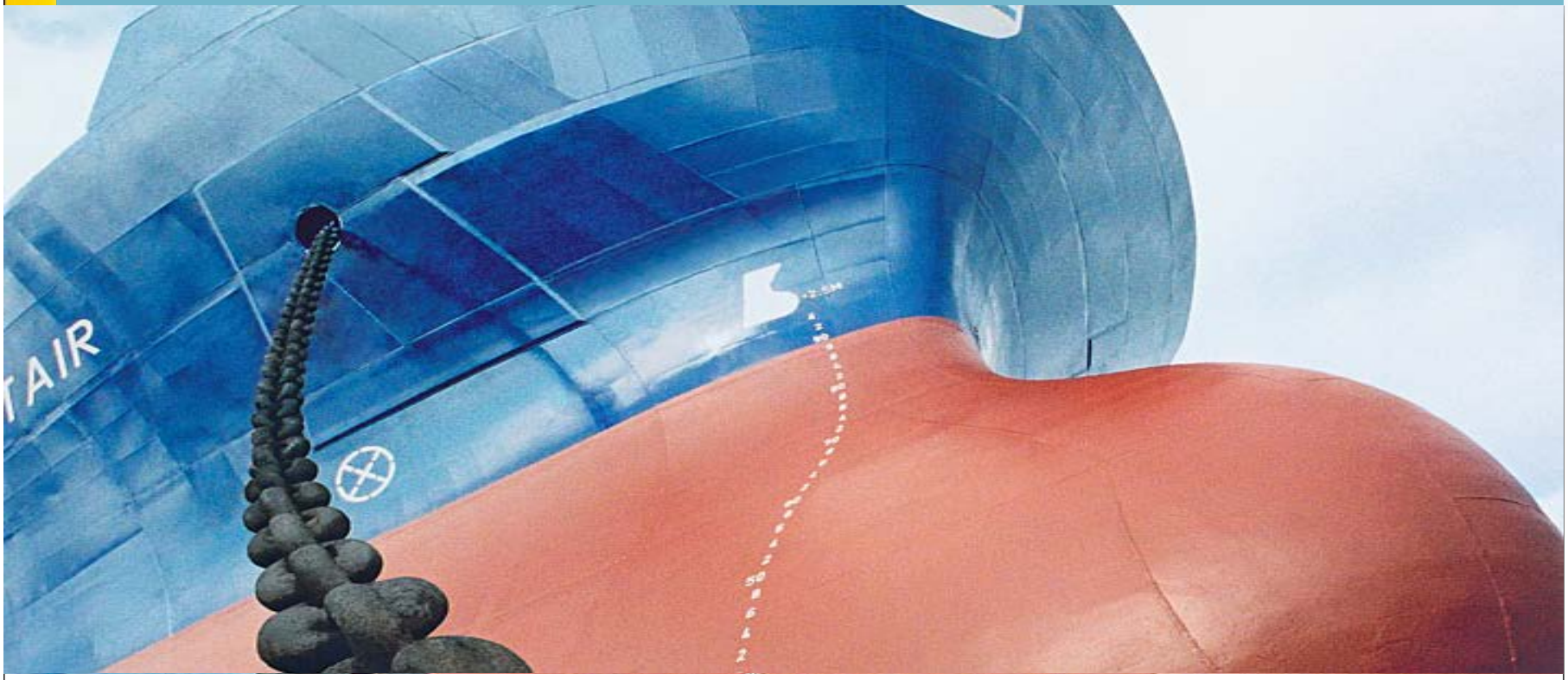
Workshop „Alternative Kraftstoffe“

Ultra-Low-Sulfur-Fuels (ULSFO) und andere alternative Kraftstoffe



Dr. Reinhard Krapp
Umweltschutz
Hamburg und Leer, 31.5./1.6.2016

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Contents

- Fuel Quality
- US EPA experiences and requirements
- ULSFO, results of LR FOBAS investigations
- Fuel alternatives

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Fuel Quality, Background

- Before the installation of SECAs fuel quality “only” had relevance for the safe and economic operation of ships.
- From then on the use of noncompliant fuel in SECAs is a legal offence
- Ship owners and operators must bunker compliant fuel and use it in SECAs accordingly
- They have to rely on the information given non the Bunker Delivery Note
- However, in the case that the bunkered fuel did not comply the ship and the master are made responsible

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Report of the Correspondence Group on Fuel oil quality

- MEPC 69/5/3 Annex 3, Page 1
- BEST PRACTICE FOR MEMBER STATE/COAST STATE

- Set, maintain and monitor standards for the bunker supply chain under the jurisdiction of the Member State/coastal State, under its domestic legal authority, to ensure that only fuel oil of MARPOL Annex VI compliant quality is provided to ships by suppliers licensed to operate within their jurisdiction.

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Results of MEPC 69

- 5.14 The Committee encouraged the **fuel oil supply industry** to develop draft best practice for fuel oil providers, submit this best practice for consideration by the Committee at a future session.
- 5.16 Best practice for **fuel oil purchaser/user** should be developed, but that further consideration was needed to reflect concerns expressed, including **how a purchaser could identify reputable fuel oil providers and could insist that fuel oil providers were following best practice.**

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Results of MEPC 69

- 5.18 Best practice guidance for **Member States/coastal State** should not go beyond the requirements of MARPOL Annex VI by imposing obligations that are not included in the Annex.
- 5.20 The majority of delegations that spoke were of the view that the contract of the supply and delivery of fuel oil to a ship was a commercial matter, and the **existing requirements in MARPOL Annex VI were adequate**.
- 5.22 Following consideration**, the Committee re-established the Correspondence Group** on Fuel oil quality, and instructed it to develop further Best Practice for Fuel Purchaser/ user and for Member State/coast State

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US EPA Experiences and requirements 2015

- 175 non-availability reports, January 1 – June 30,
  - January: 88 submissions
  - February: 36 submissions
  - March: 24 submissions
  - April: 9 submissions
  - May: 7 submissions
  - June: 10 submissions
- As of June 1, 2015, five vessels reported problems with their machinery operations while using 0.10 % fuel.
- Pilot fuel requirements for dual fuel engines,
  - EU max. 3,5% S
  - US max. 0,10%S, on special request 0,5%S

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US EPA Experiences and requirements 2015

- Exhaust Gas Cleaning Systems (EGCS)
  - Sludge or residues must not be discharged in waters subject to the VGP
  - For open loop EGCS, calculated effluent pH value is not an approved method
  - EPA does not have additional scrubber wash water effluent pH requirements outside of the 3 nm limitation of the VGP
  - The 2013 VGP requires EGCS effluent to meet certain numerical discharge limitations

US EPA Experiences and requirements 2015

- NOx Tier III
  - Approval of a dual fuel engine operating on liquid fuel during starting and stopping or reversing will be handled on a case-by-case basis during the certificate approval process
  - Operation on liquid fuel in „gas free condition“ requires approval in advance on a case-by-case basis
  - Gas mode failure caused by low Methane Number of the fuel gas due to a long voyage that requires switch to liquid fuel results in loss of compliance for NOx, and possibly for SOx
  - USCG and EPA will not accept a NOx emission averaging scheme.

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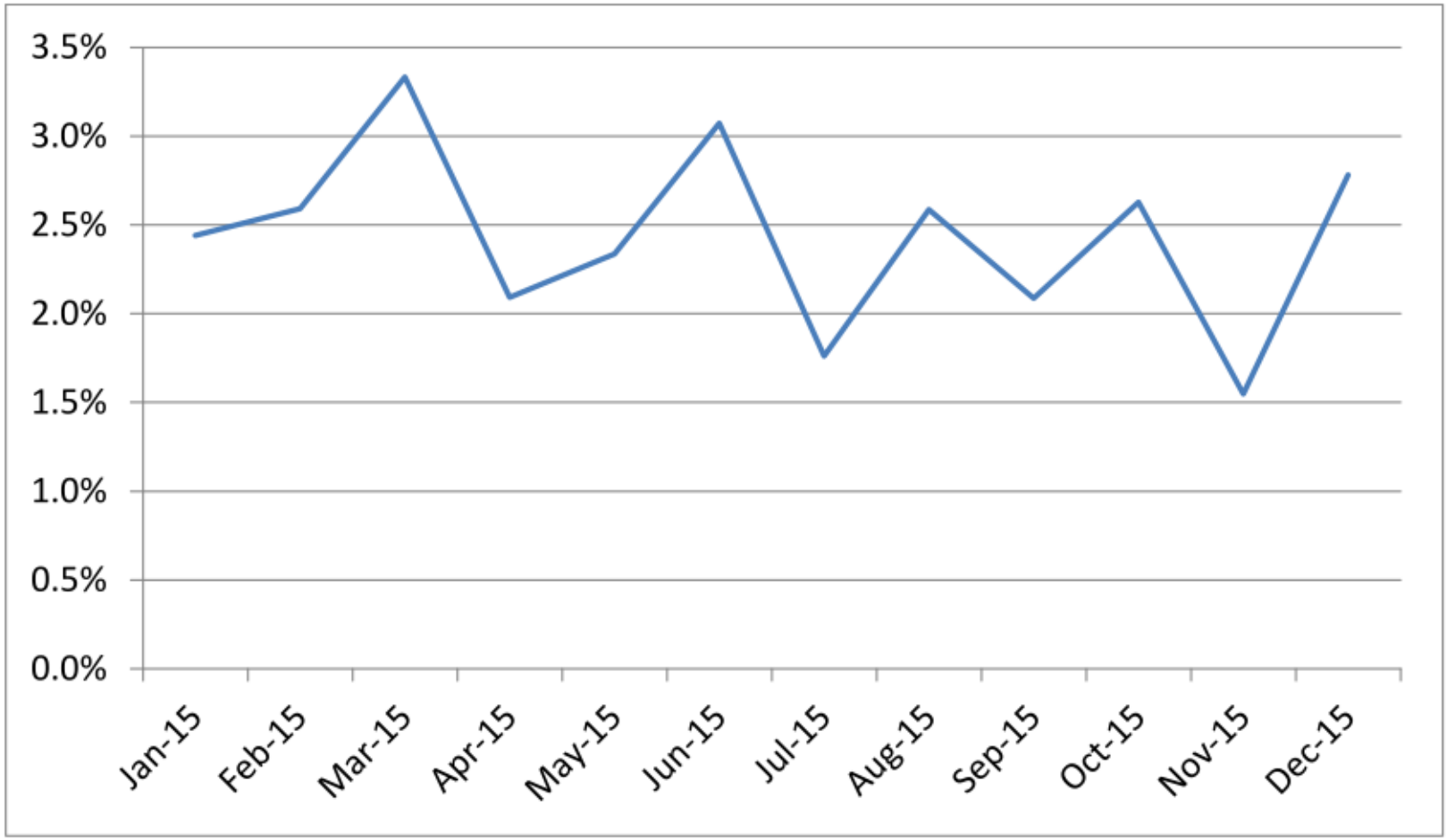
European non compliance rates



Source: International Transport Forum based on ECSA Thetis database

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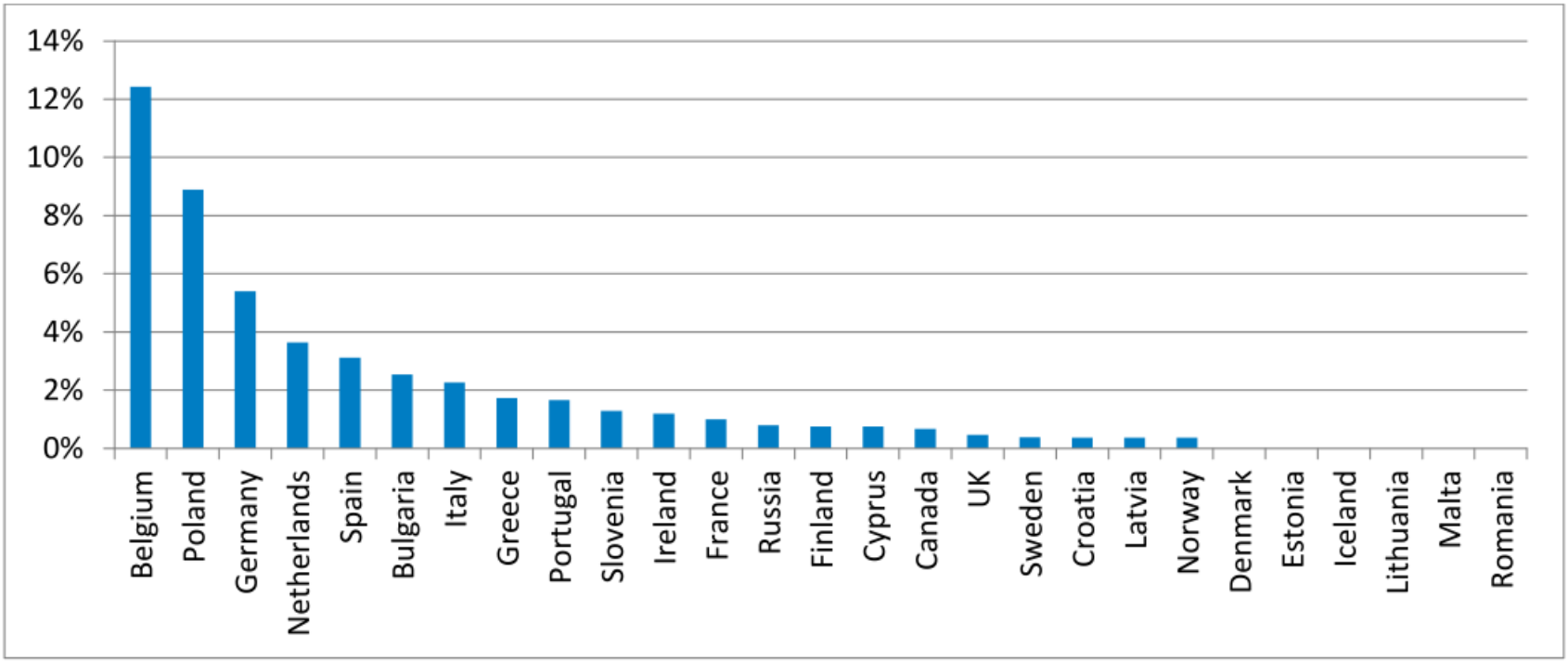
2015 non compliance rates per country



Source: International Transport Forum based on ECSA Thetis database

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Results of LR FOBAS Investigations 1

ULSFO – Typical Given Specifications – from October 2012

Supplier		Chemoil	Cepsa	BP	CHemoil	Chemoil	Shell	Exxon Mobil	Lukoil	Exxon Mobil	SK Energy	ISO 8217 2012	ISO 8217 2012	ISO 8217 2012
Product Name / Characteristic	Unit	0.10% S DMB LS (DMB)	DMB 0.1%	BP 0.1 RMD	0.10% S Mexico/ Houston (RMD80)	0.10% S New York /Savannah (RMG380)	Shell ULSFO	HDME-50	Eco Marine Fuel	AFME 200	SK ULSFO	DMB	RMD 80	RMG 380
Viscosity 50 C (40C)	cSt	(10.5)	(11)	6-13	16.84	26.3	10-60	40-70	65 (max)	67	30-40	(11) /(2)	80	380
Density 15 C	Kg/m³	885	900	850-890	859	896	790-910	895-915	910	917	928	900	975	991
Sulphur	mass%	0.085	0.1	0.1	0.084	0.1	<0.1	0.1	0.095	<0.1	0.1	2		
CCAI				760-820		795	800	795-810	860	799	790-800		860	870
Cetane Index		40										35		
Flash Point	°C	70	60	60	79	>65.5	60	70	60	>70	70	60	60	60
H2S	mass%	0.1	2	2			2	1	2			2	2	2
Acid Number	mgKOH/g	0.1	0.5	2.5		2.35	0.5	0.1	2.5	<0.1		0.5	2.5	2.5
TSA (TSE)	mass%	-0.05	0.1	0.07	0.01	0.01	0.01-0.05	0.01	0.1		0.02	(0.1)	0.1	0.1
Carbon Residue	mass%	0.1	0.3	4	<0.10	3.8	2	0.3	14	<10	6	0.3	14	18
Pour point	°C	-4	6	27	-20	-6	18	15-30	20 (max)	0	20-25	6	30	30
Water	volume%	0.05	0.3	0.3			0.05	0.05	0.1	<0.5	0.2	0.3	0.5	0.5
Ash	mass%	0.005	0.01	0.04	0.003	0.06	0.01	0.01	0.07	<0.1	0.05	0.01	0.07	0.1
Vanadium	mass%			50	<1	<1	2	1	2	1	0.7		150	350
Sodium	mass%			50	4	1	10	1	2	5	2		100	100
Aluminium	mass%				<1	<5			15					
Silicon	mass%				2	<5			2					
Al +Si	mass%		5	25	3	<10		0.3			10 to 20		40	60
Calcium	mass%				13	175	30	<1	30		5			
Zinc	mass%				2	<1	15	<1	15		1			
Phosphorus	mass%				7	<1	15		15					
Lubricity (WSD)	µm	310	520						520			520		
GSE	MJ/Kg			45.2										
Appearance		Not C and B			Not C and B	Not C and B					Black			

Source : LR FOBAS

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Results of LR FOBAS Investigations 2

ULSFO - Characteristics - DMB to RM Grades
(FOBAS global data May – Aug 2015)

Categories		3	2	1	
Test	Units	Min	Ave	Max	
DEN15	kg/l	0.8376	0.8934	0.9589	0.12
KV50	cSt	2.6	25.3	83.6	81
KV40	cSt	11.3			
ASH	% m/m	<0.01	0.02	0.09	0.09
Sulphur	% m/m	<0.01	0.09	0.14	
Water	% V/V	0.00	0.02	0.35	
Pour Point	oC	-13	12	30	43
Micro Carbon Residue	% m/m	0.00	2.04	10.53	10.53
Net Calorific Value	Mj/kg	41.57	42.46	43.16	1.59
CCAI	N/A	751	799	868	117
Silicon + Aluminium	mg/kg	0	5	58	58
Calcium	mg/kg	0	24	185	185
Vanadium	mg/kg	0	2	123	123
Nickel	mg/kg	0	14	69	69

Lloyd's Register Global Marine Testing Ltd - FOBAS

Key Operational Properties

- Viscosity + Density
- Ignition quality
- Catfines and sediment
- Compatibility and stability
- Pour Point / Cold Flow
- Sulphur
- Lubricity(DM)

Source : LR FOBAS

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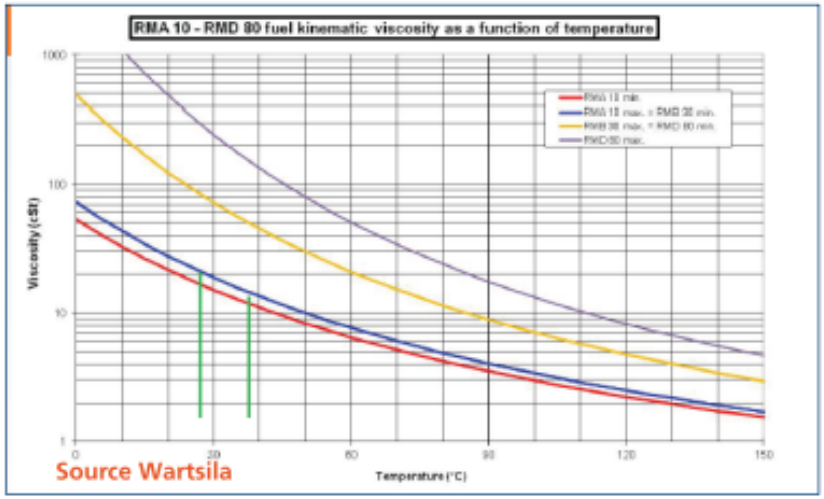
Operations - Viscosity
- Separator set up & Injection Temperatures

Viscosity [cSt @50°C]	Separation Temp. [°C]	Typical Injection Temp. 15 – 10 cSt °C
10		37-50
15		50 -63
<= 20	40	58-72
20 – 30	50	70-84
30 – 40	60	77-92
40 – 50	70	83-98
50 – 70	80	91-107
70 – 90		96-113

Temperatures stated are for Examples Only
Check ship specific separator settings

Lloyd's Register Global Marine Testing Ltd - FOBAS



Cooling as well as heating of RM fuels may be required to maintain required Injection viscosity

Check OEM specific requirements

Source : LR FOBAS

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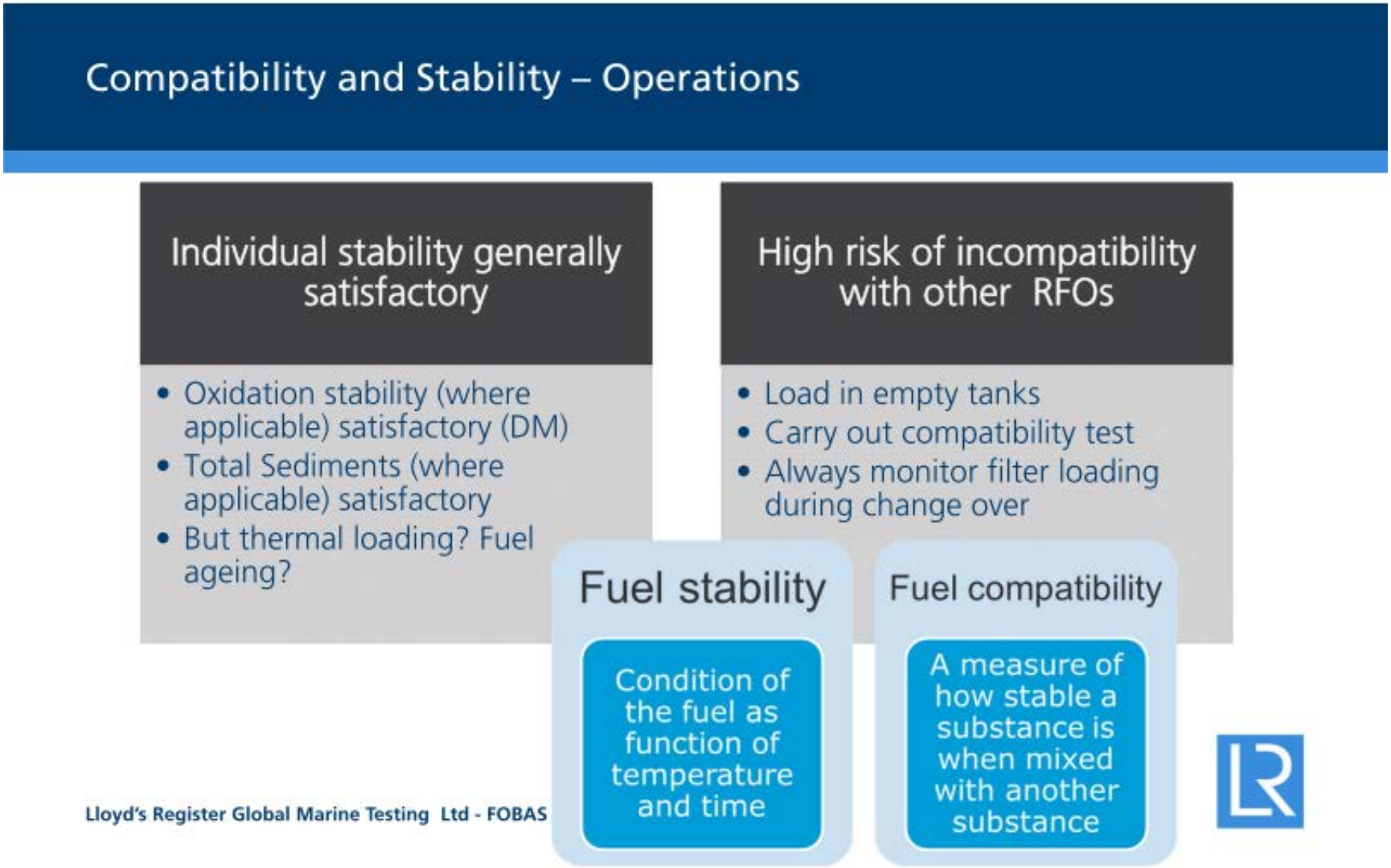
Results of LR FOBAS Investigations



Source : LR FOBAS

Summary of Technical Considerations – Check
Know what you are bunkering and inform Crew of appropriate actions

Parameter	Observations	Application
Viscosity	>DM and <RM	Heating required – avoid overheating at purifiers – check purifier setup with OEM Injection temps
Density	Wide variation	Gravity disc if applicable – Higher energy
Catfines (Al+Si)	On the whole lower than RM	RM treatment should be used
Cold flow - Pour point / CP /CFPP	Highly Wax Contents	Storage tank heating capacity – to check Check before/on delivery temperatures req'e
Ash and Sediment	Metals mostly much lower	Less fouling and filter blocking
Ignition/ Combustion	Better performance expected	Monitor engine when starting to use
CLO	LS requires lower BN	Monitor cylinder - diagnostic tools (LR)
Commingling	Paraffinic nature = Higher risk when mixing with RM fuels	Ensure segregation – keep mix with ROB to <10:90 ratio preferred 2:98 ratio
Change over	For RM 2 off service tanks needed	Changeover one RM service Tk. may take 3- 4 days – monitor filters – chose wider S-margins

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ULSFO, Conclusions

- **Fuels not standardised**
- Availability
- Compatibility of different ULSFOs, with HFO or MGO/MDO
- Tank heating required depending on pour point and sea water conditions
  - Temperature distribution in tank
  - Control of heat supply
- Long time stability
- Temperature dependency of properties (e.g. viscosity, stability, paraffin flocculation)
- Ignition and combustion characteristics (CCAI suitable index?)

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Fuel alternatives ? 1

Type of fuel	Lower heating value MJ/kg	Relative energy per volume	Pressure Tank	Emission Factor tCO2/tfuel	Emission Factor kgCO2/GJ
HFO (and scrubber)	41.5	1.0	no	3.11	75.04
MDO	42.0	1.0	no	3.21	76.33
ULSF	`?	?	no	?	?
DME	28.4	0.7	yes	0.96	33.63
LNG (Liquefied Natural Gas)	50.0	0.5	yes	2.75	55.00
LEG (Liquefied Ethane Gas)	47.0	0.6	yes	1.46	31.13
Methanol	19.9	0.4	no	1.38	69.10
Ethanol	26.8	0.5	no	1.91	71.38
Propane	46.4	0.7	yes	3.00	64.66
Butane	45.7	0.7	yes	3.03	66.30
Hydrogen	119.9	0.2	yes	0.00	0.00

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Fuel alternatives ? 2

Type of fuel	Boiling point °C	Flash Point °C	Ignition temperature °C	Ignition limits Vol %	DNEL-Value (Derived no-effect level) mg·m−3
HFO (and scrubber)		>60	~250		
MDO		>60	~250		
ULSF		>60			
DME	−24,82 °C	-41	235	2,7 - 32	1910.0
LNG (Liquefied Natural Gas)	-162	-306	595	4,4 - 16,5	
LEG (Liquefied Ethane Gas)	-89	-135	472	2,4 - 14,7	
Methanol	65	52	385	6,7 - 36	260.0
Ethanol	78,32	16.6	365	3,4 - 19	960.0
Propane	-42	-104	470	1,7 - 10,9	
Butane	-0,5	-60	288	1,8 - 8,4	
Hydrogen	-253		560	4,5 - 75	

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Some remarks on alcohols

- Methyl alcohol or Ethyl alcohol readily mix with water, **on board removal of water is not possible**
- Water in the fuels will, depending on concentration:
  - Reduce the energy content of the fuel
  - Reduce the combustion temperature and hence the efficiency of the engines
  - Make Methyl alcohol more corrosive etc.
  - The maximum power output of the engines may be reduced

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First draft of BDN for alcohols

Type of fuel	Methyl alcohol		Ethyl alcohol	
Lower calorific (heating) value MJ/kg				
Higher calorific (heating) value MJ/kg				
Density kg/m³				
Water content % m/m				
Acid content (?)				
Fuel temperature delivered °C				
Fuel temperature in storage tank(s) °C				
Pressure in storage tank(s) MPa (abs)				
Negligible byproducts (list to be developed)				

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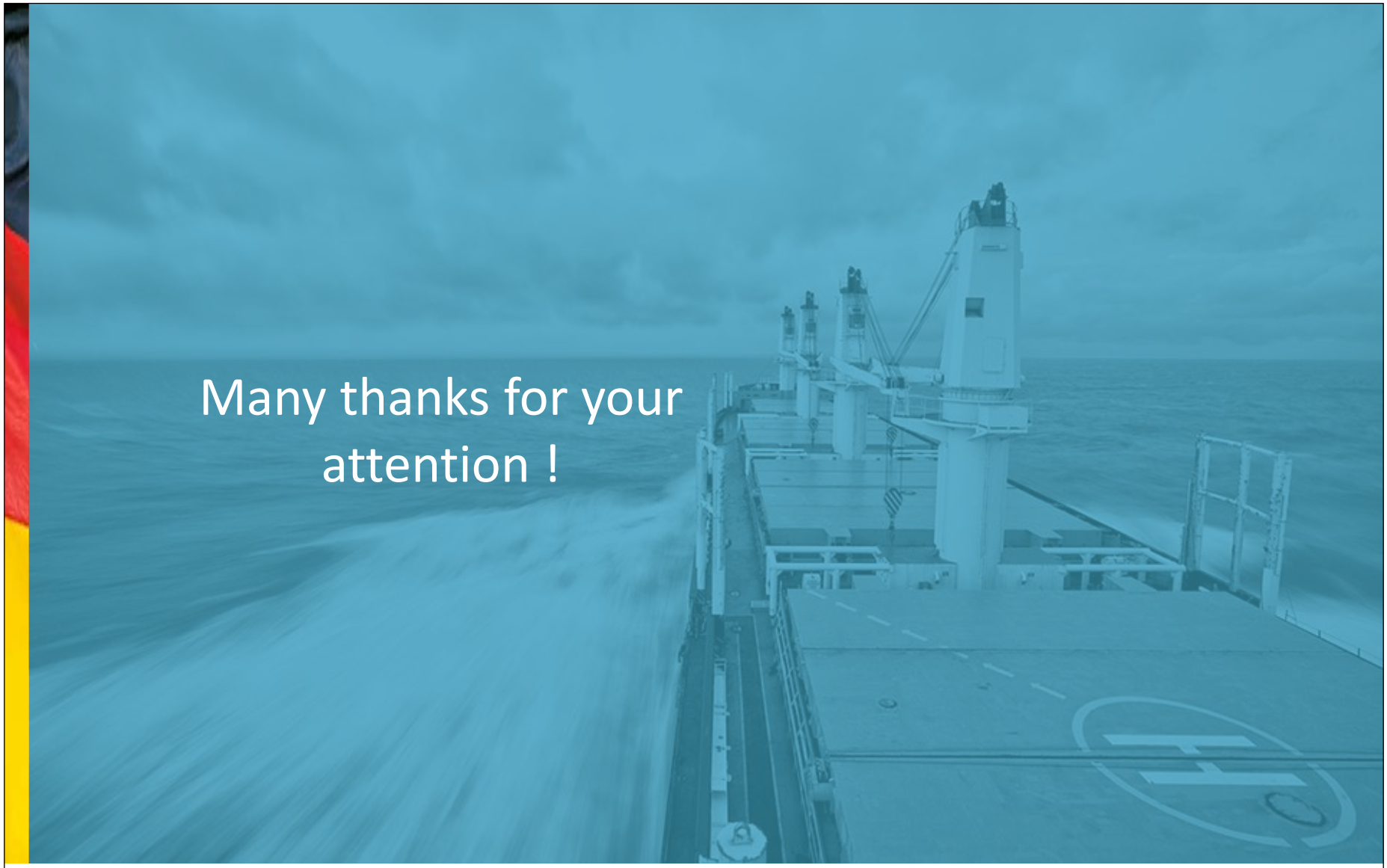

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