Large Containership Technical Challenges

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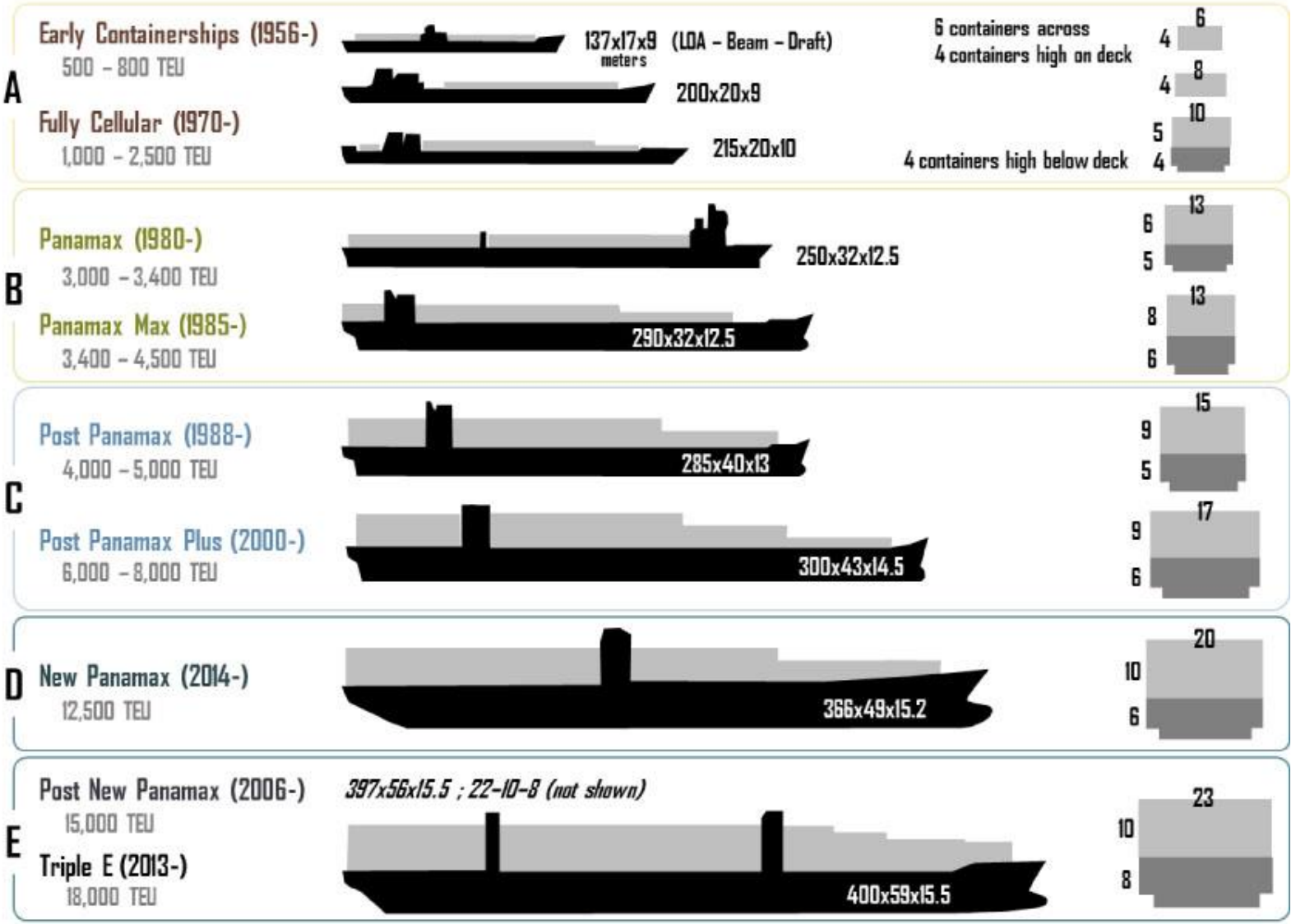
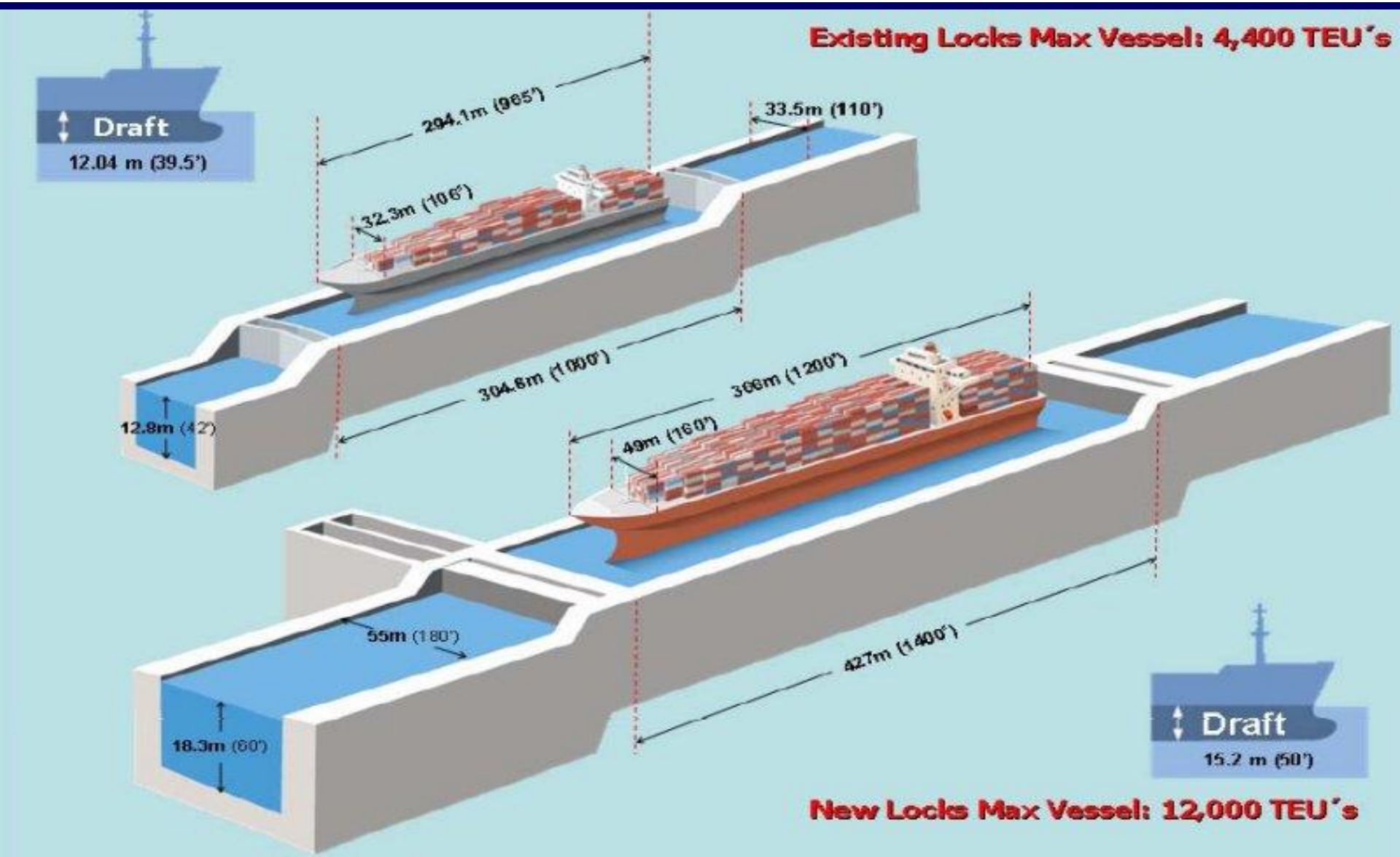
50 years of growth



Existing vs. New Locks



Technical issues with larger ships

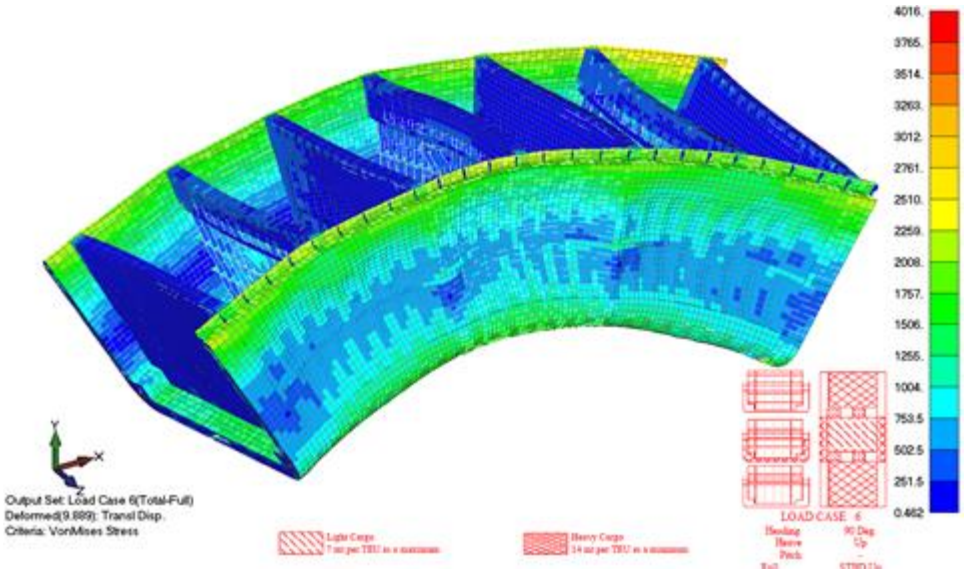
- Summary of Recent Casualties
- Technical Challenges
- Regulatory Changes

Notable Casualties

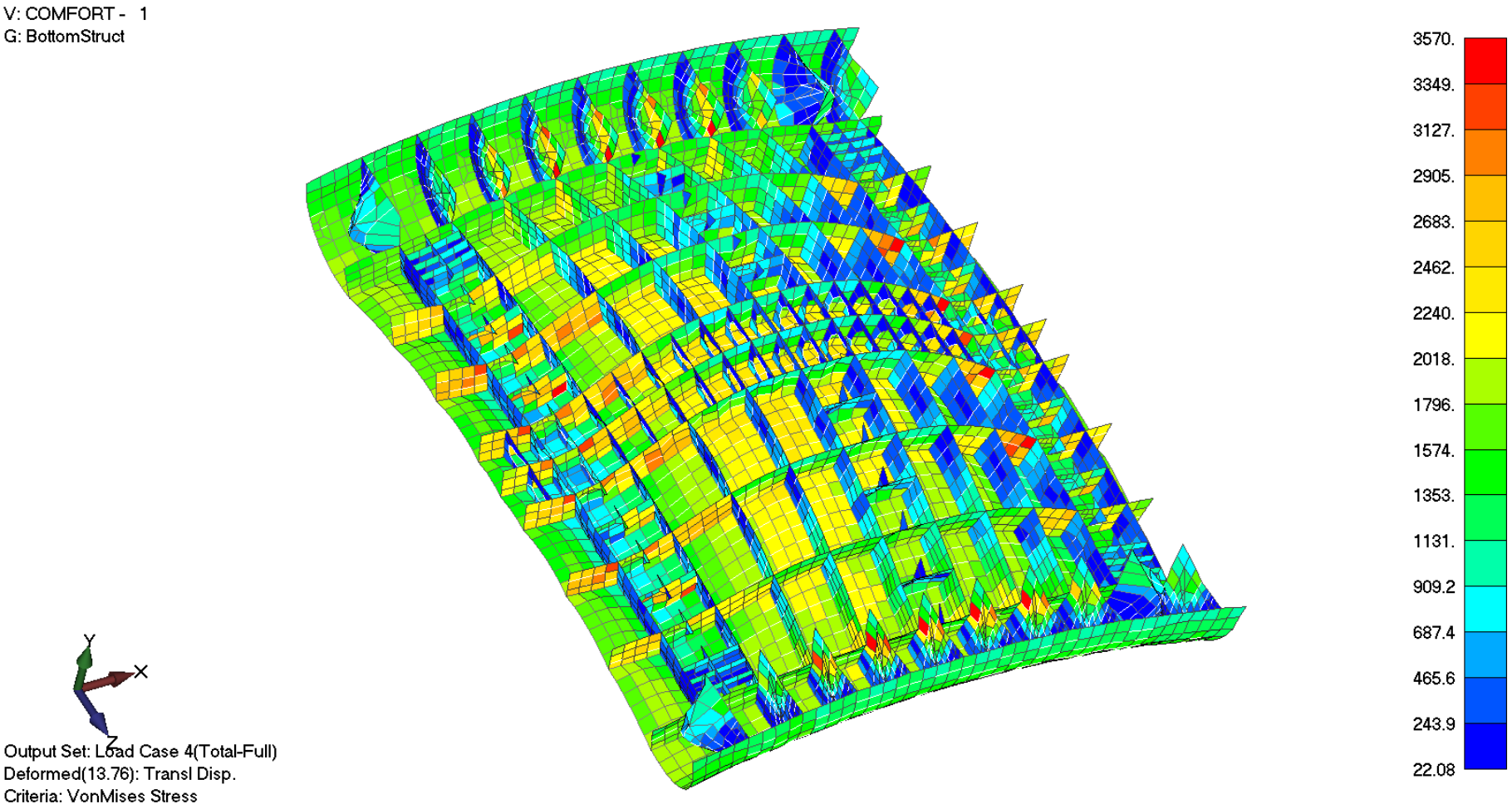
- *MOL Comfort* in 2013 – Structural Failure
- *MSC Napoli* in 2007 – Structural Failure

MOL Comfort

- *MOL Comfort* in June of 2013
  - Passed IACS Longitudinal Strength Requirements
  - High transverse stresses in bottom due to secondary bending between bulkheads
  - Buckling in bottom plating due to biaxial stress
  - May be identified with a 3 Hold Finite Element Analysis such as SafeHull



Hold 5 Bottom Shell and Double Bottom Structure
Load Case 4 Displacements and von Mises Stress



MSC Napoli

- *MSC Napoli* in 2007 – Structural Failure
  - Buckling of bottom plating in way of transverse framing at forward end of engine room
  - Buckling checks not carried out along full length of vessel
  - Casualty reports indicate that whipping contributed to damage

IACS - Regulatory Changes

- *Rena*
  - IACS revised longitudinal strength requirements to specifically indicated locations to be checked
- *MOL Comfort*
  - Longitudinal strength requirements updated for containerships (Jul ‘16)
  - New unified requirements (UR S34) specifies for Load Cases

    Finite Element Analysis
  - Minimum extent of FE model will include 3 cargo holds
  - Buckling and yielding to be checked using FEA

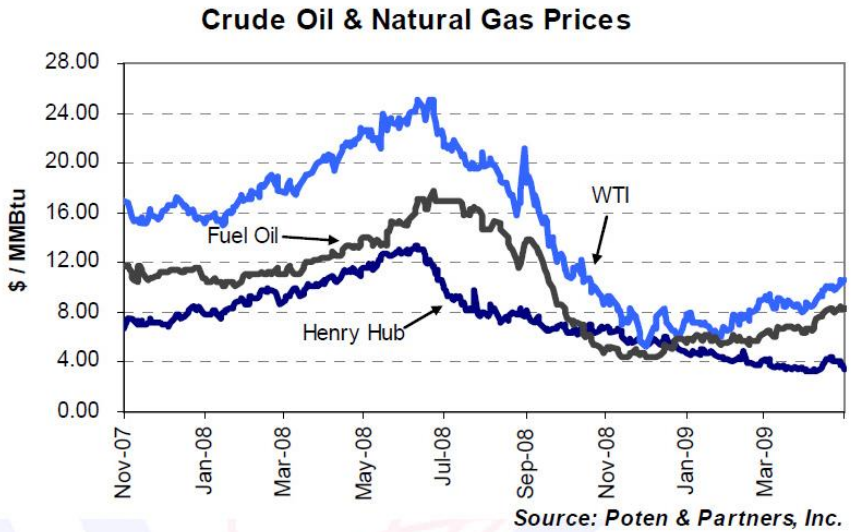
ABS Requirements for Large Containerships

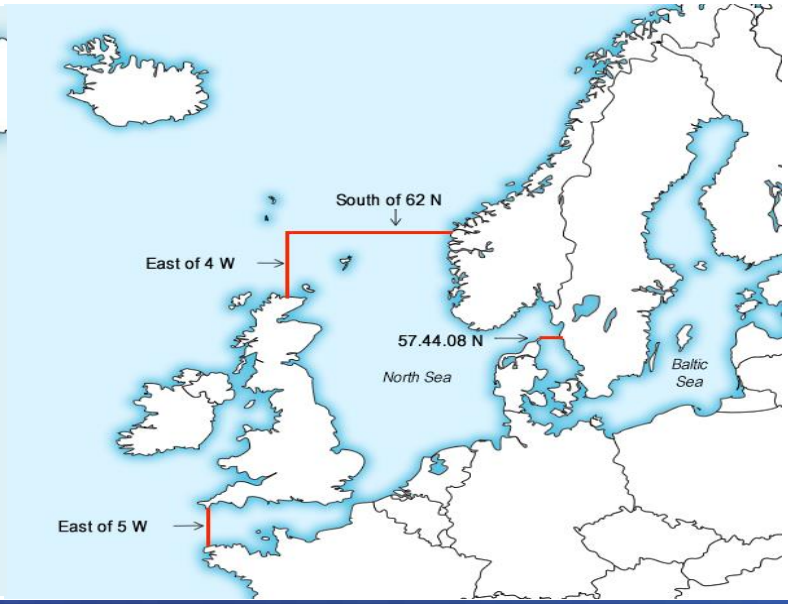
- For containerships with length greater than 350 m
  - *ABS Guide for Slamming Loads and Strength Assessment for Vessels*
  - *Guidance Notes on Whipping Assessment for Container Carriers*
  - *Guidance Notes on Springing Assessment for Container Carriers*
- For vessels using Higher Strength (HT 47) Steel
  - *ABS Guide for Application of Higher-Strength Hull Structural Thick Steel Plates in Container Carriers*
  - Analysis required includes
    - Full ship FE Analysis per ABS Guide for Dynamic Load Analysis
    - ABS Spectral Fatigue Analysis
- *ABS Guide for Enhanced Fire Protection Arrangements, 2013*
  - Optional Notation covering enclosed cargo holds and open decks of container carriers

LNG as Fuel

Motivation

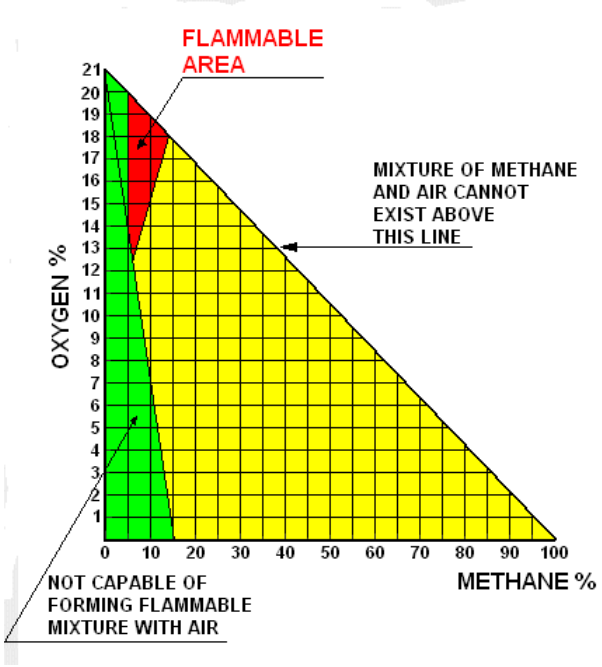
- **Emissions**
  - NOx, SOx and GHG
- **Economics**
  - Fuel price uncertainty
  - Carbon regulations

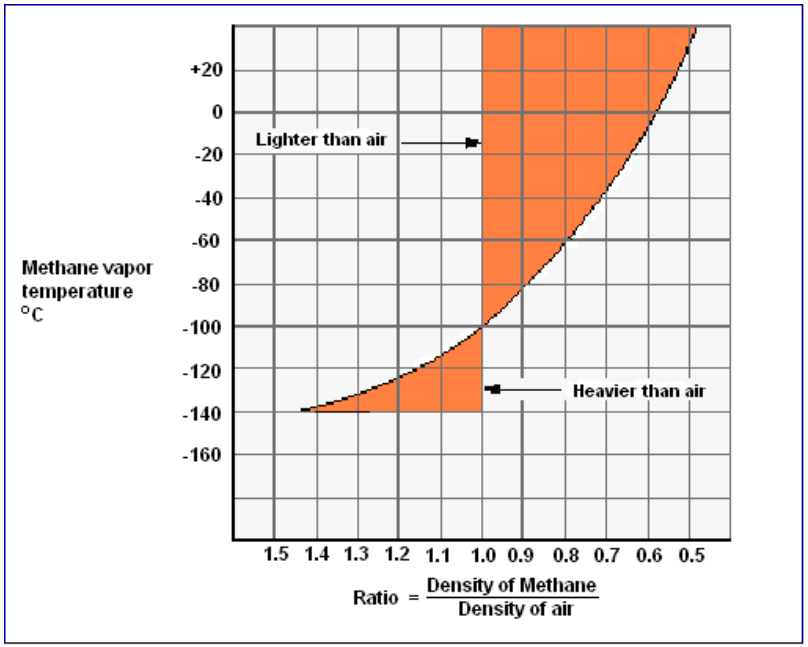




Fuel Properties

- Boiling point -163°C at atmospheric pressure
- Critical Temperature – 82 °C
- S.G. ~ 0.5
- Liquid and Gas Volume ~ 1/600





Fuel Tank Capacity

Gross Calorific Values
- HFO 41.2 MJ/Kg
- LNG 55.5 MJ/Kg

And

Density
- HFO 991 Kg/m3
- LNG 464 Kg/m^3

- For the same energy input, LNG need 1.6 times more storage volume (m^3)
- Type C tanks with access around tank, it could be 3 to 4 times
- Tank Type is a function of required capacity

Tank Location

Location of Tanks

- Risk of fire in adjacent space causing over pressure
- Risk of leaked flammable product causing fire and explosion
- Risk of leaked cryogenic fluid leading to loss of structural integrity

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