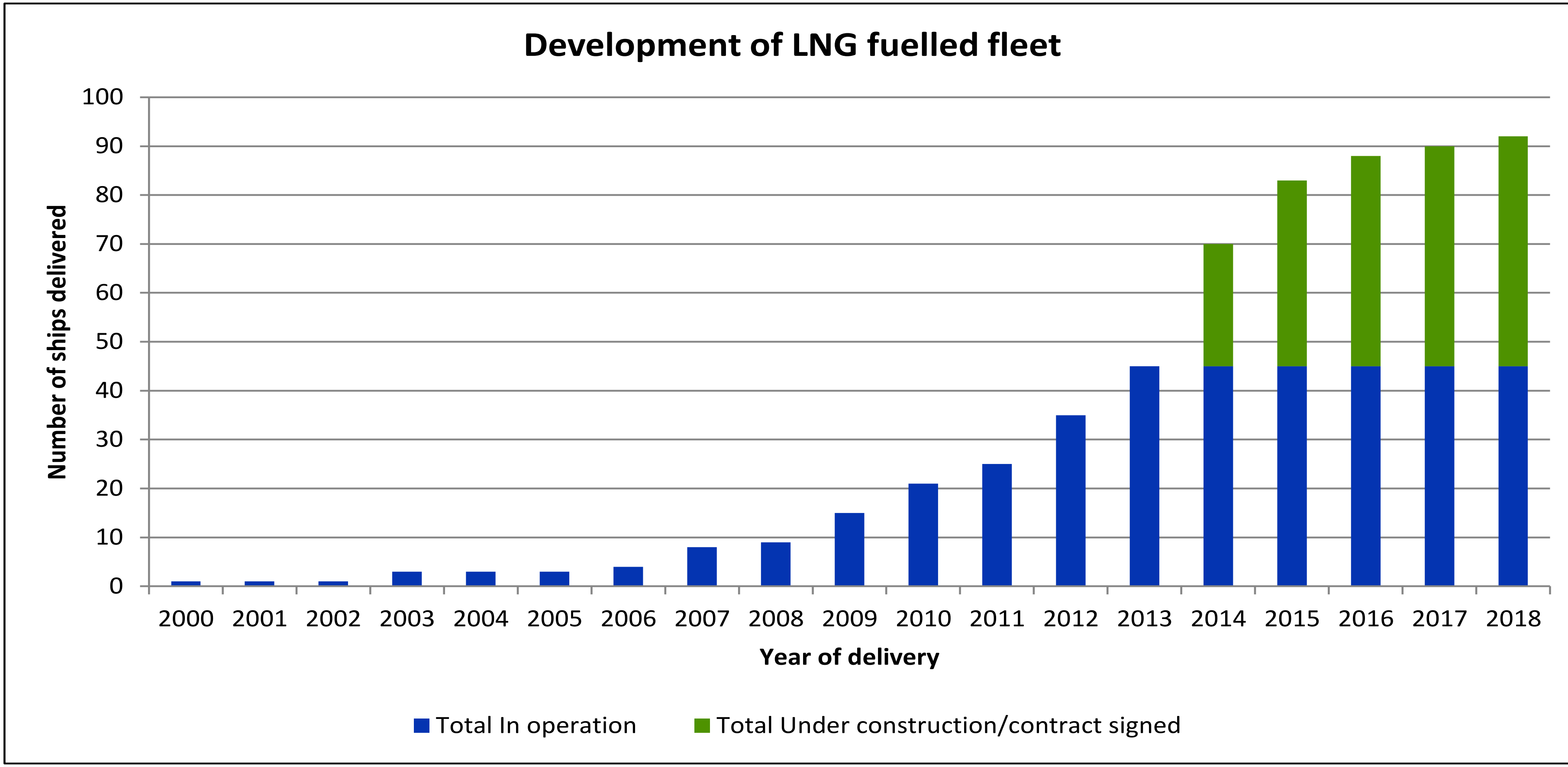


- Tank high energy content

Main safety challenges using natural gas as fuel

- Low temperature of liquid gas / cold jets from compressed natural gas
- LNG at -163°C
- Normal steel will become brittle

There are currently 92 confirmed LNG fuelled ship projects

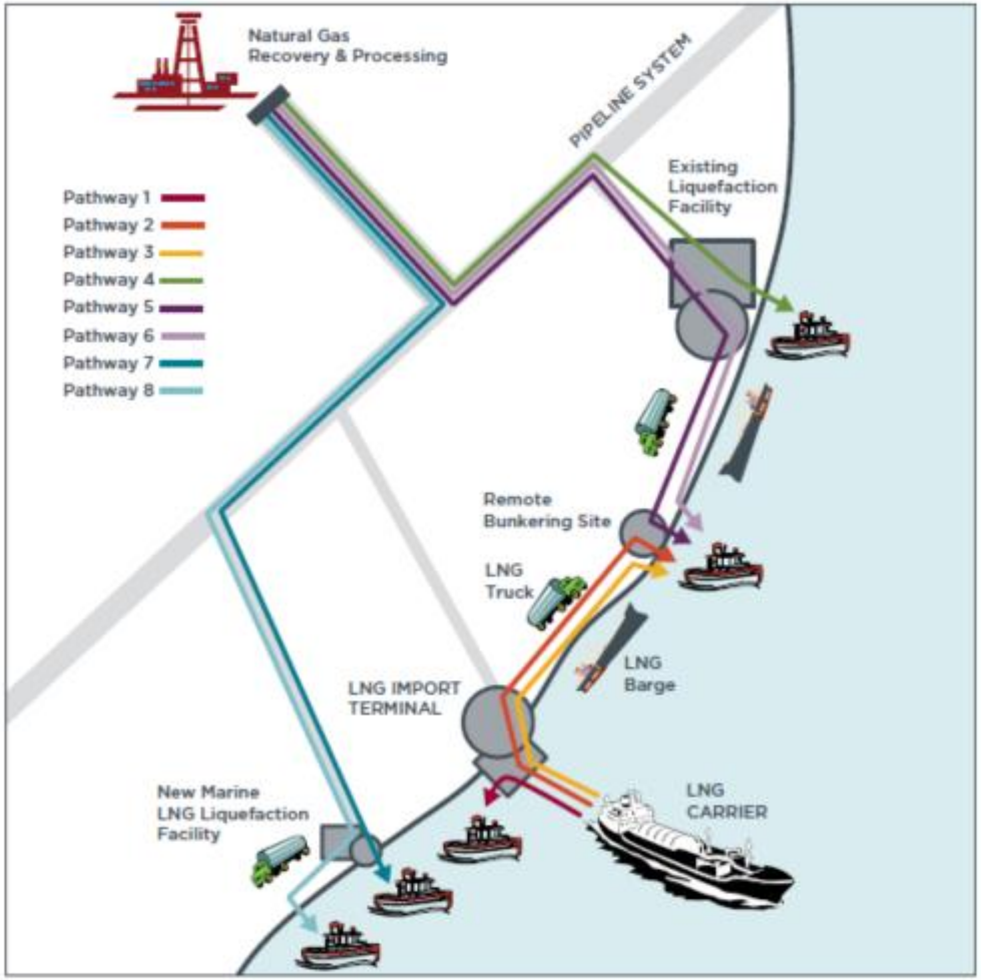


As of January 1 the order book is 47, with 22 to DNV/GL class
In NA order book is 15 NBs with 4 DNV /GL

Profile of an LNG fuelled vessel

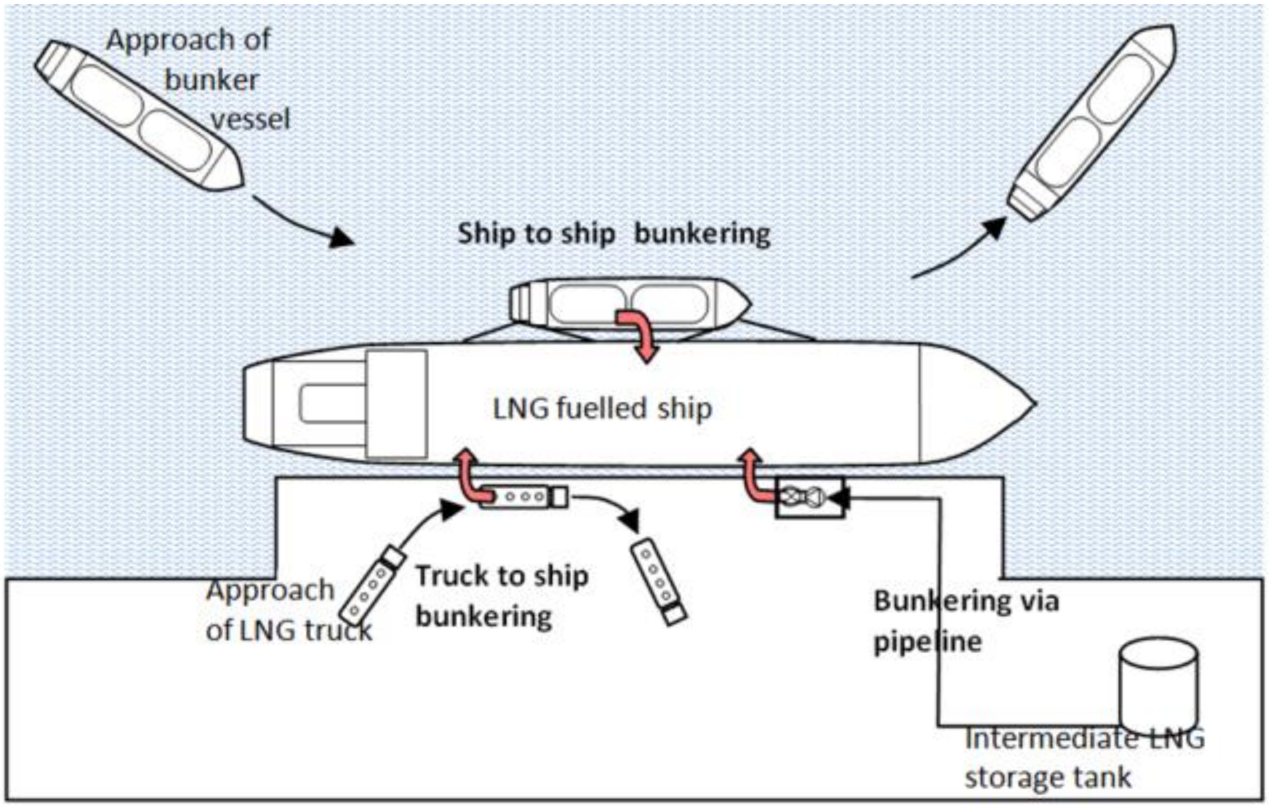
- Vessels that operate inside mostly inside the ECA, e.g short sea shipping
- Coastwise and regionally bound vessels, e.g. ferries, tugs, offshore vessel
- Fuel cost sensitivity
- Sufficient size and onboard space to accommodate the installation
- LNG bunker availability and cost
- Possibilities for conversion
- Fleet renewal demand
- Liner service, vessel on fixed routes
- Environmental profile is beneficial

LNG Infrastructure and Supply Chain



LNG Infrastructure and Supply Chain

LNG Bunkering Options



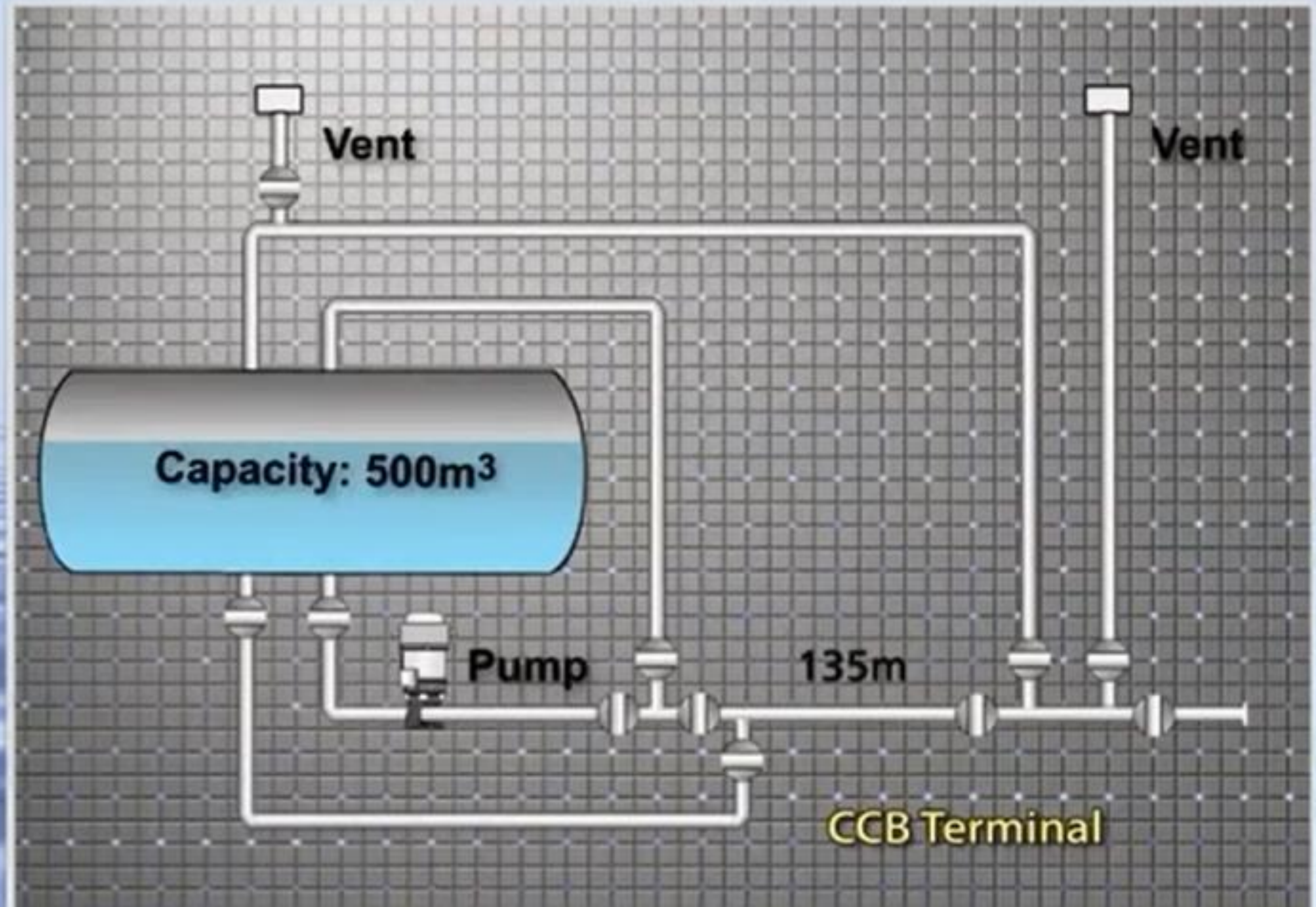
LNG Infrastructure and Supply Chain

Use of ISO standards containers..

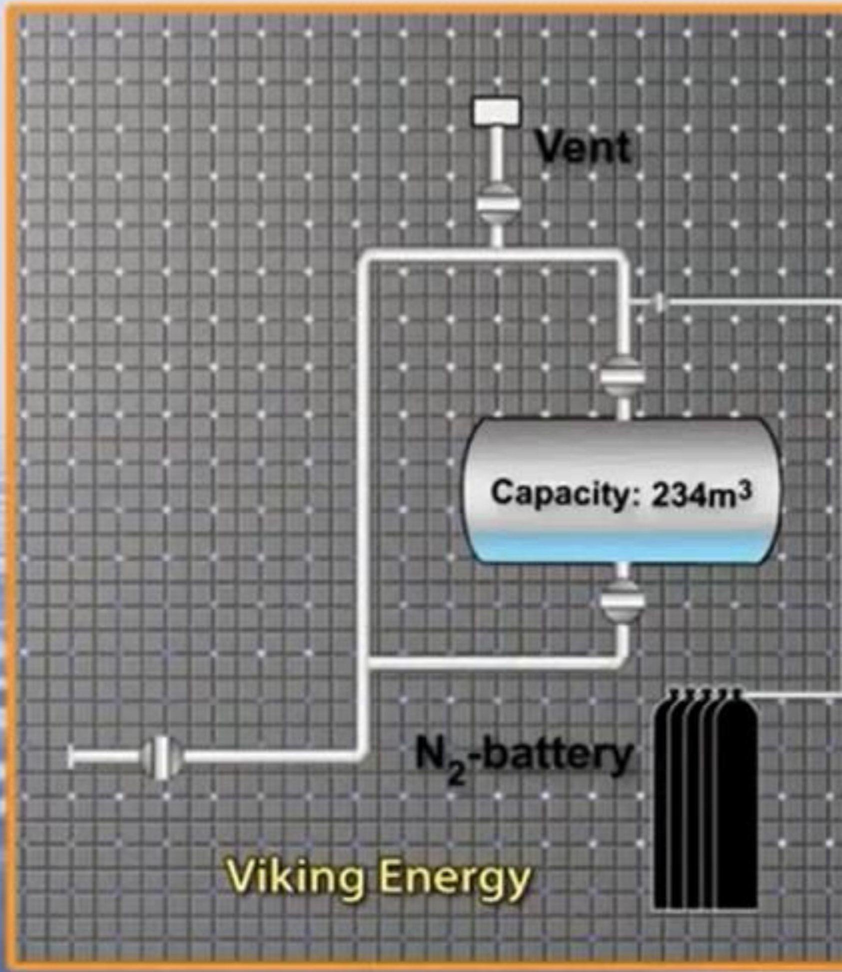
https://www.youtube.com/watch?v=oZWuTWtp5Rs

Distance to the connection point: 135m

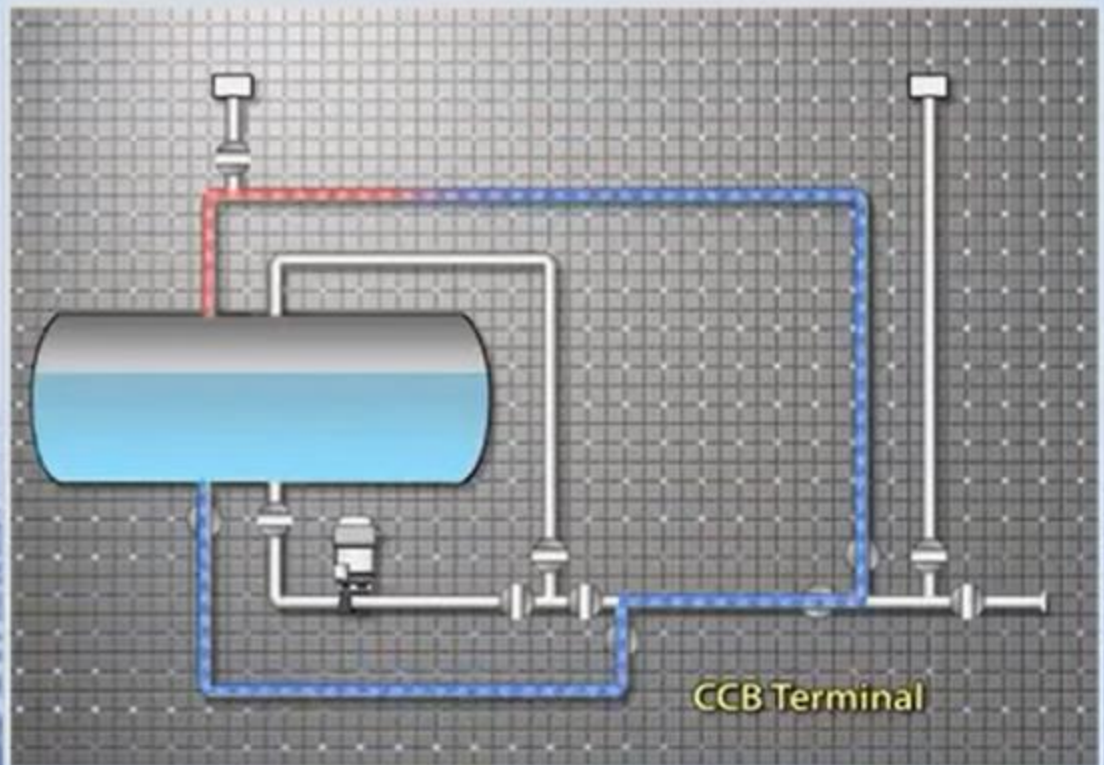
Basic Landside Layout

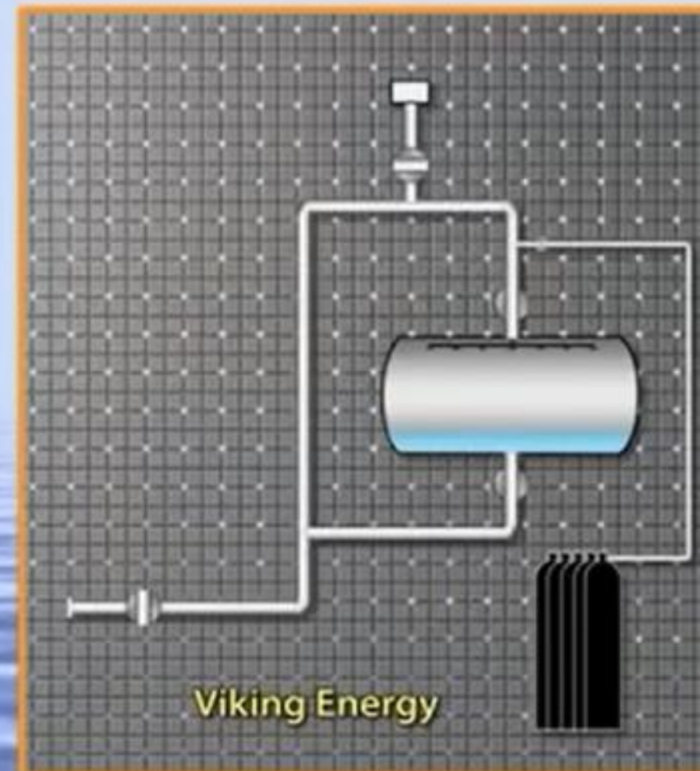


Basic Vessel Layout



Step 1 - Initial Precooling

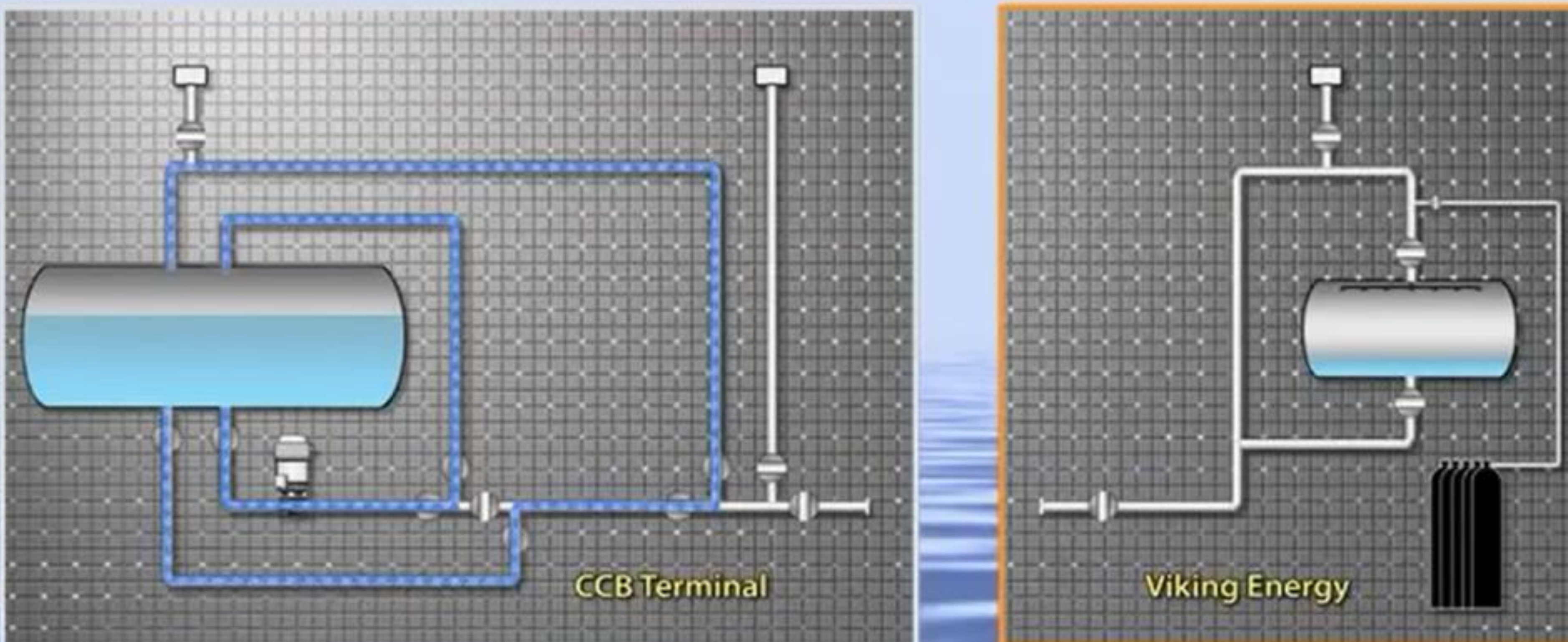




- Precooling of filling lines during vessel berthing and mooring
- The precooling sequence depends on cargo pump, terminal design and size of installation

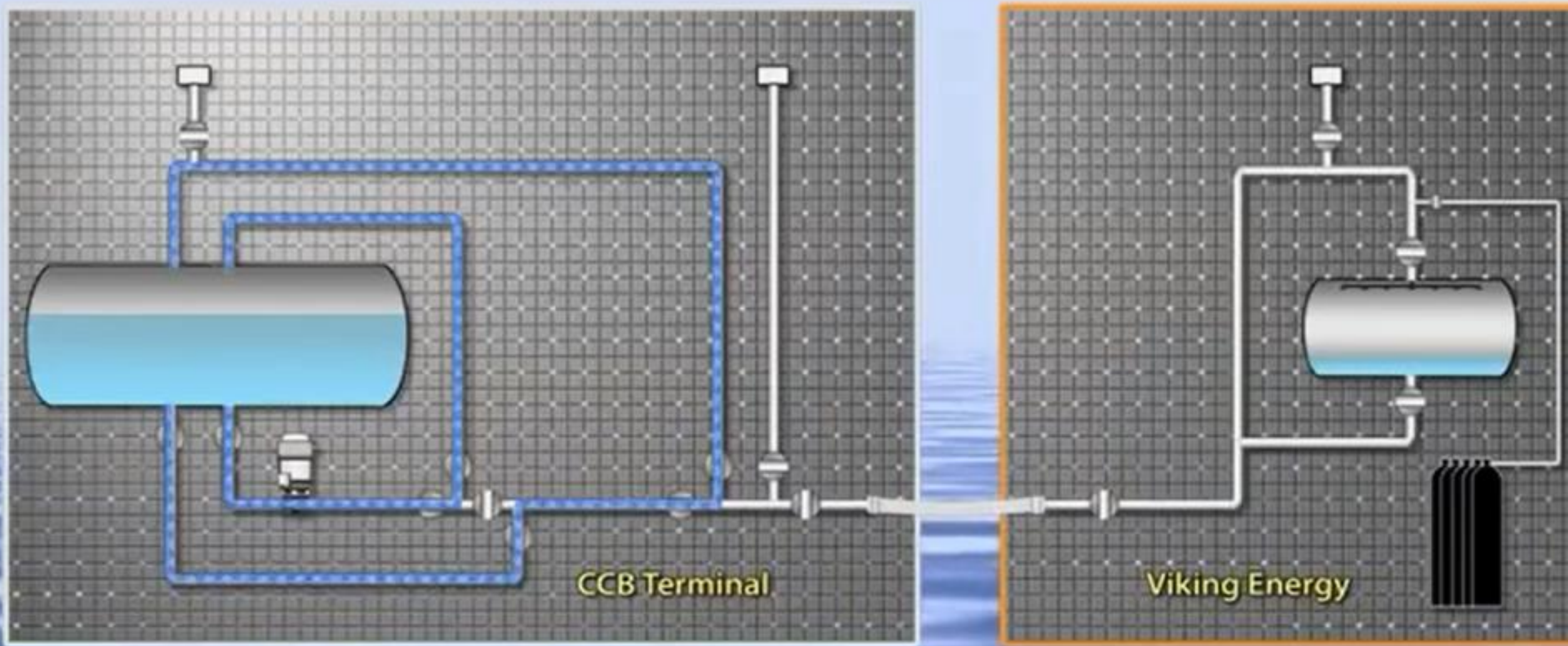
DNV

Step 2 - Initial precooling of the cargo pump



- At terminals where the pressure difference between the shore and the ship tank is > 2 bars the pressure is utilized as a driving force. This makes the cargo pump redundant

Step 3 - Connection of bunker hose

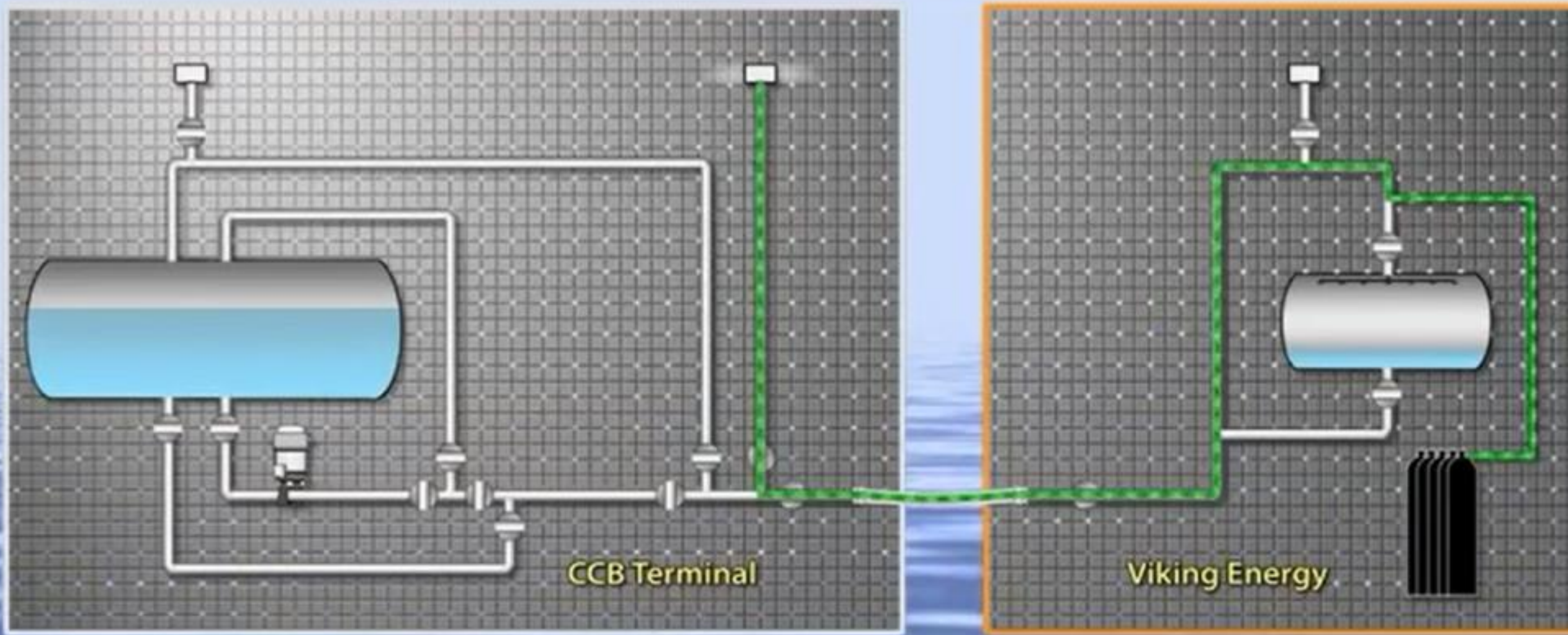


- Measures are taken to avoid groundfault arcing (e.g. isolated flanges)

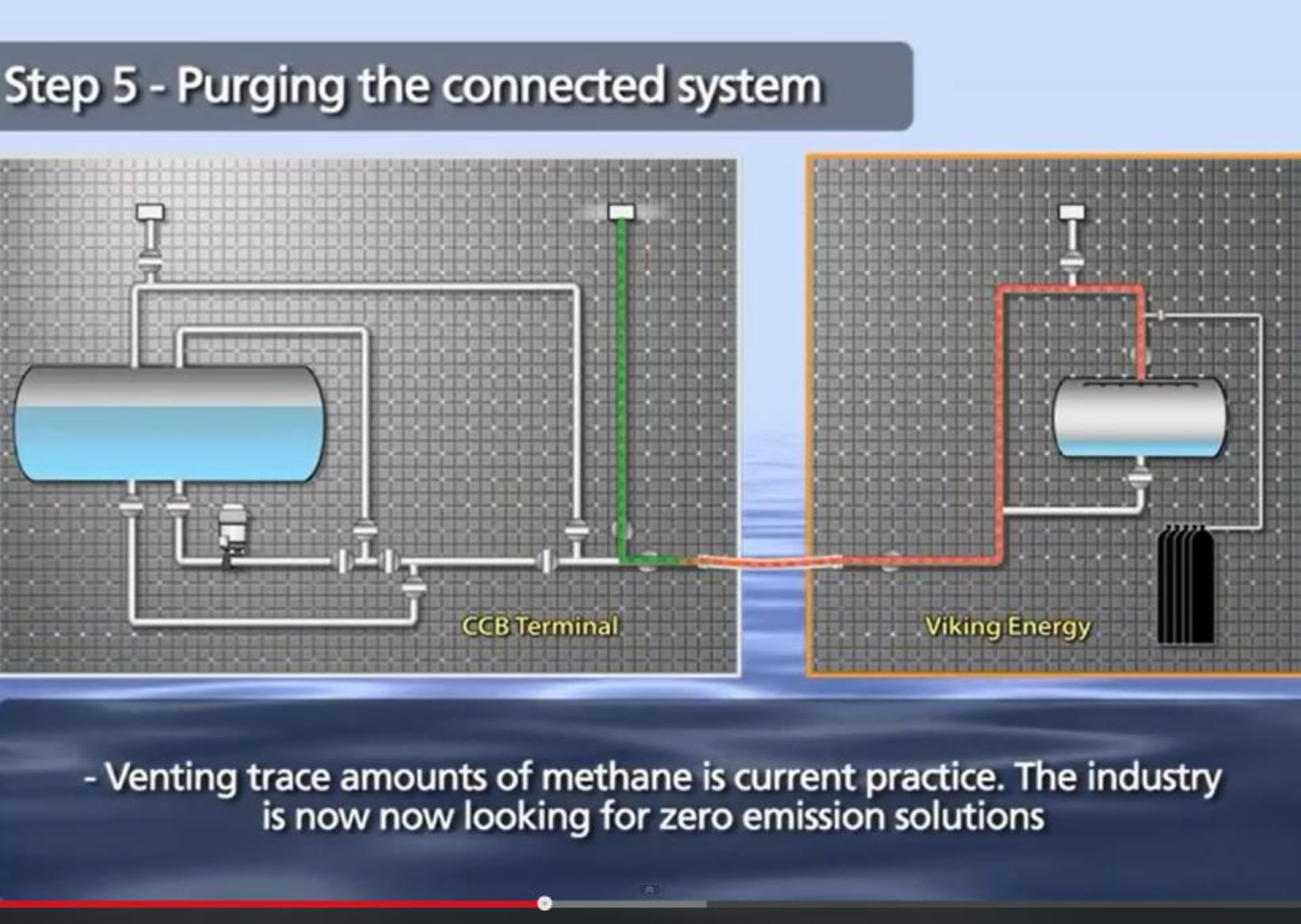
ep 3 - Connection of bunker hose

- Loading arms are available for bunker hose connection

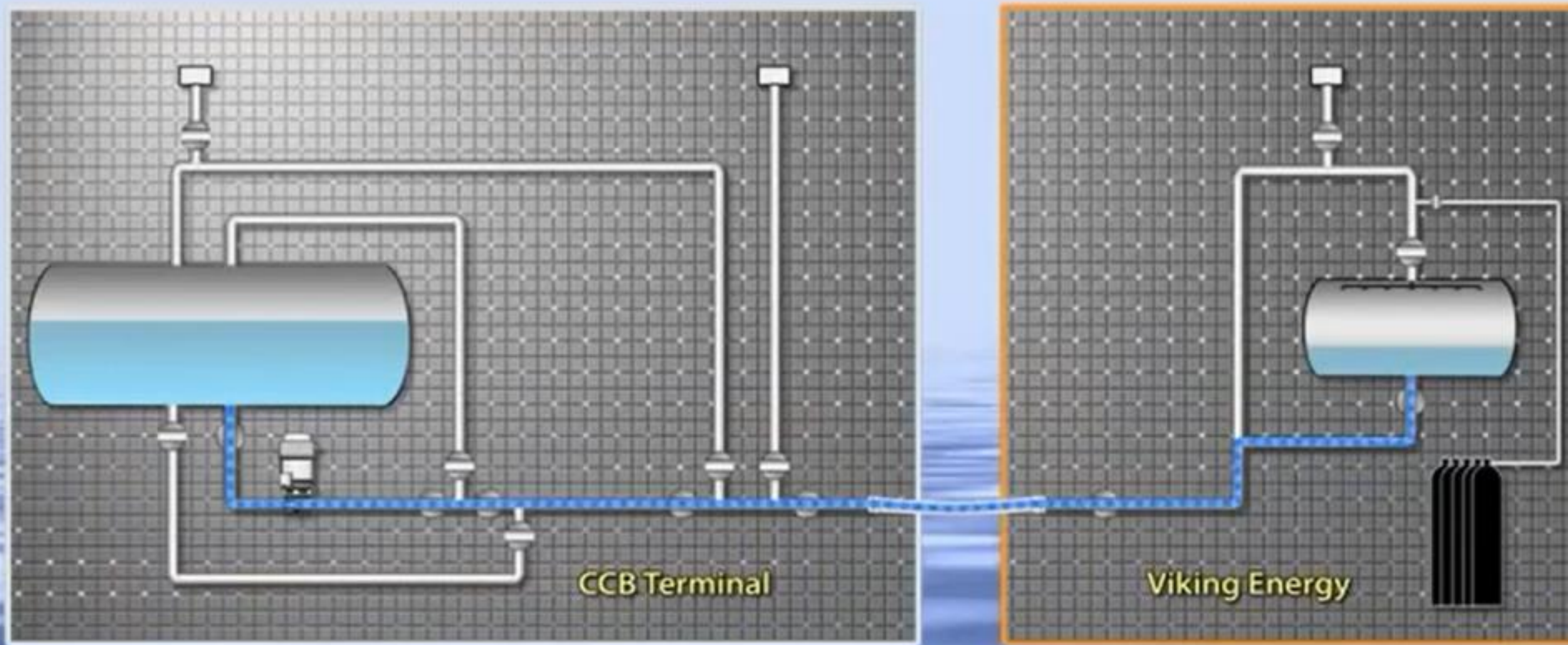
Step 4 - Inerting the connected system



- Inert gas is used to remove moisture and oxygen from the connected system
- Sequence duration: 5mins

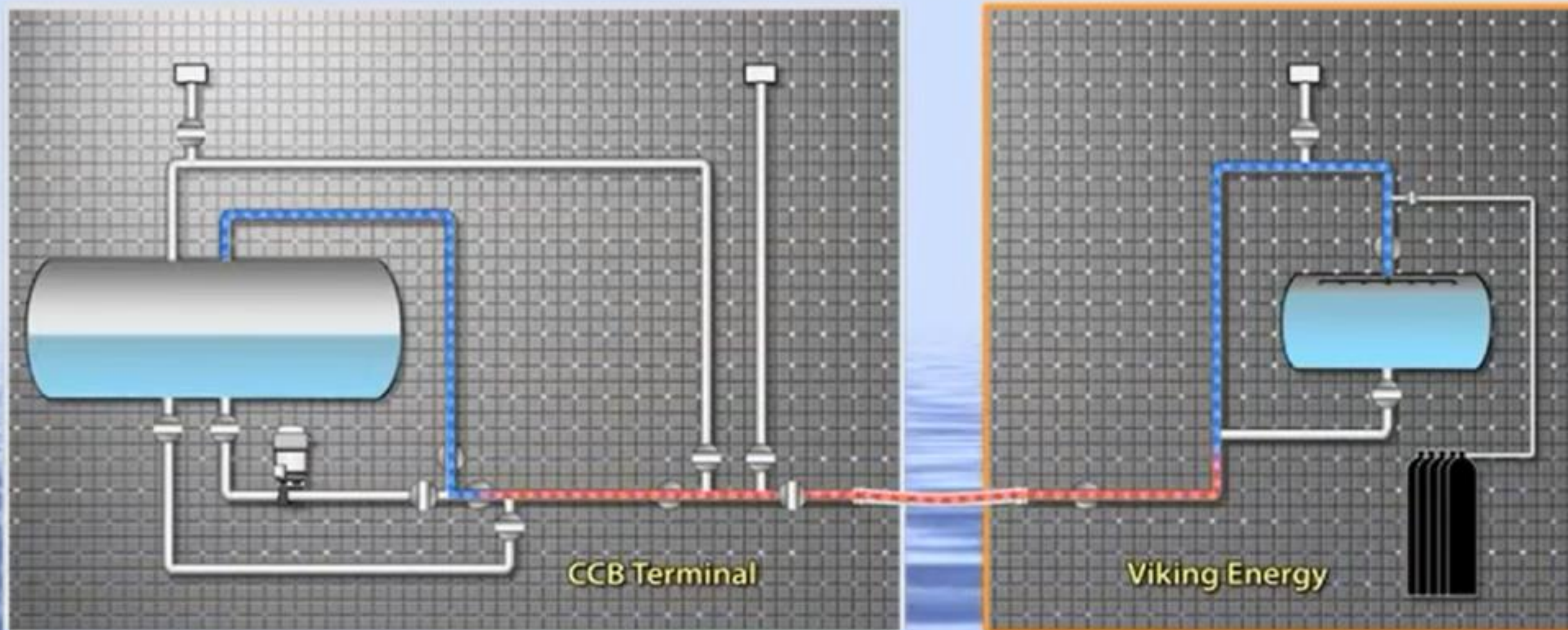

Step 5 - Purging the connected system
CCB Terminal
Viking Energy
- Venting trace amounts of methane is current practice. The industry is now now looking for zero emission solutions

Step 6 - Filling sequence



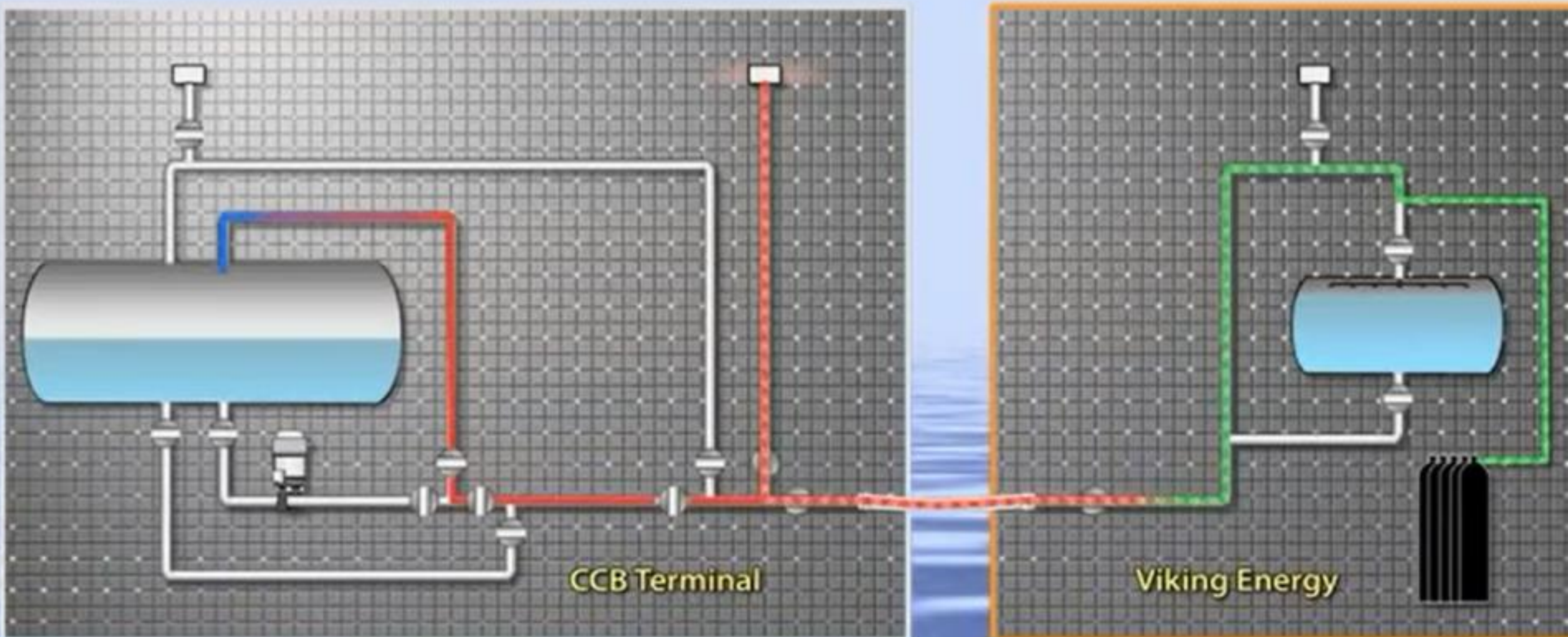
- Transfer speed range 100 - 1,000 m^3/h depending on tanks and equipment

Step 7 - Liquid line stripping



- Closing of shore-side valve. NG pressure build-up due to temperature rise. LNG residuals are forced into both tanks

Step 8 - Liquid line inerting



- Remaining NG in liquid line is removed by inert gas for safety reasons

xisting LNG Bunkering Solutions
- Transfer from onshore facility to ship
- Truck to ship transfer
- Ship-to-ship bunkering and LNG barges
ScanTank

ting LNG Bunkering Solutions

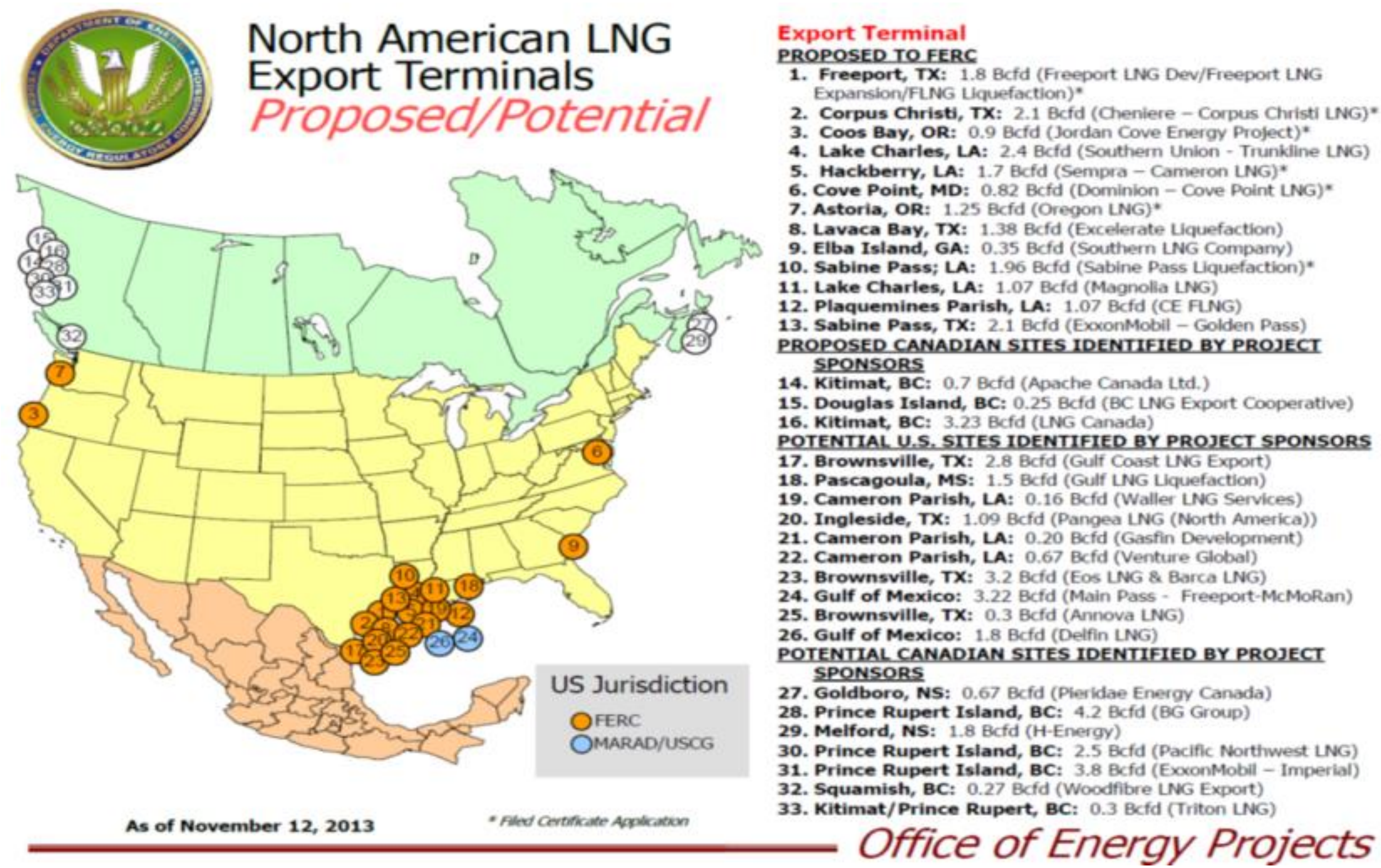
ransfer from onshore facility to ship

ruck to ship transfer

hip-to-ship bunkering and LNG barges

LNG Availability – North America

- But there many projects in the "pipeline"



Regulatory Regime

The use of gas as fuel in ships other than LNG carriers is not covered by international conventions and such installations will need ***additional acceptance by flag***

Regulatory Regime – IMO Interim Guidelines

IMO Resolution **MSC.285(86)**
'Interim Guidelines on Safety for Gas Fuelled Engine Installations in Ships'

- Finalized by IMO in 2009
- Only for natural gas and internal combustion engines
- Same technical content as the DNV Rules, in addition a risk analysis is required for new designs and concepts
- Not mandatory

Next step is the mandatory IMO "IGF code"

- To include other gases than methane/ natural gas, also low flashpoint liquids
- To include other machinery types like fuel cells, gas turbines, boilers
- Expected to enter into force in 2017

Regulatory Regime – USA & Canada

USCG has issued a Policy Letter to accept LNG fuelled ship based on IMO Interim guide lines, with some changes;

- use of US standards for type approved products
- fire protection, including monitoring systems
- electrical systems, in particular the designation of hazardous areas.

Special considerations for LNG tanks below accommodations, and the use of ESD concept.

- Transport Canada do not permit the use of LNG as fuel for ships
- IMO Interim Guidelines are not referenced in any Canadian regulation.
- WIP to develop regulations for the use of LNG as fuel for Canadian vessels

- - USCG Draft PL No. 01-13 "Guidelines for Liquefied Gas Fuel Transfer Operations and Training of Personnel of Vessels using Natural Gas as Fuel
- - USCG Draft PL No. 02-13 "Guidance Related to Vessels and Waterfront facilities Conducting Liquefied Natural gas (LNG) Marine Fuel Transfer (Bunkering) Operations
- **Code Description**
- NFPA59A Standard for the Production, Storage, and handling of LNG
- USCG 33CFR Part 127 Waterfront facilities handling LNG and Liquefied Hazardous Gas
- USCG 49CFR Part 193 LNG facilities: Federal Safety Standard
- 18 CFR Part 153 Applications for authorization to construct, operate, or modify facilities used for the export or import of natural gas

Regulatory Regime – IMO Interim Guideline

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- Class- DNV GL is developing a Recommended Practice (RP) for LNG bunkering. A draft was issued in October 2013, and following an external comment period, the document will be formally published.

Thank you for your attention!

Geoff Ashton
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Please contact
jan.hagen.andersen@dnvgl.com
+1 281 396 1526

www.dnvgl.com

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