AOG 2019

LNG bunkering technical and training challenges – an update

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15th March 2019

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MARPOL ANNEX VI

Sulphur in Fuel Oil Limits

China to expand ECA to cover all territorial waters

Chinese government has proposed a plan to make the entire territorial waters subject to a 0.5% sulphur cap from January 1, 2019. Beijing's schedule will be 12 months head of that of the International Maritime Organization deadline

Options? Cost?
Availability? Quality?
SAFETY? Operations?
Enforcement?
IMO? ISO?
What? When? How?

Anticipated market take up for 2020 for SOx compliance

58,000+ ships on international trade

Conventional option

MGO, ULSFO and VLSFO

Up to 0.10 S % m/m inside a SOx ECA

and up to 0.50 S % m/m outside SOx ECA

151 LNG fuelled ships on order excl. GC

4 methanol ships on order

Numbers approximate

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IMO Availability study

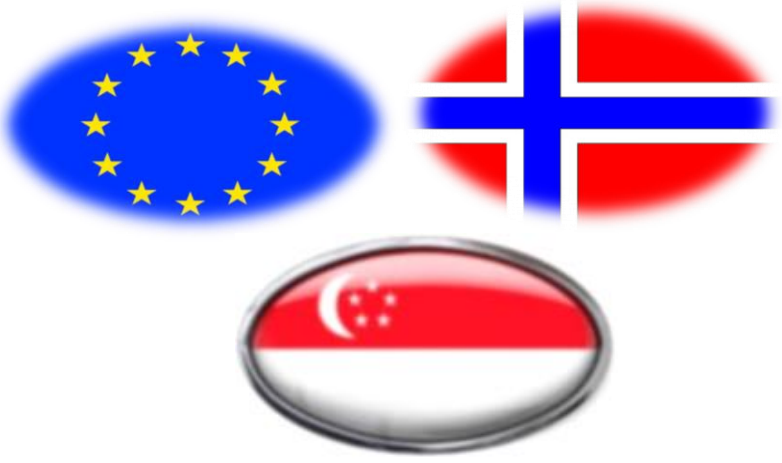
Today – closer to 15 M M/T

Fuel type	Demand forecast for 2020 (mill MT)
HFO (scrubbed)	36 (11%)
Max 0.10% sulphur fuels	39 (12%)
Fuels between 0.10% and 0.50% sulphur	233 (73%)
LNG	12 (4%)
Total	320 (100%)

Optimistic?

Factors influencing use of LNG as a Marine Propulsion fuel

- Marine emission requirements
  - MARPOL Annex VI – NOx & SOx Emissions
- Stable LNG Fuel prices
- Development of reliable Dual fuel engines
- Promotion of LNG as the preferred fuel by Governments



LNG Bunkering Port Development

Existing and planned LNG bunker ports plus many more…..

Aarhus	Port Fourchon	Le Havre	Santander
Amsterdam	Fredrikstad	Long Beach	Singapore
Antwerp	Fujairah	Los Angeles	Stavanger
Bergen	Ghent	Lübeck	Stockholm
Bodø	Gijón	Lysekil	Talinn
Bremerhaven	Gothenburg	Mongstad	Turku
Brunsbüttel	Hamburg	Nanjing	Wilhelmshaven
Buenos Aires	Helsinki	Nynäsham	Zeebrugge
Busan	Hirtshals	Oslo	Zhoushan
Copenhagen	Incheon	Oulu	Zwijndrecht
Ferrol	Karmøy	Roscoff	
Florø	Kristiansund	Rotterdam	

Why are low flash alternative fuels more hazardous than traditional fuel oil?

1. Cryogenic Burns Liquid contact with skin will cause burns and can result in fatality	✓	X
2. Low Temperature Embrittlement Equipment/structures can fail on contact with liquid	✓	X
3. Rapid Phase Transition (RPT) Released onto the sea a near instantaneous ‘explosive’ transition from liquid to gas can occur. This can result in structural damage to the hull	✓	X
4. Gas Expansion A liquid pool rapidly boils, and as the gas warms and expands it requires a volume 600 times that of the liquid	✓	X
5. Pool Fire/Flash Fire Pool fire. The intensity of the radiation can cause fatal injury and fail structure and critical equipment	✓	X

LNG Bunkering

- Truck to Ship (TTS)
  - Small volume bunkering (100m^3/hr maximum transfer)
    - ISO tank = 40m^3
  - Bunkering same side of vessel as other operations
  - Low infrastructure cost
- Ship to Ship (STS)
  - Mature technology from LNG tankers
  - Larger transfer rates

LNG Bunkering Challenges

Deep Sea Shipping

- LNG receiving ship (design and technology)
- LNG bunkering/delivery ship (design and technology)
- The interphase between LNG receiving and delivery ships (custody transfer)

Codes, Standards & Studies

Enabling LNG bunkering for deep sea shipping

- IGF code EIF 1 January 2017
- BS EN 1472-2; 2008 (BSI 2009)
- ISO 28460 (ISO 2010)
- ISO /TS 18683 (ISO 2015)
- Singapore TR 56
- EMSA LNG bunkering assessments

IGF code

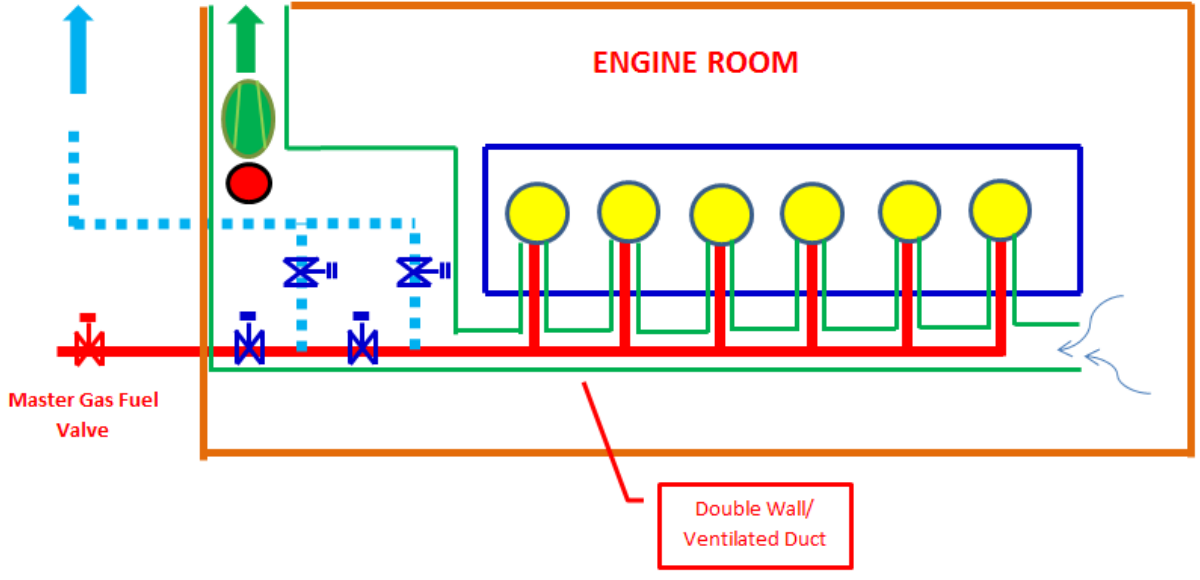
- Purpose - to provide an international standard for ships using low-flashpoint fuel, other than ships covered by the IGC Code
- Adopted by MSC 95 June 2015 - Entry into force on **1st January 2017**
- Supersedes MSC.285(86) ‘Interim Guidelines on Safety for Natural Gas-Fuelled Engine Installations in Ships’
- Follows **goal based** approach
- **Risk assessment**
- Detailed requirements for natural gas
- Other low flash point fuels allowed
- Not applicable to Gas Carriers – IGC Code applies

Ship Design and Arrangement

- Requirements for shipboard arrangements
- Tank location
  - Sets **deterministic** limits for the spacing between tank boundary and shipside
  - Also allows a **probabilistic** approach – may result in reduced distance but limits the permissible length of the tank
  - On open deck/below deck
- Machinery space concepts
  - Gas safe/ESD Protected

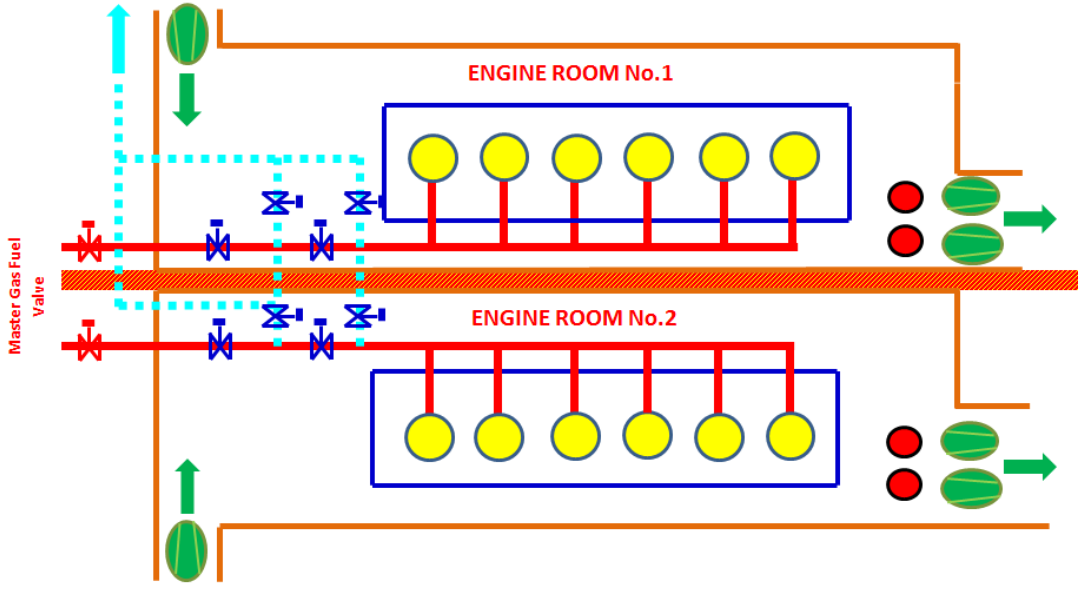
Gas-Safe Machinery Space

- Single failure does not lead to gas leakage
- Fuel piping within machinery space to be double walled/ventilated duct
- Machinery space redundancy not required
- High pressure gas fuel operation permitted



ESD – Protected Machinery Space

- Electrical equipment of non-safe type to be disconnected upon gas detection
- Single walled fuel lines in the machinery space
- Redundancy
  - Machinery spaces
  - Gas Detection
  - Ventilation redundancy
- Fuel Gas pressure less than 1MPa



IGF Code – Other Chapters

7. Material & General Pipe Design

8. Bunkering

9. Fuel Supply to Consumers

10. Power Generation Including Propulsion & Other Gas Consumers

11. Fire Safety

12. Explosion Prevention

13. Ventilation

14. Electrical Installations

15. Control, Monitoring and Safety Systems

16. Manufacture, Workmanship and Testing

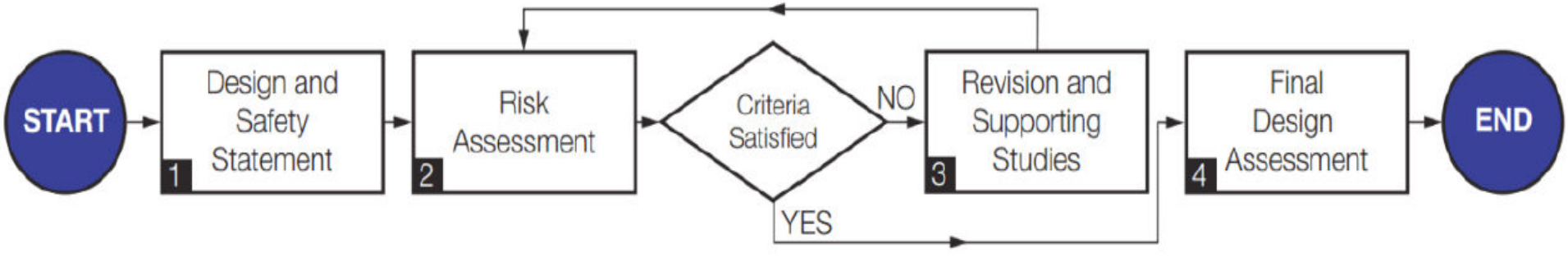
17. Drills and Emergency Exercises

18. Operation

19. Training

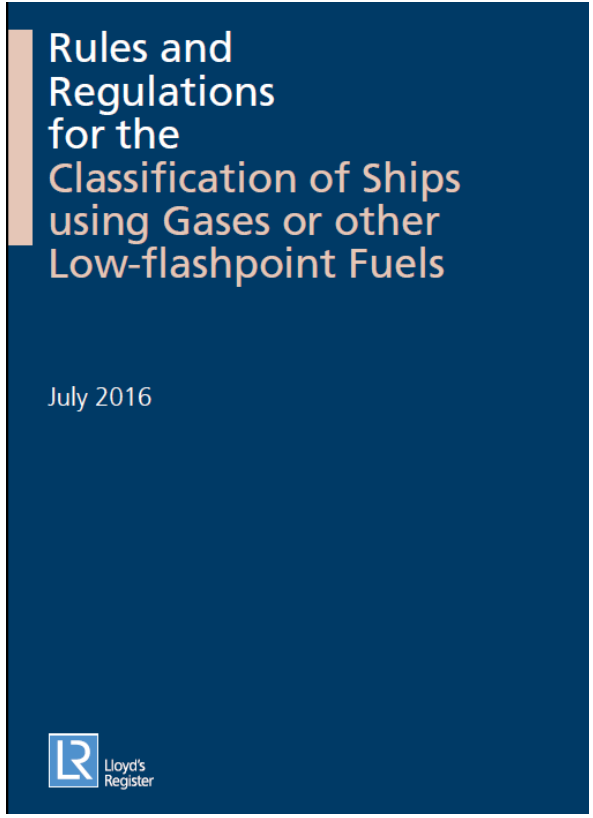
International GC/GF- Risk Based Design

- Application of Novel Technology accepted by IGC/IGF Codes
- Risk Assessment



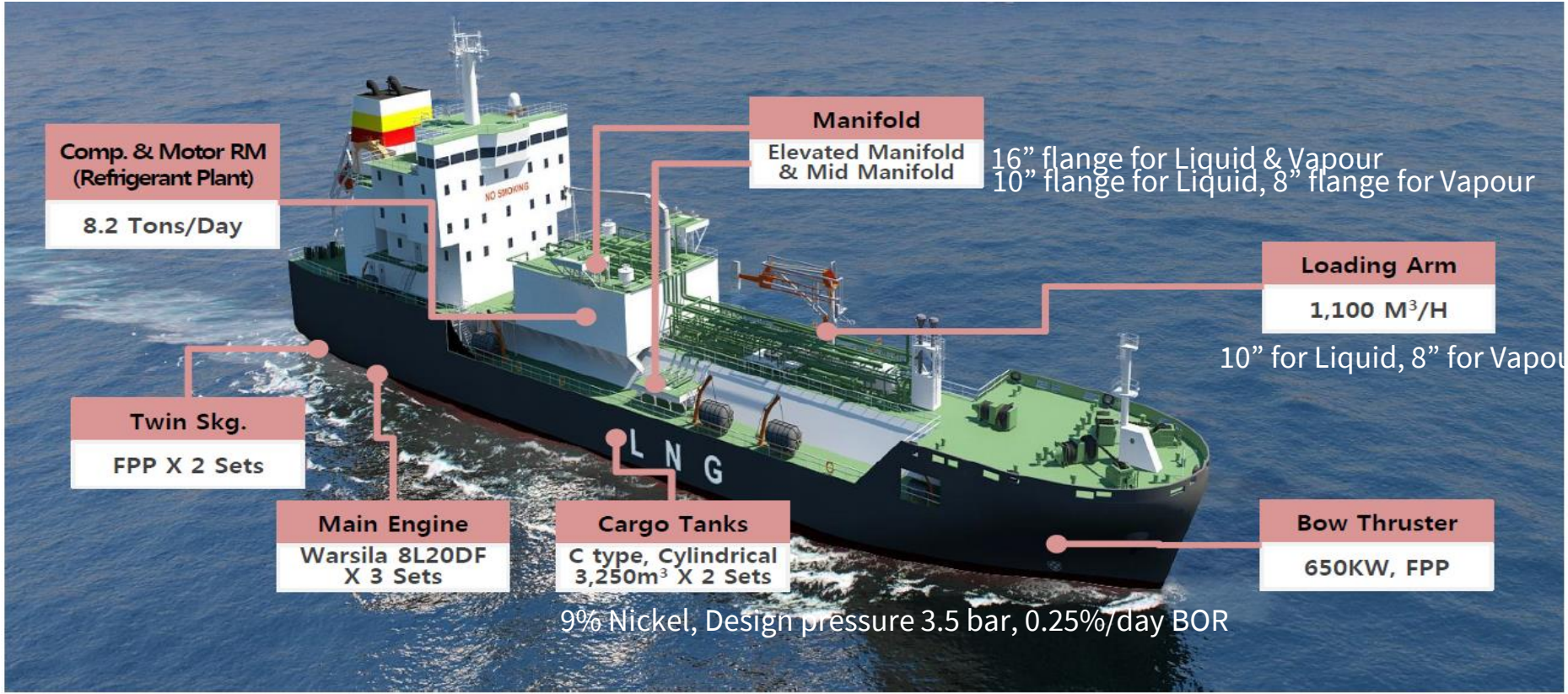
Rules and regulations for the classification of ships using gases or other low-flashpoint fuels

- Follows IGF Code, includes LR interpretations
- Functional requirements allows innovation
- **LFPF (GF, NG)** – Machinery Notation **(EG-Ethane, LP-LPG, ML - Methanol** etc.**)**
- **GR** – Descriptive Note
  - A - AiP
  - S - Structural arrg't provided
  - T – Fuel storage tank
  - P – Piping systems
  - E – Engines/Boiler



Shell

Cardissa



The Human Element in LNG bunkering operations

The challenge ahead

- Standards and infrastructure procedures understood and largely maturing.
- LNG bunkering is an activity that will not be able to be quickly adapted to by the usual fuel oil bunkering suspects and **human operator competence needs to be developed and managed for LNG bunkering applications**.

Unlike conventional liquid oil bunkering which is a simple means of fuelling ships LNG bunkering carries a much higher risk and requires a level of sophistication not experienced or attained in main stream shipping thus far.

Making People Aware and Competent in the LNG bunker supply chain

LNG Bunkering where technology meets logistics

Gaps:

- Complete Competency Standards for Gas Bunkering for
  - Bunker Tankers Crew
  - Receiving Ships Crew
  - Bunker Terminals Personnel
- Standards for Gas Bunkering Suppliers and its Personnel

Solutions:

- Creation of Competence Standards to cover gaps – Creating a Syllabus for Complete Training Manual for Gas Bunkering
- Continuous Competency Management System (CCMS)
- STCW approach

1. LNG Bunker Tanker: Deck Officers, Engineer Officers & Ratings
2. LNG-Fuelled Receiving Vessel: Deck Officers, Engineer Officers & Ratings

Wrap up

LNG bunkering – Where technology meets Logistics

- LNG standards, technology and procedures largely mature or maturing.
- Many Ports already LNG bunkering ready or in process of doing so.
- LNG bunkering is not to be confused with liquid oil bunkering and a different set-of skills is required for personnel handling LNG bunkering.

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