DNV·GL

BPO meeting: SECA is real now – first impressions of sulphur limits

Ship owners' Compliance strategies: Dynamics, facts, figures

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Transport Week, Gdansk, 18 March 2015

Content





Additional topic, may soon come: Focus on NOx, Black Carbon CO2, EEDI, MRV

SOx emissions Compliance options

Basically 3 options available:











- Low sulphur distillate
- New low sulphur heavy hybrid fuels



? ...or fleet redeployment, i.e. remove your ship from ECAs...

LNG as fuel for SOx and NOx removal:



- •LNG fuel prices vs oil price, and LNG price to end-user
- Fleet flexibility, ships' second hand value
- •LNG fuel providers' margins
- •LNG fuel quality and quantity measurements upon bunkering

?

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However, there are still some "if's and but's"

- Lowered business risk for <u>Ship Owner</u>:
 - LNG is flooding the world markets,
 - Standardized tech & operations.
 - Steady LNG quality and pricing

IDEAL LNG FUEL CASE:

- Newbuilds
- Long Contract periods
- Owner pays the fuel bill
- Fixed routes, much ECA
- Subsidies
- Level playing field: ECA compliance properly enforced! (Trident Alliance)
- LNG being available at right volumes upon arrival, one to many bunker service
- Close collaboration with Charterer (and party paying for fuel)
- The development in Sweden, Finland and Lithuania is very interesting
- Increased predictability for <u>LNG fuel provider:</u>
 - Access to LNG
 - Ability to supply a steady LNG quality
 - Which client base? How many vessels?
 Sales volume? Bunkering frequency?
 Manning? Insurance? Training? Regulations? Permits?



There are currently 138 confirmed LNG fuelled ship projects 60 ships in operation + 78 ships under construction/refitting)



Updated 10.03.2015 Excluding LNG carriers and inland waterway vessels

78 confirmed LNG fuelled newbuilds – DNV GL also first choice for future projects (1/2)

Confirmed orderbook

Year	Type of vessel	Owner	Class
2015	Ro-Ro	Norlines	DNV
2015	Car/passenger ferry	Society of Quebec	LR
2015	Car/passenger ferry	Society of Quebec	LR
2015	Car/passenger ferry	Society of Quebec	LR
2015	PSV	Harvey Gulf Int.	ABS
2015*	Oil/chemical tanker	Bergen Tankers	LR
2015	Car/passenger ferry	AG Ems	GL
2015*	Car/passenger ferry	AG Ems	GL
2015	Car/passenger ferry	Samsoe Municipality	DNV
2015	Tug	CNOOC	CCS
2015	Tug	CNOOC	CCS
2015	PSV	Siem Offshore	DNV
2015	PSV	Siem Offshore	DNV
2015	PSV	Simon Møkster	DNV
2015	PSV	Harvey Gulf Int.	ABS
2015	PSV	Harvey Gulf Int.	ABS
2015	PSV	Harvey Gulf Int.	ABS
2015	Tug	NYK	NK
2015	Gas carrier	Chemgas Shipping	
2015	Gas carrier	Evergas	BV
2015	Gas carrier	Evergas	BV
2015	Gas carrier	Evergas	BV
2015	Bulk ship	Erik Thun	LR
2015	Container Ship	Brodosplit	DNV GL
2015	Container Ship	Brodosplit	DNV GL
2015	PSV	Siem Offshore	DNV GL
2015	PSV	Siem Offshore	DNV GL

Year	Type of vessel	Owner	Class
2015*	Oil/chemical tanker	Furetank Rederi AB	BV
2015	Container ship	TOTE Shipholdings	ABS
2016	Container ship	TOTE Shipholdings	ABS
2016	PSV	Harvey Gulf Internationa	ABS
2016	Icebreaker	Finnish Transport Agancy	' LR
2016	PSV	Siem Offshore	DNV GL
2016	PSV	Siem Offshore	DNV GL
2016	Gas carrier	Chemgas Shipping	
2016	Oil/chemical tanker	Terntank	BV
2016	Oil/chemical tanker	Terntank	BV
2016	Oil/chemical tanker	Terntank	BV
2016	Ro-Ro	TOTE Shipholdings	ABS
2016	Ro-Ro	TOTE Shipholdings	ABS
2016	Car carrier	UECC	LR
2016	Car carrier	UECC	LR
2016	Car/passenger ferry	Boreal	DNV GL
2016	Car/passenger ferry	Boreal	DNV GL
2016	Container ship	GNS Shipping	ABS
2016	Container ship	GNS Shipping	ABS
2016	Ro-Ro	SeaRoad Holdings	DNV GL
2016	Car/passenger ferry	BC Ferries	LR
2016	Car/passenger ferry	BC Ferries	LR
2016	Gas carrier	Ocean Yield	DNV GL
2016	Gas carrier	Ocean Yield	DNV GL
2016	Gas carrier	Ocean Yield	DNV GL

* Conversion project

Updated 10.03.2015 Excluding LNG carriers and inland waterway vessels

78 confirmed LNG fuelled newbuilds – DNV GL also first choice for future projects (2/2)

Confirmed orderbook

Year	Type of vessel	Owner	Class	
2016	Car/passenger ferry	Seaspan Ferries	LR	Global development
2016	Car/passenger ferry	Seaspan Ferries	LR	 confirmed orderbook
2016	Gas carrier	Navigator Gas	ABS	
2016	Gas carrier	Navigator Gas	ABS	
2016	Gas carrier	Navigator Gas	ABS	
2016	Gas carrier	Navigator Gas	ABS	
2016	Car/passenger ferry	Baleària	BV	
2016	Container ship	Universal Marine	DNV GL	
2016	Container ship	Universal Marine	DNV GL	
2017	Container ship	Universal Marine	DNV GL	
2017	Container ship	Universal Marine	DNV GL	
2017	Tug	Østensjø Rederi		Norway
2017	Tug	Østensjø Rederi		
2017	Tug	Østensjø Rederi		■ Europe
2017	RoPax	Rederi AB Gotland	DNV GL	■ America
2017	Oil/chemical tanker	Groupe Desgagnés	BV	
2017	Oil/chemical tanker	Groupe Desgagnés	BV	Asia & Pacific
2017	Container ship	GNS Shipping	ABS	
2017	Container ship	GNS Shipping	ABS	
2017	Car/passenger ferry	BC Ferries	LR	
2017	Oil/chemical tanker	Terntank	BV	
2017	Container ship	Crowley Maritime	DNV GL	
2017	Container ship	Crowley Maritime	DNV GL	
2017	Car/passenger ferry	Tallink		
2018	Container ship	Matson Navigation	DNV GL	
2018	Container ship	Matson Navigation	DNV GL	

Updated 10.03.2015 Excluding LNG carriers and inland waterway vessels

Interesting new vessel: Nor Lines 2 x Combined cargo vessels, mono fuel LNG

- First ship «Kvitbjørn» underway from Tsuji Yard in China to Norway (North Sea trade). Second ship launced in June
- Rolls Royce LNG engines and design, DNVGL Class
- Specially designed for coastal/short sea traffic, competing with trucks «Green Corridors»
- Refulled in India on her way to Europe (Kochi LNG terminal)



LNG bunker vessel orderbook [1/3]

Jahre Marine

- Order placed at Avic Dingheng, delivery 2015
- Rolls-Royce design
- Type A tank with capacity of 6,300m³
- The company received financial support from Norwegian NOx Fund and Innovation Norway's Environmental Technology Funding

GDF Suez / NYK

- LNG capacity of 5,100 m³ split between two IMO Type C pressure tanks.
- Hanjin Heavy Industries yard, Korea
- It will be based at the port of Zeebrugge, Belgium, and initially it will supply LNG fuel from GDF-SUEZ to the fleet of United European Car Carriers (UECC).
- Delivery in 2016





LNG bunker vessel orderbook [2/3]

Argos - Combined LNG Bunker

- Inland bunker ship to handle both LNG and marine diesel.
- Rensen-Driessen Shipbuilding yard with GTT membrane tank.
- Delivery late 2015
- LNG capacity of 1,870 m³ using four Type C tanks. Plus 1,400 m³ of marine diesel.
- Co-financed by the European Union under the LNG Masterplan for Rhine-Main-Danube.
- Expected to operate in Rotterdam / Gate Terminal



Shell's Bunker vessel

- Home base: Rotterdam/Based at the Gate terminal
- Capacity: 6500 m3. Ocean-going capacities
- Yard: STX Offshore & Shipbuilding, Korea, 3 x Wärtsilä 20DF-engines
- Delivery Q2 2016



LNG bunker vessel orderbook [3/3]

Sirius Veder Gas & Skangass (Gasum)

- Owner: Sirius Veder Gas AB.
- Operator: Sirius Rederi AB, Sweden for Skangass (Gasum).
- Yard: Royal Bodewes, NL
- Norway/Sweden/Baltic operation (?)
- Capacity: 5800 m3. Ocean-going capacities
- Delivery: Q2 2017
- EU support (Pilot LNG: Joint Industry project FLEXI)



Amsterdam/Rotterdam/Antwerp region

- Owned by Dutch conglomerate VEKA Group, Deen Shipping, IUVENIS and Count
- The "LNG PRIME" is 90 meters long and has a loading capacity of 1.000 ton of LNG.
- The "LNG PRIME" will operate in ARAregion from early 2016



Scrubber for SOx removal:

- SOx compliance achievable (SECA regimes)
- Ship operators continue using conventional fuel: No fuel switch-over problems, extensive fuel supply network, no new low sulphur fuel tanks, familiar fuel procurement and bunkering routines etc
- Lower CAPEX than an LNG fuel installation (but only SOx removal)
- Easier to refit scrubbers than an LNG solution (no cryogenic systems etc.)
- Growing reference base, > 50 installations worldwide
- Increases OPEX by giving ~2% fuel penalty
- Documentation needed to prove proper scrubber in operation while in ECA
- Wash water quality criteria to be met. Check local discharge requirements
- Large installation which require proper interfaces with ship
- Sludge reception facilities needed in ports
- Limited experience, but growing fast
- •Heat recovery options? Exhaust gas temperature?
- Durability or corrosion issues over time?
- •All engines to one scrubber (Combined)? Multiple inline scrubbers?
- Combinations with NOx abatement systems? With boilers?
- Closed loop / Open loop / Hybrid scrubber operation?

How does a Scrubber work?

SOx+Sodium hydroxide→*Sodium sulphate solution slurry*

(un-combusted fuel → PAH/soot pollution etc)

Sodium sulphate slurry will be concentrated by Centrifuge separator to a sludge, which must be landed as <u>special waste</u>. Treated water to be discharged to sea where allowed. Acceptance criteria being discussed.

MEPC.184(59) § 10.4 "Washwater residue:

10.4.1 Residues generated by the EGC unit should be delivered ashore to adequate reception facilities. Such residues should not be discharged to the sea or incinerated on board.

10.4.2 Each ship fitted with an EGC unit should record the storage and disposal of washwater residues in an EGC log, including the date, time and location of such storage and disposal. The EGC log may form a part of an existing log-book or electronic recording system as approved by the Administration."

IDEAL SCRUBBER CASE:

- Newbuilds & <u>retrofits</u>
- Long Contract periods
- Owner pays the fuel bill
- Fixed routes, much ECA



Description of working principle – Wet scrubber <u>closed</u> loop



There are currently more then 200 confirmed scrubber projects



Updated 03.03.2015

Scrubbers in operation and in the orderbook



Dominant suppliers: Wärtsilä, Alfa Laval, Yara (Green Tech Marine), but there are many

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The scrubber shall not impact negatively upon safety of the ship or persons on board

- Typical risks regarding safety:
 - Fire/explosion
 - Flooding of the engine room
 - Water backflow to the engine
 - Handling and storage of chemicals
 - Bunkering of chemicals
 - Material selection



Exhaust gas cleaning systems – what to consider

- Scrubber technology proven on land, but still early days at sea
- Investment costs for existing vs newbuildings
- Additional energy consumption
- Capacity & scalability, physical footprint
- Sludge production and disposal/reception facilities
- Integration challenges: SOx scrubbers + NOx SCR/EGR
- Training and qualification of crew
- Ensuring compliance to international regulations
 - Waste water discharge monitoring
 - Performance monitoring & documentation
- Manufacturer capacity as 2015 and 2020 approaches?



Fuel switch

Switch to conventional low sulphur marine diesel oil



Autumn 2014: "Hybrid ECO compliant fuels" introduced

		7		
			DMA	HDME 50
	EXONMODI	Characteristics	ISO 8217	Typicals
	Marine Fuels & Lubricants	Kinematic Viscosity, cSt @ 40°C	6	40 - 75
		Density @ 15°C kg/m3	890	895 - 915
	l echnical Bulletin	CCAI	-	795 - 810
		Cetane Index	40	N/A
		Sulfur, mass %	1.50	0.1
	HDME 50	Flash Point, °C	60	>70
		Hydrogen Sulfide, mg/kg	2	< 1
		Acid Number, mg KOH/g	0.5	< 0.1
	Total Sediment Aged, mass %		0.01	
		Oxidation Stability, g/m3	25	N/A
 Performance over time? Stability? Mixing with HFO? Availability? 		Carbon Residue, mass %	0.3	< 0.30
		Pour Point, °C	-6	15 - 30
		Appearance	C&B	Green/Brown
		Water, vol %	-	0.05
		Ash, mass %	0.01	< 0.01
		Lubricity, microns	520	< 320
		Vanadium, mg/kg	-	< 1
Pricina?		Sodium, mg/kg	-	< 1
- rncing:		Al + Si, mg/kg	-	< 0.3
etc		Calcium, mg/kg	-	< 1
		Zinc, mg/kg	-	< 1

Business cases: LNG fuel, scrubber+HFO, Low sulphur distillate



Explanation

Each line represents the additional cumulative costs of the respective configuration compared to baseline (HFO).

LNG has a high investment cost, but depending on the fuel price the operational savings can be significant.

MGO price 950 USD/tonne 23.5 USD/MMBtu

HFO price 600 USD/tonne 15.8 USD/MMBtu

Predictability in financials and regulations

- Recent oil price drop
- Regional emission regulations in US and EU, misaligned with IMO
- Many different, personal agendas mess up the picture (NGOs / ship owners / suppliers / environmental politicians..)
- Law enforcement? Un-even penalties of non-conformity
- Open loop scrubber OK or not? (US-VGP, EU Water framework Dir..)

• The industry needs predictable regulations and practical solutions!

Other emissions and issues NOX, CO₂, EEDI, and MRV



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SOx reduktion

NOx reduktion

The Norwegian NOx Fund: 655 supported and installed measures, NOx reduction 28,600 t/y

NOx reduction since 2006: 28 623 tonnes, from 655 installed (and verified) measures





EEDI - in place and gearing up towards review

Reduction factors (in percentage) for the EEDI relative to the reference line for each ship type.

	Size	Phase 0	Phase 1	Phase 2	Phase 3
		1 Jan 2013 –	1 Jan 2015 –	1 Jan 2020 –	1 Jan 2025
		31 Dec 2014	31 Dec 2019	31 Dec 2024	onwards
Bulk Carriers	>20,000 Dwt	0%	10%	20%	30%
	10-20,000 Dwt	n/a	0-10%*	0-20%*	0-30%*
Gas tankers	>10,000 Dwt	0%	10%	20%	30%
	2-10,000 Dwt	n/a	0-10%*	0-20%*	0-30%*
Tanker and combination carriers	>20,000 Dwt	0%	10%	20%	30%
	4-20,000 Dwt	n/a	0-10%*	0-20%*	0-30%*
Container ships	>15,000 Dwt	0%	10%	20%	30%
	10-15,000 Dwt	n/a	0-10%*	0-20%*	0-30%*
General Cargo ships	>15,000 Dwt	0%	10%	15%	30%
	3-15,000 Dwt	n/a	0-10%*	0-15%*	0-30%*
Refrigerated cargo carriers	>5,000 Dwt	0%	10%	15%	30%
	3-5,000 Dwt	n/a	0-10%*	0-15%*	0-30%*

* The reduction factor is to be linearly interpolated between the two values depending on the vessel size. The lower value of the reduction factor is to be applied to the smaller ship size.

- Schedule and/or levels may change subject to IMO reviews in 2015 and 2022
- IMO Apr `14: LNG carriers, Ro-Ro's and cruise to be included with own regime

EU developments – CO2 Monitoring, Reporting and Verification (MRV) scheme



- Ships above 5000 GT (all flags) have to annually report CO2 emission on voyages to, from and between EU ports
- Regulation in effect January 1 2018, reporting plans to be ready by September 1 2017
- Four monitoring methods
 - Bunker Fuel Delivery Note (BDN)
 - Fuel tank sounding on board
 - Fuel flow meters
 - Direct emissions measurements
- Efficiency data, i.e. tonne-nm also to be reported
- Political agreement with EU Council and Parliament reached, legal adoption expected 2015



IMO discusses aspects of a data collection system for fuel consumption

Correspondence group to report to MEPC 68

CONCLUSIONS

Air emissions in a nutshell

- SOx ECA requirements remain unchanged. Global 0.5% may be delayed until 2025 – but note 0.5% sulphur in EU waters in 2020
- 2. Limited near-term spread of new ECAs, prime candidates are Bosporus / Marmara, Hong Kong / Guangdong, Mexico
- 3. NECA (NOx) Tier III requirements for NB's effective in North American waters from 2016
- NECA (NOx) application for North Sea possible as early as '17-'18, but politically challenging. Effective date will depend on applications. The Baltic will likely lag behind
- 5. CO_2 MRV for the EU in 2018, may possibly be superseded by IMO MRV
- 6. Be aware of potential impact of EU NEC Directive (National Emission Ceiling) + Water Framework Directive
- 7. CO_2 pricing in the 2020's at the earliest, potential UNFCCC deal at COP 21 (Paris '15)

Low sulphur fuel HFO+scrubber LNG fuel

SCR (NOx) EGR (NOx)

Energy efficiency measures

Thank you for your attention

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