

Neue Entwicklungen und Betriebserfahrungen in der Schiffsbetriebstechnik

44. ISF-Tagung
22. und 23. Juni 2023

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Grußwort

Herzlich willkommen zur 44. ISF-Tagung im Hörsaalzentrum der Hochschule Flensburg!

Wir freuen uns auf interessante Vorträge, anregende Gespräche und einen regen Austausch auf verschiedensten Fachgebieten.

Wir wünschen Ihnen einen angenehmen und spannenden Aufenthalt in unserem Haus!

Lageplan:



Lageplan

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Programm

44. Informationstagung
zur Schiffsbetriebsforschung
(ISF-Tagung)

Neue Entwicklungen und
Betriebserfahrungen in der
Schiffsbetriebstechnik

Freitag, 23. Juni 2023
im Hörsaalzentrum / Audimax
der Hochschule Flensburg

Programm

8:00 Uhr Registrierung

9:00 Uhr Begrüßung
Dr. Christoph Jansen
Präsident der Hochschule Flensburg

9:10 Uhr Grußwort
Andreas Burmester
Maritimer Koordinator der Landesregierung
Schleswig-Holstein

9:20 Uhr Eröffnung
Prof. Dr.-Ing. Peter Boy

Vortragsgruppe 1

Chairman: Prof. Dr.-Ing. H. Watter

9:30 Uhr Aktueller Stand der CO2-Bepreisung
Sebastian Ebbing
Verband Deutscher Reeder, Hamburg

10:00 Uhr CII - Erste Erfahrungen aus dem Betrieb
Tobias Neumann-Overholthaus
Seacotec, Hamburg

10:30 Uhr Kaffeepause

Programm

Vortragsgruppe 2

Chairman: Prof. Dr.-Ing. M. Thiemke

11:00 Uhr Trimmen oder nicht Trimmen, das ist hier die
Frage - Feedback aus dem Einsatz des DNV
Trimmttools
Andre Kauffeldt
Det Norske Veritas, Hamburg

11:30 Uhr Felderfahrungen mit Cloud-basierter
Torsionsschwingungsüberwachung bei
Schiffsantrieben
Prof. Dr. Heinrich Mohr, Dr. Andreas
Thalhammer, Florian Zeitler
Geislinger, Hallwang Österreich

12:00 Uhr Erfahrungen mit Hafenstaatkontrollen
Hajo Gerkens
Bureau Veritas, Hamburg

12:30 Uhr Mittagspause

Programm

Vortragsgruppe 3

Chairman: Prof. Dr. Peter Boy

13:30 Uhr Wärtsilä Methanol Fuel-Plattform
Lucca Ratz
Wärtsilä, Hamburg

14:00 Uhr 12X92DF Service Experience
Konrad Räss
WinGD, Winterthur Schweiz

14:30 Uhr Kaffeepause

15:00 Uhr Latest service experiences of lubrication oil
and wear of conventional and dual fuel engines
Kristian Mogensen
MAN SE Kopenhagen Dänemark

15:30 Uhr Schlussworte
Prof. Dr.-Ing. P. Boy



44. ISF-Tagung 23. Juni 2023

Verband Deutscher Reeder, Hamburg

Aktueller Stand der CO₂-Bepreisung Sebastian Ebbing

Der Vortrag lag bei Redaktionsschluss leider nicht vor



Seacotec GmbH & Co. KG
Zippelhaus 3, 20457 Hamburg

CII – erste Erfahrungen aus dem Betrieb **Tobias Neumann-Overholthaus, SEACOTEC GmbH & Co. KG**

Sechs Monate nach dem Inkrafttreten der Anforderungen an den Carbon Intensity Indicator (CII - Kapitel 4 aus MARPOL Annex VI, Regulation 19 – 29) ist es an der Zeit ein erstes Zwischenfazit zu ziehen.

Schließlich sind nun noch weitere sechs Monate Zeit, um aus dem ersten Halbjahr zu lernen, CII verbessernde Maßnahmen einzuleiten oder aber auch die Richtlinie im Detail zu lesen und zu verstehen.

Die SEACOTEC GmbH & Co. KG aus Hamburg hat es sich seit 2017 zur Aufgabe gemacht, für die von uns betreute Flotte MRV und DCS relevante Reisedaten tagesaktuell zu validieren. Dies beinhaltet beispielsweise die Überprüfung der Reisen gegen AIS Daten sowie die Prüfung aller Bunker- (BDNs) und Ladungsnachweise. Bei Bedarf wird durch eine direkte Kommunikation mit dem Schiff die Korrektur von fehlenden oder fehlerhaften Daten veranlasst.

Nur dieses Vorgehen stellt unserer Meinung nach sicher, dass Reeder und Charterer auf einer zuverlässigen Basis die Performance Ihrer Schiffe rechtzeitig bewerten und eventuelle Maßnahmen einleiten können.

Im Bereich Datenqualität konnten wir in den letzten sechs Jahren sehr viel Erfahrung sammeln, typische Fehlerquellen eliminieren und eine wertvolle Datenbasis schaffen, welche uns nun in der Auswertung und Vorhersage der CII Werte der Schiffe hilft.

Mit Bezug auf die Umsetzung des CII erleben wir sinnbildlich bei Reedern und Charterern einen Informationsstand im Bereich von Rating A (Superior) bis E (Inferior).

Einige Reeder sind offensichtlich sehr intensiv mit Ihrem Charterer im Gespräch, um z.B. die Auswirkungen des CII auf den Chartervertrag zu diskutieren. Dazu werden bei uns detaillierte (und validierte) Daten Ihrer Schiffe angefragt, welche wir dem Kunden über ein CII Dashboard reisespezifisch zur Verfügung stellen.

In diesem Zusammenhang müssen reisespezifische CII Werte kritisch hinterfragt und in Relation zur gesamten Reisedauer gesehen werden. So kann zum Beispiel kann eine kurze Reise in „E“ durch eine längere Reise in „B“ oder „C“ sehr leicht kompensiert werden.

Während ein negativer CII-Wert einer Reise eindeutig auf einen Fehler im Reporting zurückzuführen ist, können sehr hohe Werte durchaus in einer langen Anker- und/oder Hafenliegezeit begründet sein.

Den Reedern ist bewusst geworden, dass eine Passage durch den Nord-Ostsee Kanal im Vergleich zu einer Fahrt durch den Skagerrak einen schlechteren CII zur Folge hat – absolut betrachtet jedoch bei einem höherem Kraftstoffverbrauch und höheren CO₂ Emissionen.

Ballastreisen sind nun nicht mehr automatisch „schlechte“ Reisen, da bei der CII Berechnungsformel nur das Deadweight eines Schiffes berücksichtigt wird, nicht aber die tatsächlich beförderte Ladung.

Zu guter Letzt sendet der Charterer eine Anweisung an die Besatzung, mit möglichst geringer Schiffsgeschwindigkeit zum nächsten Hafen zu fahren. Aufgrund des hohen spezifischen Kraftstoffverbrauchs bei Niedriglast könnte der CII-Wert dann aber schlechter ausfallen als bei einer höheren Reisegeschwindigkeit mit anschließender Ankerliegezeit.

All diese Diskussionen zeigen, dass es essentiell ist nicht nur ausreichend viele, sondern vor allem rechtzeitig gute und validierte Daten zu haben, welche je nach Anforderung aufbereitet werden können.

Andere Reeder und Charterer hingegen möchten gerne schon heute auf die zweite Nachkommastelle wissen, welches CII Rating Ihr Schiff denn wohl Ende 2023 haben wird. Oder man stellt in Frage, warum zwei vermeintlich gleiche Reisen von Hamburg nach Rotterdam sehr unterschiedliche CII-Ratings haben können.

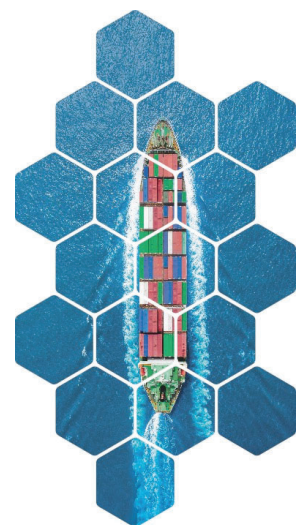
So bleibt auch für die zweite Jahreshälfte noch viel zu tun, ab dem nächsten Jahr schauen wir dann alle gemeinsam auf EU ETS. Dann sprechen wir allerdings nicht nur über die Buchstaben A bis E, sondern in 2026 um CO₂ Kompensationen im Wert von voraussichtlich rund 10 Milliarden Euro.



Agenda



- Über SEACOTEC
- CII - Was ist das?
- Erste Erfahrungen
- CII Fakten Check
- Zusammenfassung / Ausblick
- Fragen & Antworten

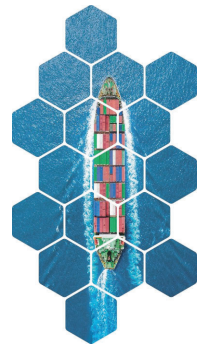




Über SEACOTEC



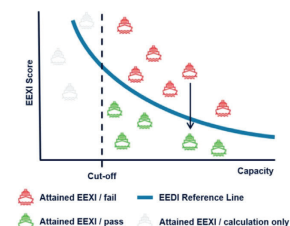
- SEACOTEC GmbH & Co. KG gegründet im Februar 2016, im September 2018 Gründung der SEACOTEC DS (Digital Solutions) GmbH & Co. KG
- Zurzeit 9 feste und 2 freie Mitarbeiter*innen
- Unsere Stärken
 - Emissions to Air inkl. IMO DCS, EU/UK MRV, EEXI, CII, EU ETS, Fuel EU
 - Validierung von schiffsspezifischen Reise- und Verbrauchsdaten
 - Schadens- und Zustandsbesichtigungen, Bauaufsicht
 - Material & Schweißtechnik, externe Schweißaufsicht
- ISO 9001:2015 zertifiziert
- Über 180 Kunden weltweit
- Service. Support. Solutions.



CII – was ist das?

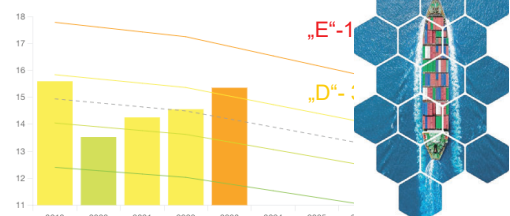


- Das Marine Environment Protection Committee (MEPC) der IMO hat auf seiner 75. Sitzung im November 2020 zwei wesentliche Maßnahmen beschlossen um die CO₂ Emissionen der Welthandelsflotte zu reduzieren.
- Alle Schiffe ab 400 GT müssen einen schiffsspezifischen „Attained EEXI“ (Energy Existing Ship Index) ausweisen, welcher kleiner sein muss als der „Required EEXI“. (Konstruktiver Index)
 - Derzeit in der finalen Umsetzung / Annual IAPP Survey
 - Bisher kein direkter Einfluss auf die CO₂ Emissionen erkennbar
- Jedes Schiff erhält auf Basis der in 2023 gesammelten IMO DCS Daten (Verbrauch & zurückgelegte Strecke) eine Bewertung seiner CO₂-Intensität, die in fünf Kategorien von A bis E eingeteilt wird: Carbon Intensity Indicator CII. (Operativer Index)



$$\text{CII attained} = \frac{\text{Annual fuel consumption} * \text{CO}_2 \text{ factor}}{\text{Annual distance travelled} * \text{Capacity}}$$

CII Attained per Year





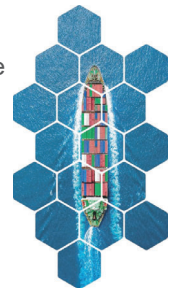
CII – Erste Erfahrungen



- Der reine CII Wert hat wenig Aussagekraft, da er immer in Bezug auf den schiffsspezifischen CII required gesehen werden muss.
- Dazu nutzen wir ein **CII ratio**, welcher verschiedene Schiffe in ihrer Performance vergleichbar macht.

$$CII\ ratio = \frac{CII\ attained}{CII\ required}$$

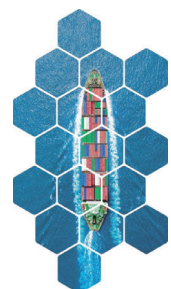
- Gemäß IMO Richtlinie muss der **CII einmal jährlich** im Zuge der IMO DCS Berichterstattung berechnet werden.
- Reeder, Manager, Charterer und Crews benötigen aber einen **YTD CII**, einen **reisespezifischen CII** sowie einen **prognostizierten CII** um eventuelle Maßnahmen rechtzeitig einleiten zu können.
- **Validierte Daten sind Voraussetzung** für eine zuverlässige Aussage über die Performance eines Schiffes.
- Fehler im Reporting seitens der Besatzung sind an der Tagesordnung. **Punkt.**



CII – Fakten Check



	Ja	Nein	Vielleicht
„Viel fahren hilft viel“ – verbessert den CII			
Hafen-und Ankerliegezeiten verschlechtern den			
Schiffe im Short Sea Shipping sind zu 80% in „E“			
Ein Schiff im „E“ Rating ist ein schlechtes Schiff			
Kanal Passagen sind schlecht für den CII			
Reefer Reporting verbessert den CII			
Mit BioFuel kann ich den CII verbessern			
Der CII reduziert den CO ₂ Ausstoß			

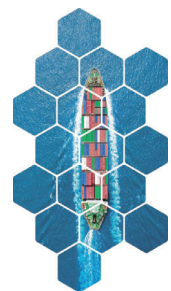
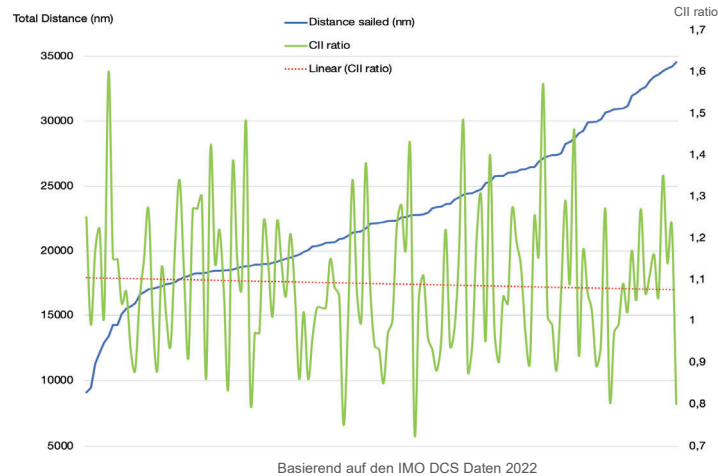




CII – Fakten Check (1)



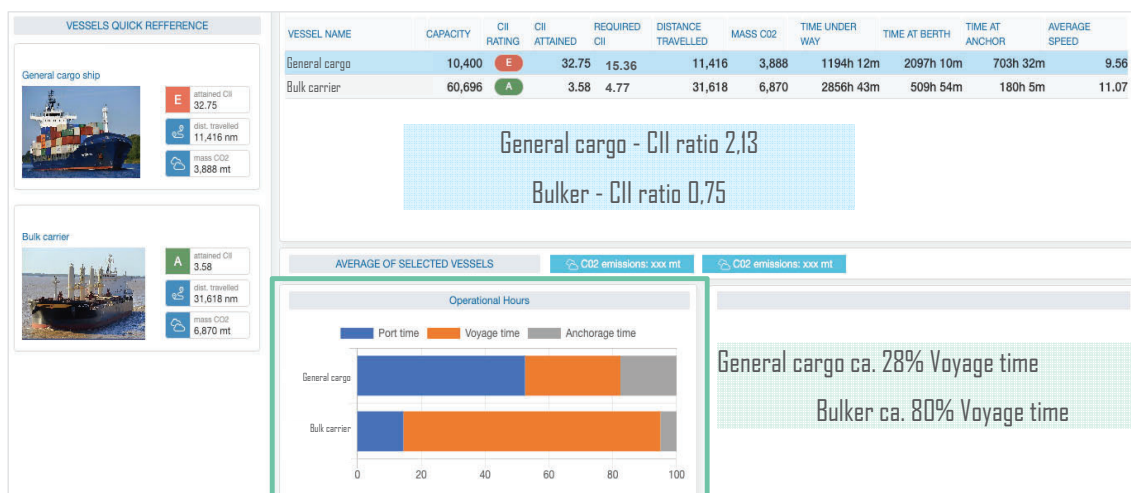
	Ja	Nein	Vielleicht
„Viel fahren hilft viel“ – verbessert den CII			✓



CII – Fakten Check (2)



	Ja	Nein	Vielleicht
Hafen- und Ankerliegezeiten verschlechtern den CII	✓		

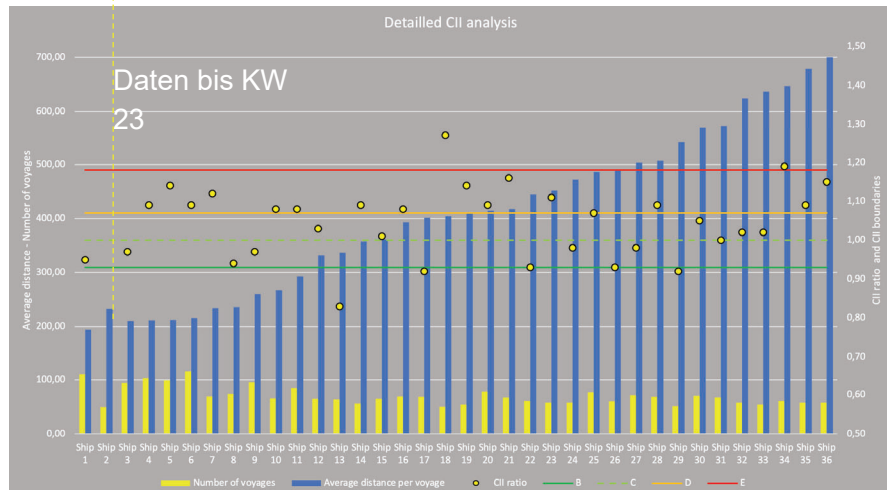




CII – Fakten Check (3)

	Ja	Nein	Vielleicht
Schiffe im Short Sea Shipping sind zu 80% in „E“ CII ratio 2.13		✗	

- Regional verschieden, Schiffe im Nord-Ostsee Betrieb haben kaum Ankerzeiten und angemessene Hafenliegezeiten
- Im östlichen Mittelmeer bis zu 80% Anker/Hafenliegezeit
- Das durchschnittliche Rating unserer Short Sea Flotte ist „C“
- CII ratio 1,05



CII – Fakten Check (4)

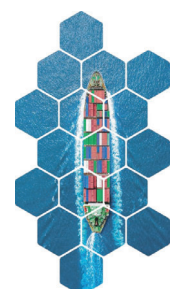
	Ja	Nein	Vielleicht
Ein Schiff im „E“ Rating ist ein schlechtes Schiff		✗	

- Für wen ist das Schiff schlecht?
 - Umwelt – Nein
 - Eigner – Nein
 - Charterer – Nein
 - Für die IMO – Ja...

3000 t weniger CO₂ emittiert, aber ein „E“-

Rating

VESSEL NAME	CII RATING	CII ATTAINED	REQUIRED CII	DISTANCE TRAVELLED	MASS CO2
General cargo	E	32.75		11,416	3,888
Bulk carrier	A	3.58		31,618	6,870





CII – Fakten Check (5 & 6)

	Ja	Nein	Vielleicht
Kanal Passagen sind schlecht für den CII (aber gut für EU)	✓		
Reefer Reporting verbessert den CII	✓		

- Kanal Passagen – durch schlechten Betriebspunkt der Hauptmaschine (hoher SFOC) und kurze Distanzen negativer Einfluss auf den CII erkennbar
- Reefer Reporting kann signifikanten Einfluss auf den CII haben

GBLIV-NLRTM (inkl. Hafenliegezeit NLRTM) 06.03. – 12.03.2023

Cargo: 2184 mt (4309 mt ballast)

Voyage details: 80 h at berth, 46h at sea, distance 736 nm

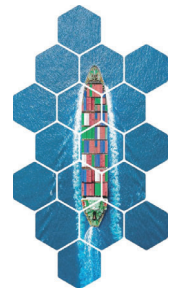
Consumption: 22,12 mt VLSFO, 49,93 mt MGOLS

Total Emissions: 229,78 t CO₂,

CII-rating 22,68 **"E"**

120 live-reefer verbessern das CII-rating auf 21,93 **"E"**

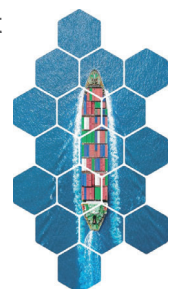
200 live-reefer verbessern das CII-Rating auf 21,42 **"D"**



CII – Fakten Check (7)

	Ja	Nein	Vielleicht
Mit BioFuel kann ich den CII verbessern			✓

- Für Brennstoffsorten die nicht durch die IMO Resolutions MEPC.346(78) (SEEMP) und MEPC.352(78) (CII) abgedeckt sind muss der Umrechnungsfaktor Cf durch den Bunkerlieferanten mitgeliefert werden (BDN).
- Derzeit ist kein BioFuel durch diese Resolutions abgedeckt.
- Cf Faktoren werden durch den Bunkerlieferanten nicht bereitgestellt.
- Wird ein „non-standard approach“ gewählt, muss dieser durch den Flaggenstaat und die für die IMO DCS Verifizierung zuständige RO genehmigt werden.
Die gewählten Kraftstoffsorten mit den jeweiligen Cf sind im SEEMP II zu beschreiben.
- Vgl. EU ETS – **B20 entspricht 20% Reduktion** der zu kompensierenden Emissionen

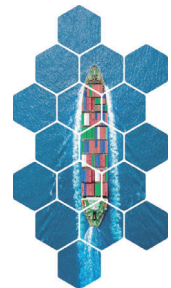




CII – Fakten Check (8)

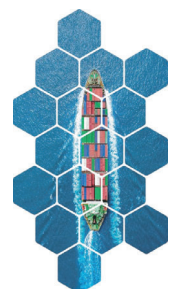
	Ja	Nein	Vielleicht
Der CII reduziert den CO ₂ Ausstoß		✗	

- Ballastreisen sind im CII besser als Reisen mit Ladung und können am Jahresende als „Kompensationsfahrten“ dienen (Rating E)
- Ladungsmengen werden in der CII Berechnung nicht berücksichtigt.
- Der CII motiviert den Reeder längere Wege mit einem absolut höherem Kraftstoffverbrauch zu wählen.
- Ein Umweg oder „Kreise“ fahren ist besser als am Anker zu liegen.



Zusammenfassung / Ausblick

	Ja	Nein	Vielleicht
„Viel fahren hilft viel“ – verbessert den CII			✓ ✗
Hafen-und Ankerliegezeiten verschlechtern den	✓		
Schiffe im Short Sea Shipping sind zu 80% in „E“		✗	
Ein Schiff im „E“ Rating ist ein schlechtes Schiff		✗	
Kanal Passagen sind schlecht für den CII	✓		
Reefer Reporting verbessert den CII	✓		
Mit BioFuel kann ich den CII verbessern			✓ ✗
Der CII reduziert den CO ₂ Ausstoß		✗	

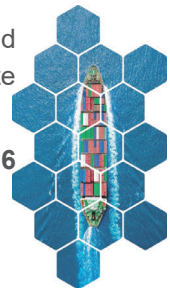




Zusammenfassung / Ausblick



- Der CII wird in der Industrie als **zahnloser Tiger** angesehen, da die Richtlinie keine wirklichen Konsequenzen beschreibt.
- Der CII ist **direkt abhängig von dem Trade des Schiffes**, nicht von dessen Effizienz.
- Es besteht **kein Anreiz zur konsequenten Einhaltung** der Richtlinie. Reeder können das C-zu-E-zu-C-Spiel ohne Konsequenzen spielen.
- Derzeitige **Charterverträge enthalten** in der Regel **keine klaren Regeln /** Monetarisierung bezüglich des CII.
- Die Einführung des CII hat bisher **keine einzige Tonne Kraftstoff** eingespart.
- Mit Start des **EU ETS** am 1. Januar 2024 rückt der CII für alle im EU MRV Bereich operierenden Schiffe in den Hintergrund.
- **CII und EU ETS sind zwei sich gegenseitig torpedierende Systeme.** Während CII eine maximal zurückgelegte Distanz belohnt, kostet im EU ETS jede verbrannte Tonne Treibstoff ca. 300€.
- Die derzeit gültige EEXI / CII Richtlinie wird spätestens im **Januar 2026 überarbeitet**, basierend auf den bis dahin gesammelten Erfahrungen.



Fragen & Antworten



„Moin Herr Neumann, top! Danke!

Kann man schon bei „Vessel 1“ und „Vessel 2“ abschätzen, in welches Rating (A bis E) die beiden Schiffe fallen?“

„Da kann etwas mit dem berechneten CII nicht stimmen. Wir haben doch den EEXI erfüllt!“

„Mein Charterer sagt ich soll so langsam wie möglich fahren, um ein gutes CII Rating zu bekommen, stimmt das?“

Contact us!

SEACOTEC GmbH & Co. KG



www.seacotec.com



info@seacotec.com

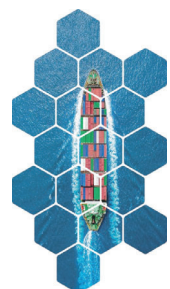


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„Wir hatten zweimal die gleiche Anzahl an Reefern, warum ist der CII unterschiedlich?“





44. ISF-Tagung 23. Juni 2023

Ship Performance Center
DNV Maritime

André Kauffeldt

Zunehmender Wettbewerb, steigende Brennstoffpreise und immer strengere Umweltauflagen zwingen die Reedereien verstärkt auf die Effizienz Ihrer Schiffe zu achten. Das beschränkt sich nicht nur auf den Neubau sondern auch erstreckt sich auch auf den Betrieb der existierenden Flotte. Nachdem mit der Einführung von Slow-Steaming Brennstoffeinsparungen in der Größenordnung von 25% erreicht wurden, sollen Retrofits, Performance Management und der Einsatz von Optimierungstools weitere Einsparpotentiale freisetzen. Unter den Tools verspricht insbesondere die Trimmoptimierung ein gutes Kosten-Nutzen Verhältnis. Die Frage ist: Kann sie im Alltagseinsatz halten, was sie verspricht?

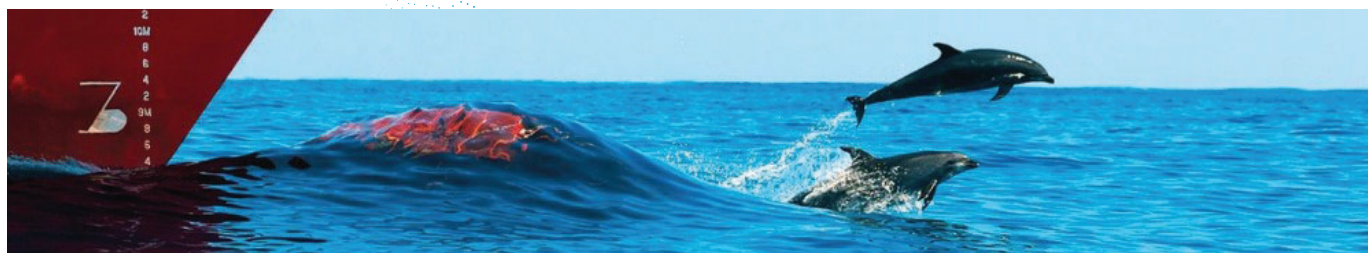
Die Rümpfe der meisten Schiffe sind auf einen bestimmten Designpunkt hin optimiert, der im täglichen Einsatz allerdings nur selten oder gar nicht erreicht wird. Je weiter entfernt vom Designfall die Schiffe aber hinsichtlich Geschwindigkeit und Tiefgang betrieben werden, desto stärker lässt normalerweise die Effizienz der Bugwülste nach. Viele konventionelle Bugwülste wirken sogar widerstandserhöhend, wenn sie nicht vollständig getaucht sind oder zu langsam angeströmt werden. Ziel der Trimmoptimierung ist es nun, den Trimm zu identifizieren, bei dem der Rumpfwiderstand für einen bestimmten Betriebszustand hinsichtlich Verdrängung und Geschwindigkeit am geringsten ist.

Da der optimale Trimm eines Schiffes von mehreren Faktoren abhängt, die sich gegenseitig beeinflussen, ist und bleibt dessen zuverlässige Identifikation eine Herausforderung. Im Laufe der letzten Jahre haben sich verschiedene Methoden etabliert, die das Problem der Trimmoptimierung angehen. Diese reichen von selbstlernenden Systemen über Modellversuche bis hin zu numerisch Methoden, zu denen beispielsweise auch der ECO Assistant des DNV zählt.

Generell sind die erreichbaren Einsparpotentiale abhängig vom Schiffstyp. Besonders lohnend ist die Trimmoptimierung für große Containerschiffe, die mit ihren leistungsstarken Motoren auch im Slow-Steaming Betrieb noch vergleichsweise schnell unterwegs sind und große Trimm-Potentiale bieten. Insbesondere wenn diese Schiffe regelmäßig weit entfernt vom Entwurfsunkt betrieben werden, sind durchschnittliche Einsparungen von über 5% realisierbar. Große Tanker und Bulk-Carrier hingegen bieten nahezu kein Potential. Mit ihren relativ kleinen Hauptmaschinen sind sie oft nur langsam unterwegs und werden hauptsächlich voll beladen oder im Ballast betrieben, wofür sie bereits optimiert sind.

Die Genauigkeit der Trimmtrends war vor allem bei der Einführung der Trimmoptimierung Thema intensiver Diskussionen und ausgedehnter Untersuchungen. Mittlerweile ist die Zuverlässigkeit von zum Beispiel CFD-basierten Prognosen durch unzählige Modellversuche und Sea-Trials bestätigt worden und die Ergebnisse werden allgemein anerkannt – das bedeutet, Trimmoptimierung macht für bestimmte Schiffstypen absolut Sinn und funktioniert.

Die größte Herausforderung der Trimmoptimierung bleibt aber die Umsetzung im täglichen Betrieb. Der ECO Assistant des DNV ist als eines der ersten Trimmtools seit mehr als 12 Jahren auf dem Markt, entsprechend umfangreich ist das Kundenfeedback. Es reicht von perfekter Integration inklusive automatisierter Alarmsysteme bei Nichtbeachtung des optimalen Trimms bis hin zu Rückfragen, ob man 5 Jahre nach Erstauslieferung nicht noch einmal eine Schulung bekommen kann, da man die Software erstmalig auf einem Schiff der Flotte installiert hat ...



Trimmen oder nicht Trimmen, das ist hier die Frage – Feedback aus dem Einsatz des DNV Trimmtools

Ship Performance Center

André Kauffeldt, Principal Engineer
23 June 2023

Administrative information

Report title:	Trimmen oder nicht Trimmen, das ist hier die Frage – Feedback aus dem Einsatz des DNV Trimmtools	DNV GL – Maritime Brooktorkai 18 D-20457 Hamburg/Germany Phone: +49-40-36149-0 Fax: +49-40-36149-200 HRB 115442
Customer:	44. ISF Tagung – Maritimes Zentrum Hochschule Flensburg	
Contact person:	Prof. Dr.-Ing Peter Boy	
Date of first release	2023-06-19	
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Keywords:
ECO Assistant, trim optimization, CV, energy efficiency, fuel saving, reduction of GHG emissions

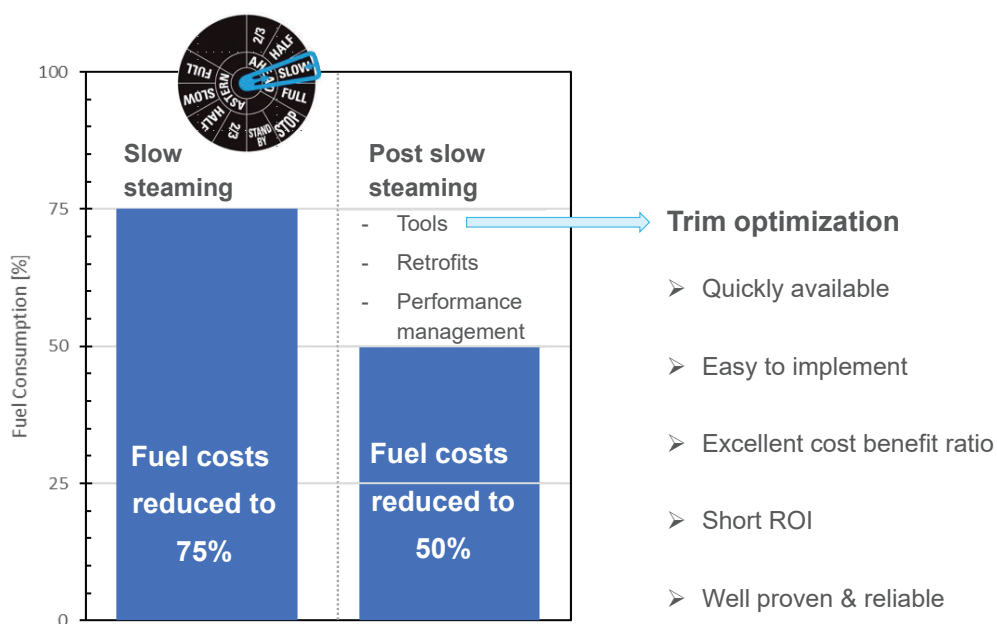
The need for trim optimization



4 DNV © 23 JUNE 2023 TRIM OPTIMIZATION



Industry leaders are focusing on energy efficiency improvement



5 DNV © 23 JUNE 2023 TRIM OPTIMIZATION Source: DNV

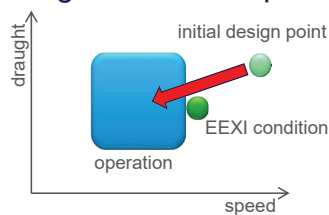


What to expect from

Bulbous bow retrofit

- Little impact on EEXI
- Huge impact on CII

- Large savings at “real” operating range but less at high drafts and speeds



6 DNV © 23 JUNE 2023

Propeller retrofit

- Moderate impact on EEXI
- Huge impact on CII

- Large saving can be achieved when engine power is limited → less loading on the propeller, more slender and efficient design
- Savings more or less constant across operating range

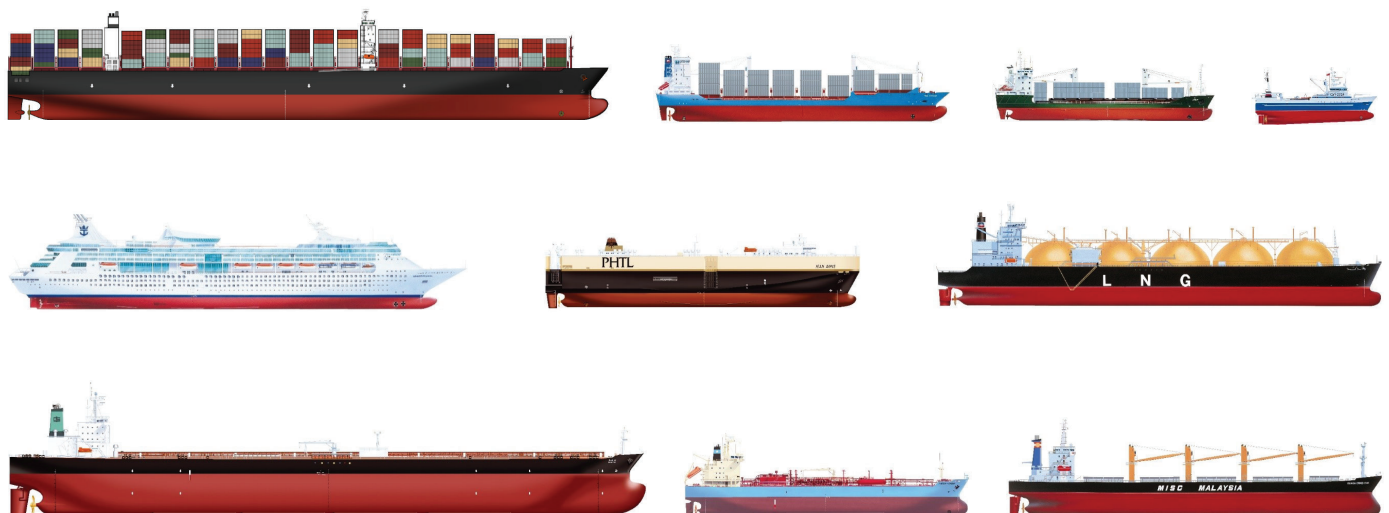
Trim optimization

- Not applicable for EEXI
- Huge impact on CII

- Not permanently effective, success depends on implementation and crew engagement
- Large saving potential for vessels that frequently operate at off-design conditions



Hull shape is optimized for cargo and transport requirements



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Source: DNV



A bulbous bow improves the flow field at a certain design point

Intention of a bulbous bow:

- Tailor-made generation of a counter wave, that aims to favorably superimpose the waves generated by the hull and cancel them out
- Minimizing the wave making resistance and thus the power demand



The typical operational profile of container vessels today is outside of their design conditions

- Typically, the bulbous bow is optimized for a certain design point far away from current operating conditions.
- The pronounced bulbous bow has significant influence on the flow field for off-design conditions and results in substantial trim optimization potential.



Operational profile in percent of sailing time
This includes the AIS navigational status 0, 4, 7 and 8

Draft \ Speed	<6kn	6-8kn	8-10kn	10-12kn	12-14kn	14-16kn	16-18kn	>18kn	Total
8-9m	0.02	0.00	0.01	0.03	0.16	0.34	0.00	0.00	0.56
9-10m	0.55	0.10	0.15	0.63	1.30	0.78	0.44	0.18	4.13
10-11m	1.76	0.41	0.71	4.05	6.60	6.60	2.34	0.81	23.28
11-12m	1.63	0.47	1.62	7.93	8.93	6.52	2.65	1.88	31.63
12-13m	1.21	0.20	0.48	3.49	7.17	6.98	2.49	3.03	25.05
13-14m	0.21	0.07	0.04	0.46	1.57	4.79	5.68	2.28	15.10
14-15m	0.02	0.00	0.00	0.18	0.05	0.00	0.00	0.00	0.25
Total	5.40	1.26	3.01	16.78	25.78	26.01	13.59	8.17	100.00

Example of a 12 months operating profile for a 5,600 TEU container vessel (2020)

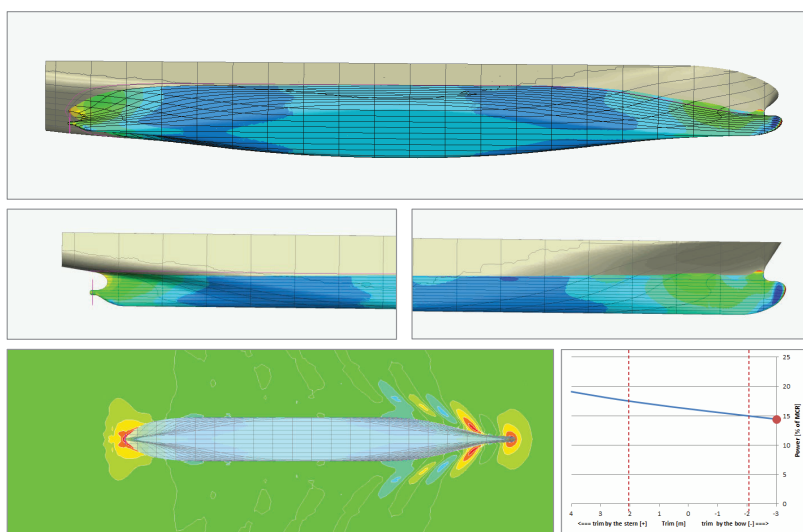
At off-design conditions a bulbous bow can worsen the flow field

At off design condition bulbous bows can cause:

- Deep wave troughs behind the bulbous bow
- Very high and steep wave crests
- Substantial wave breaking



Why does trim lead to fuel savings?



Background:

- Many existing vessels are hydrodynamically optimised to produce low resistance at their design condition (design speed and draft at even keel)
- As soon as a vessel sails outside of this condition the flow field around the vessel is less favourable
- When changing trim the interaction of vessel and water (flow field) changes and the resistance may reduce

Rule of thumb: Trim potential increases the more distinct the underwater lines of a vessel and the more it sails outside of its design conditions!

The Challenge of finding the best trim



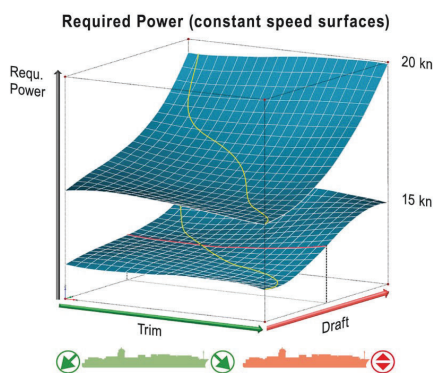
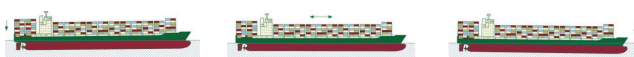
15 DNV © 23 JUNE 2023 TRIM OPTIMIZATION



Finding the optimum trim goes beyond typical experience

How to trim the vessel? In principal 3 trim options.

- To stern?
- Even keel?
- To bow?



The challenge with trim:

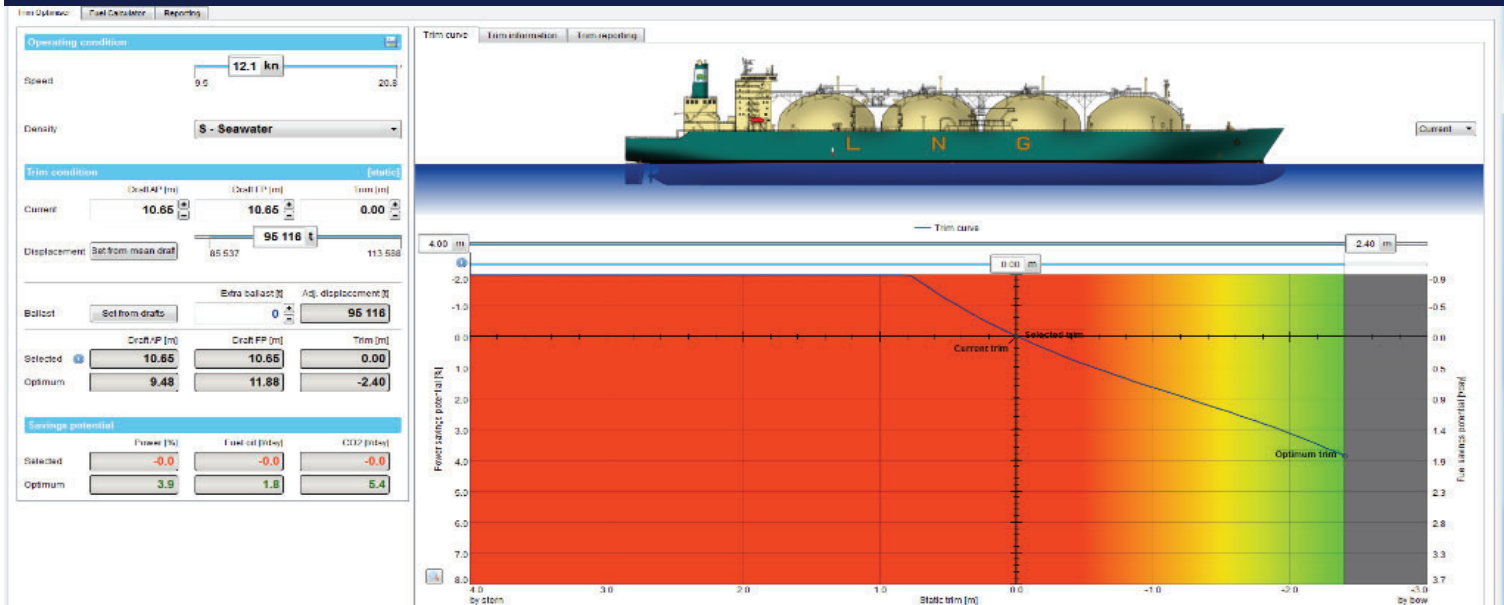
- **Complex factors:** speed, draft, water depth – different for each vessel
- **Experience limited** to familiar trim conditions, but the optimum might be beyond
- **Frequently changing** and **off-design** conditions like **slow steaming** hardly fit into “rules of thumb”

The solution:

- **Detailed analysis** of **all** relevant **operation conditions**
- **Make results available** to crew and management - **easily**



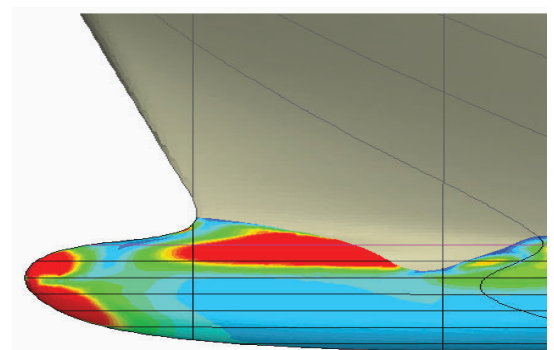
Implementation of trim optimization



Pre-computed numerical simulations for your specific vessel

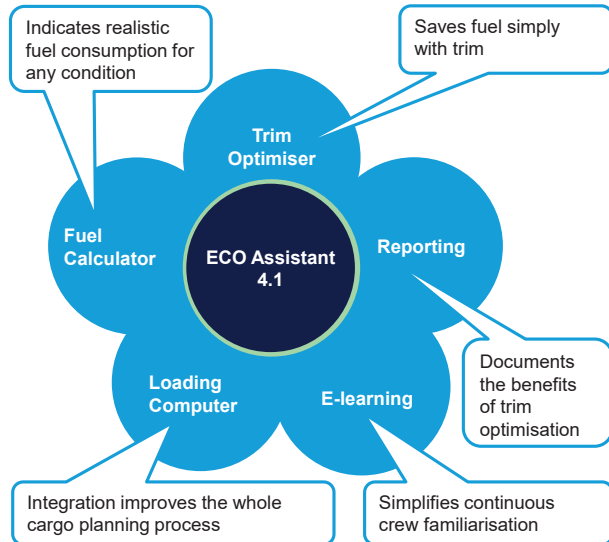
- Challenge: there is no unique optimum trim, but best trim is a function of hull shape, propulsion system, speed, displacement and water depth
- DNV approach: conduct CFD based trim optimisation for a range of operating conditions and make results available to crew and ship operator through easy-to-use software tool
- Use a high number of simulations to densely cover the entire operating range regarding:
 - Draft
 - Speed
 - Trim

Parameter	Range	Data points
Speed	10 ... 24 kn	10
Mean draft	6 ... 16.5 m	9
Trim	-3 ... 4 m	7
		Σ 630



Modules combined in ECO Assistant 4.1

Energy Consumption Optimization
Increase efficiency & optimise operations!



- Pre-computed computational fluid dynamic (CFD) results for your specific vessel
- Simulating a large number of tank trials with different speeds, displacements, water depths¹ and trim angles
- Extensive computational power needed
- Results shown in a simple viewer with few parameters only to be used onboard before a voyage or at sea
- No interfacing with ship's sensors required

Available languages:

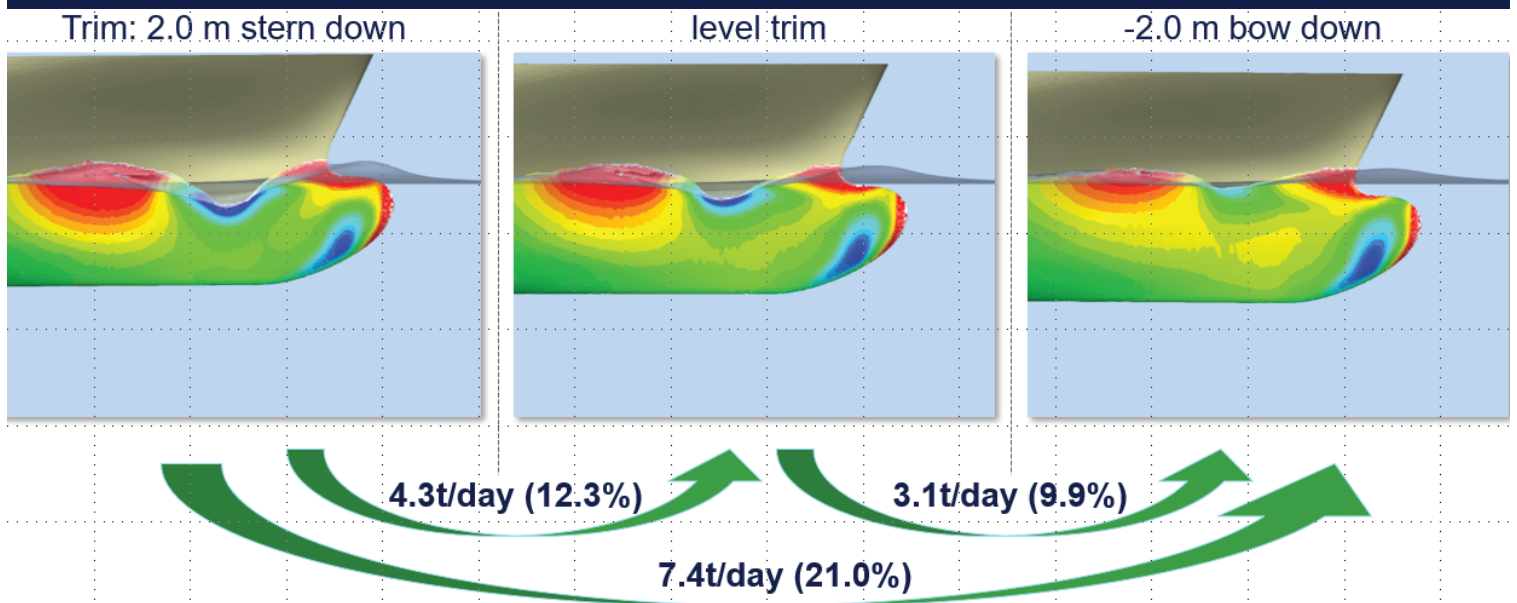
- English
- German
- Russian
- Japanese
- Chinese

¹ Optional (extra costs arise)

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Achievable trim potentials



28 DNV © 23 JUNE 2023 TRIM OPTIMIZATION



Different vessel types benefit differently from trim optimization

Achievable average trim potentials:

▪ Large container vessels:

3-7%



- + Broad draft and speed range, frequently operated at off-design conditions, large main engine, relatively high service speeds, pronounced bulbous bow, wide transom, worldwide trades with long legs
- /

▪ Small container vessels:

2.5-5%



- + Broad draft and speed range, frequently operated at off-design conditions, relatively high service speeds, pronounced bulbous bow
- Small main engine, local feeder traffic with relatively short legs

▪ RoRo carrier, ferries, passenger vessels:

2-3%



- + Broad speed range, relatively high service speeds, pronounced bulbous bow, medium main engines
- Narrow operating range regarding draft, frequently operated near design draft, moderate main engine, strict trim limitations

Different vessel types benefit differently from trim optimization

Achievable average trim potentials:

▪ LNG carrier:

1.5-4%



- + Pronounced bulbous bow, slow steaming is common, ballast draft with partly emerged bulbous bow, medium sized main engine, relatively high service speeds, worldwide trades with long legs
- Relatively narrow draft range, load case near design draft,

▪ MPV, product tanker:

1-3%



- + Broad draft range, slow steaming is common, often operated at ballast or medium drafts, bulky bulbous bow
- Small main engine, relatively small size, slow service speed

▪ Large tanker or bulk carrier:

0-1.5%



- + Medium sized main engine, slow steaming
- Operation at 2 main conditions only (loaded & ballast), hull shape optimized for that operating profile, slow service speed, frictional resistance is dominant, compared to vessel size relatively small bulbous bow,

Trim optimisation by DNV has been proven for all segments

Case study selection



110 000 DWT Tanker

- 50 000 USD annual savings per vessel
- Data: 2 years voyage reports; 8 ships



53 000 DWT Bulker

- 84 000 USD annual savings per vessel
- Data: sea trial measurement



OSV

- 90 000 USD annual savings per vessel
- Data: only transit voyages



30 000 DWT MPV

- 170 000 USD annual savings per vessel
- Data: performance measurement



8 750 TEU CV

- 420 000 USD annual savings per vessel
- Data: 17 months including 53 voyages

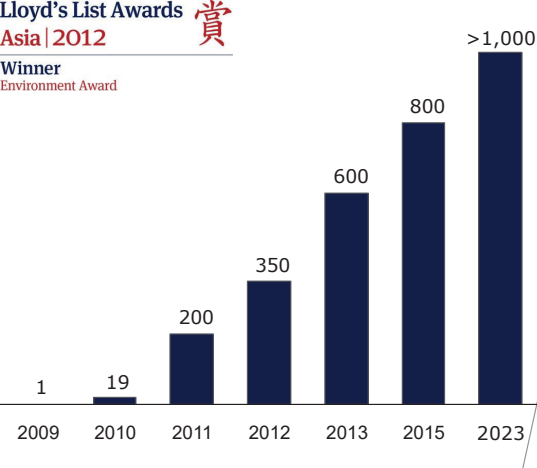
Feedback

For trim optimisation, ECO Assistant is the industry's first choice

ECO Assistant installations trend

– on board & office –

Lloyd's List Awards
Asia | 2012
Winner
Environment Award

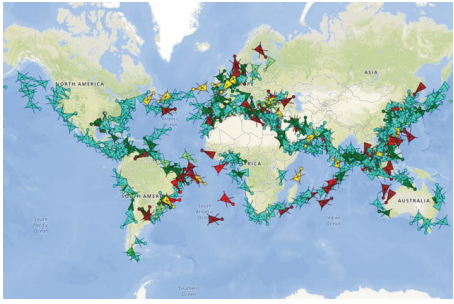


1. Over the lifecycle of in average 20 years, 650 USD/t, 1.5% savings; at presentation date
Source: DNV

Environmental & economic impact

- Ships equipped: > 1000
- Overall savings¹:
 - Emission: 13.1 m tons CO₂
 - Bunker cost: 2.7 bn US\$

Ships currently sailing with ECO Assistant

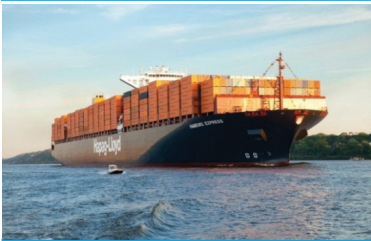


References

Experience with various ship types and sizes



95 x Bulker
from 32,500 DWT to 140,000 DWT



>700 x Container vessels
from 600 TEU to 23,600 TEU



>60 x Tanker
from 24,000 DWT to 366,500 DWT



>100 x MPV / Heavy Lift
from 3,600 DWT to 62,000 DWT

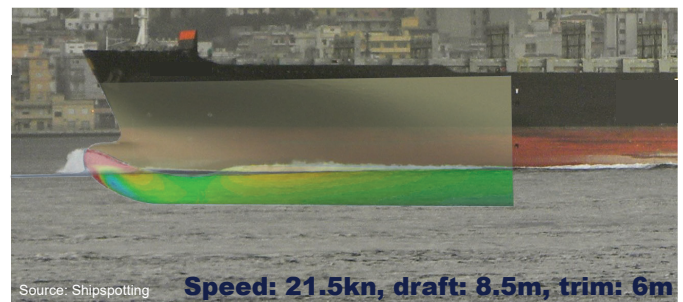
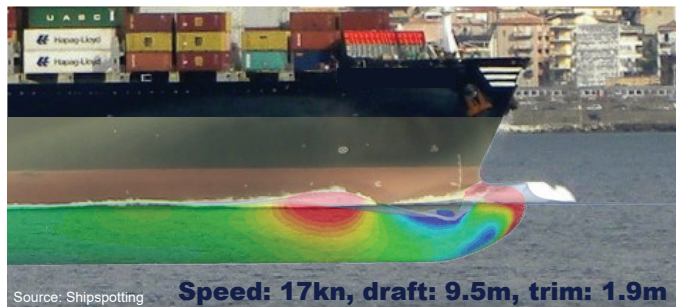


>10 x LPG / LNG
from 58,000 DWT to 118,000 DWT



39 x RoRo / PCC
from 7,400 DWT to 25,000 DWT

Good agreement between observed and calculated flow field

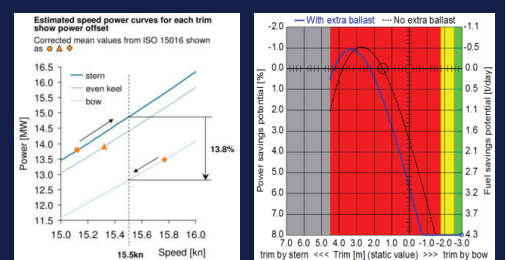


ECO Assistant – benefit case

SITUATION AND CRITICAL ISSUE

ECO Assistant sea trial verification

Client wants to cut down fuel costs for class of 8,600 TEU CVs via trim optimization. To test system trustworthiness a client conducted sea trial should verify ECO Assistant recommendations.



DNV SOLUTION

- **ECO Assistant production** for respective vessel class and installation on vessel
- **2nd opinion on client conducted sea trial:**
 - Review of chosen sea trial conditions and data quality through DNV measurement experts
- **ISO 15016 Analysis** of sea trial measurements and comparison with ECO Assistant savings

VALUE DELIVERED

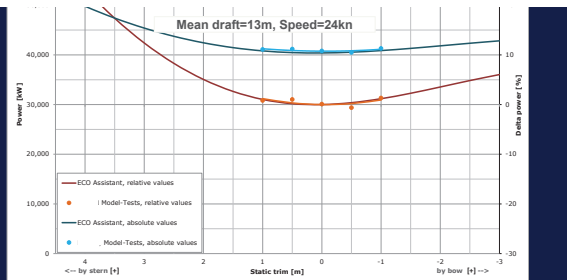
- **Trust** in realistic advice given by ECO Assistant
 - ECO Assistant **prediction in line with measurement** of 13.8% (at 15.5kn, 11.4m mean draft and trim change of 1.5m aft to bow)
- **Attractive savings** through trim optimization
 - **Large fuel saving potentials** in off-design conditions

ECO Assistant – benefit case

SITUATION AND CRITICAL ISSUE

A comparison of ECO Assistant and model tests results

DNV was tasked to extend the existing trim study of a competitor to meet the operational range of the vessels. While the existing approach was using traditional model tests, DNVGL opted for assessment by means of computational fluid dynamics (CFD)



DNV SOLUTION

- The CFD, a so called RANS/VoF computation in combination with a propeller model was used to simulate the self propulsion condition in calm water at full scale Reynolds number
- Due to the different technical approach to model the performance of the vessels, the question how well these approaches correspond is obvious.
- The study compares the absolute and the relative power difference (%) by trim

VALUE DELIVERED

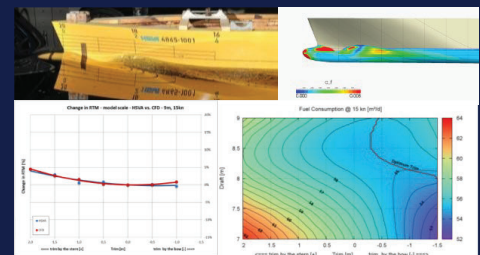
- Model test confirms ECO Assistant with consistent results (absolute power and relative savings)
- The benefit with ECO Assistant is the wide operational range – for a much lower price compared to model tests
- The key lies in the high computational power of DNV's cluster which allows to compute a dense grid with >500 conditions

ECO Assistant – benefit case

SITUATION AND CRITICAL ISSUE

ECO Assistant in comprehensive navy test campaign

To reduce fuel oil consumption and carbon footprint the US Navy Military Sealift Command (MSC) contracted DNV to conduct CFD analyses and perform model tests for trim optimization



DNV SOLUTION

- ECO Assistant: **Identification of trim impact on power requirement and fuel savings potential**
- **Validation** of CFD calculations **by systematic model tests**
- **Comparison** of CFD calculations with numerous MSC conducted **full scale trim trials**

VALUE DELIVERED

- **Insight** – Model scale **CFD** and measured **tank test data agree very well**
- **Proof** – Vessel trim sea trial results and **full scale CFD results match consistently**
- Considering the entire trim range **full scale CFD proves being superior** as no scale effects influence the results
- **Effect** – **Significant fuel saving potential identified**

ECO Assistant – benefit case: Columbia Shipmanagement



SITUATION AND CRITICAL ISSUE

Verification by shaft power measurement on a 30,500 DWT

ECO Assistants trim advice has been verified by a shaft power measurement on the Multi Purpose Vessel „Golden Isle“ of Columbia Shipmanagement



DNV SOLUTION

- Owners want to improve energy efficiency for an 30,500 DWT MPV and ordered ECO Assistant for trim advice
- Crew shall be sensitized for energy efficiency measures and consider trim whilst cargo planning process
- A sea trial with shaft power measurement shall confirm the trim advice and predicted savings

VALUE DELIVERED

- Engine power could be reduced by 3% after trim was optimized on advice of ECO Assistant
- The crew can realize an annual fuel oil saving of 270t per ship; or 170,000 USD.

ECO Assistant – benefit case

SITUATION AND CRITICAL ISSUE

Trim optimization for LNG carrier

LNG carrier have a significant potential for trim optimization. This potential increases with ship size, sailing leg length and operation away from design condition (like slow steaming, part load or ballast voyages)



DNV SOLUTION

- Several classes of LNG carriers sailing and saving world wide with ECO Assistant trim optimization
- Viscous computational fluid dynamics (RANS CFD) analyses are performed in full scale, avoiding scale effects and capturing all flow components including breaking bow waves and transom effects
- Easy usage with input of speed and drafts gives immediate trim and saving advice
- E-learning supports crew training on-board

VALUE DELIVERED

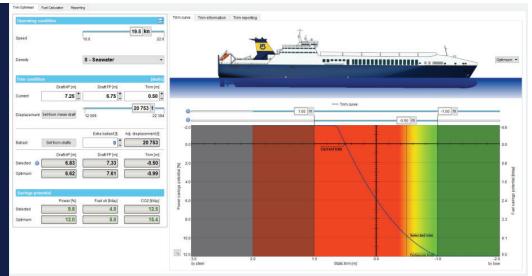
- Depending on the operation an 137,000m³ LNG carrier saves between 1% and 2% with trim, which equates to fuel savings of 0.5 to 1 t/day
- 1% leads to annual savings of 110 tons or about 50,000 USD per ship
- ROI for a class of 4 vessels is <4 month
- The predicted FOC represents the reported consumption during the voyages well

ECO Assistant – benefit case

SITUATION AND CRITICAL ISSUE

Trim optimization for RoRo ferries

RoRo ferries have a significant potential for trim optimization. This potential increases with ship size, sailing leg length and operation away from design condition (like slow steaming, part load or ballast voyages)



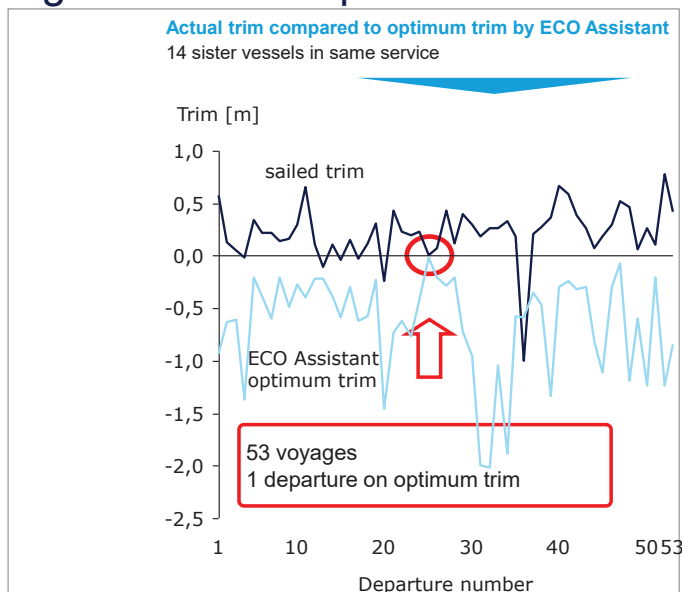
DNV SOLUTION

- U.N. RoRo fleet of 12 ferries is equipped with ECO Assistant trim optimization
- Viscous computational fluid dynamics (RANS CFD) analyses are performed in full scale, avoiding scale effects and capturing all flow components including breaking bow waves and transom effects
- Easy usage with input of speed and drafts gives immediate trim and saving advice
- E-learning supports crew training on-board

VALUE DELIVERED

- Small trim changes from 0.5m stern down to 0.5m bow down can save up to 4 t/day of fuel
- Average trim savings potential of 0.5 t/day (2-3%)
- 600,000 USD annual fuel savings potential for U.N. RoRo
- ROI for the 12 vessels is less than 2 month
- Performance monitoring shows trim optimization after ECO Assistant implementation

Lack of knowledge on optimum trim typically leads to unnecessary high fuel consumption



Source: DNV GL; voyage records from client

Without trim optimization:

- Clear gap between sailed and optimum trim
- Consequently **savings potential**
- Need for advice**
 - You cannot improve what you don't know.

Where is the optimum trim



Implementation of trim optimization

Involvement of the crew is essential for a successful implementation of a trim optimization

- Training, explanations, Establishing environmental awareness
- Integration into the common vessel operating
- Consideration of trim during cargo planning
- Support systems (alert systems)



Implementation of trim optimization

Involvement of the crew is essential for a successful implementation of a trim optimization

Quote from a customer Report:

“In 2021 through trim optimisation, the fleet saved about 20,000 t fuel oil and about 60,000 t of CO₂. On average this a saving of about 1.5% for the individual vessel and may sound relatively small, but it adds up over the fleet to a very remarkable amount. ...

Successful trim optimisation is a joint achievement by the Masters and officers on board as well as the stowage planners ashore. The latter also see trim optimisation potential of each vessel prior to departure and can influence it by clever stowage planning. Our recommendation is to have a timely exchange with your respective stowage planner on your preferred trim for the long ocean leg. They cannot do wonders but should consider your demands with the given loading conditions. Furthermore, an active Captain from the fleet, who is in the office for three to six months, is monitoring our fleet's trim potential.

Some of you see the trim recommendation on board in more than one tool. If this is true for you, please use the ECO Assistant installation. We compared other alternatives and even when data used by various softwares are same; the results displayed in other tools are less accurate and sometimes even wrong. ...

As trim optimisation has proven to be a very important measure for an efficient voyage, we have rolled it out to another 29 long-term charter vessels last year.”

Thank you!

Trimmen oder nicht Trimmen, das ist hier die Frage -
Feedback aus dem Einsatz des DNV Trimmtools

Ship Performance Center

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www.dnv.com



Felderfahrungen mit Cloud-basierter Torsionsschwingungsüberwachung bei Schiffsantrieben

Prof. Dr. Hinrich Mohr, Dr. Andreas Thalhammer, Florian Zeitler

Der heutige Seetransport verlangt aufgrund häufiger Anpassungen der Fahrpläne eine hohe Flexibilität bezüglich Schiffsgeschwindigkeit und Hafenanläufen. Dadurch sollte die Auslegung einer Schiffsantriebsanlage für einen deutlich größeren Betriebsbereich erfolgen als früher üblich, um sicher und effizient zu funktionieren. Gleiches gilt für Anwendungsfälle, bei denen ein aus wirtschaftlichen Gründen durchgeführtes De-Rating oder Re-Engineering der Antriebsanlage durchgeführt wird. Dies ist häufig mit dem Austausch des Propellers verbunden. Hier sind ursächlich die durch die IMO als Anhänge zum MARPOL Annex VI angenommenen Regeln zum EEXI und zum CII zu nennen. Dabei gilt die Leistungsreduzierung der Antriebsanlage ein einfacher und kostengünstiger Weg, die aktuellen IMO-Vorgaben zumindest kurzfristig zu erfüllen.

Die vorgenannten Maßnahmen haben deutliche Auswirkungen auf das Torsionsschwingungsverhalten des Antriebsstrangs. Die Erfahrungen zeigen, dass es hier zu deutlichen Veränderungen bzw. sogar Verstärkungen der Torsionsschwingungen kommen kann. Deshalb ist eine permanente Überwachung der Drehschwingungen sinnvoll, um Schäden zu vermeiden und den Instandhaltungsaufwand von Komponenten wie Kupplungen und Torsionsschwingungsdämpfern zu reduzieren.

Geislinger hat hierfür ein neues Überwachungssystem entwickelt, das eine permanente Drehschwingungsüberwachung des Antriebsstrangs ermöglicht. Durch eine Kopplung mit dem Internet werden die generierten Messdaten, idealerweise zusammen mit Kontextdaten aus dem Alarm- und Monitoringsystem des Schiffes, in eine Cloud übertragen und dort automatisiert ausgewertet. Dabei wird auch ein digitaler Zwilling des Antriebssystems mit eingebunden. Die Schwerpunkte der Auswertung liegen dabei auf der Performance-Optimierung, der Generierung von KPIs, der Anomalie-Erkennung und der Abschätzung von Lebensdauern für die Geislinger-Komponenten. Ein weiterer wichtiger Aspekt ist der Flottenvergleich, um Schiffe untereinander gegenüberstellen zu können. Aufgrund der mittlerweile großen Anwendung in unterschiedlichen Applikationen - 2-Takt und 4-Takt, Containerschiffe, Fähren, Car Carrier, Multi-Purpose Schiffe - lassen sich interessante Erkenntnisse zeigen, die für die jeweiligen Reedereien sehr wichtig sind und eine Optimierung des Betriebs zu realisieren.

Felderfahrten mit Cloud-basierter Torsionsschwingungsüberwachung bei Schiffsantrieben

Prof. Dr. Hinrich Mohr, Dr. Andreas Thalhammer, Florian Zeitler

44. ISF-Tagung, Flensburg, 23.06.23

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POWERTRAIN SOLUTIONS. BUILT TO LAST.

AGENDA

- Einleitung & Hintergrund
- Geislinger Digital Solutions – Aufbau und Messprinzip
- Felderfahrten & Referenzen
- Ausblick
- Zusammenfassung

EINLEITUNG UND HINTERGRUND

- Aufgrund dringend erforderlicher und kurzfristig umzusetzender Maßnahmen zur Reduzierung des CO₂-Ausstoßes und anderer Emissionen steht die Schifffahrt vor großen Herausforderungen.
- Zusätzlich ändert sich das Betriebsprofil von Schiffen häufig aufgrund von Marktänderungen oder politischen Rahmenbedingungen, durchaus mehrfach in einem Schiffsleben > 15 Jahre.
- Dafür wurden und werden auch weiterhin Änderungen an Rumpf, Propeller und Antriebsanlage als Retrofit-Maßnahmen vorgenommen.
- Die Reedereien müssen in allen Fällen eine hohe Ausfallsicherheit, maximale Effizienz und minimale Emissionen gewährleisten – und dabei auch profitabel bleiben.
- Durch die erweiterte Nutzung von umfangreichen Betriebsdaten in Verbindung mit modernen Auswertetechnologien können diese Herausforderungen stark unterstützt werden.
- Dieser Vortrag zeigt hierzu beispielhaft die Überwachung und Auswertung der Antriebsstrangdaten.

3

Felderfahrungen mit Cloud-basierter Torsionsschwingungsüberwachung bei Schiffsantrieben
44. ISF-Tagung, Flensburg, 23.06.23

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GEISLINGER IN ZAHLEN

91.2

MILLION €
Turnover FY 2021/22

100%

FAMILY OWNED BUSINESS
Ownership

800

EMPLOYEES WORLDWIDE
700 in Austria: 530 in Bad Sankt Leonhard,
170 in Salzburg

1958

FOUNDING YEAR
More than 60 years of experience

10%

**OF TURNOVER IS
INVESTED ANNUALLY**

6

PLANTS WORLDWIDE
Austria, Korea, USA, China, Japan

4

Felderfahrungen mit Cloud-basierter Torsionsschwingungsüberwachung bei Schiffsantrieben
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GEISLINGER ANWENDUNGEN



MARINE



WINDPOWER



RAIL



ELECTRIC & HYBRID



POWER GENERATION



MINING



OIL & GAS



RACING

5 | Felderfahrungen mit Cloud-basierter Torsionsschwingungsüberwachung bei Schiffsantrieben
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Vom klassischen Marine Produkt ...

DÄMPFER



Damper



Vdamp®

KUPPLUNGEN



SAE Coupling



Flexlink



Coupling

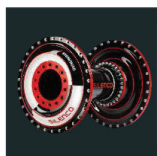


Gesilco® Butterfly



Gesilco® Composhaft®

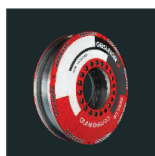
KUPPLUNGEN



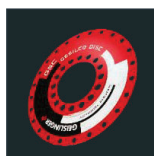
Silenco®



Carbotorq®



Compowind®



Disc

WELLEN

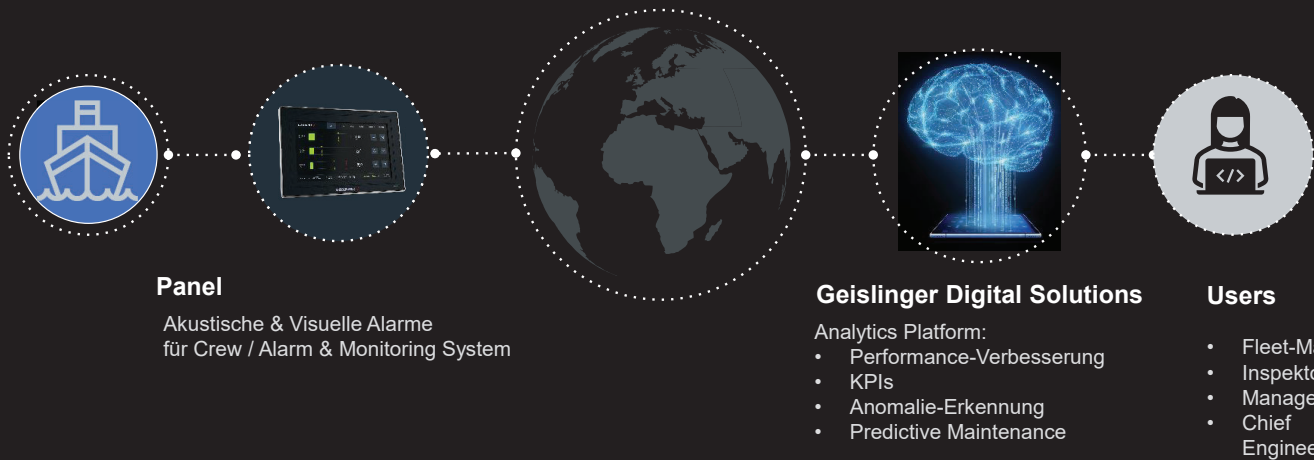


Gesilco® Shaft

6 | Felderfahrungen mit Cloud-basierter Torsionsschwingungsüberwachung bei Schiffsantrieben
44. ISF-Tagung, Flensburg, 23.06.23

GEISLINGER®
POWERTRAIN SOLUTIONS. BUILT TO LAST.

... zu den GEISLINGER DIGITAL SOLUTIONS

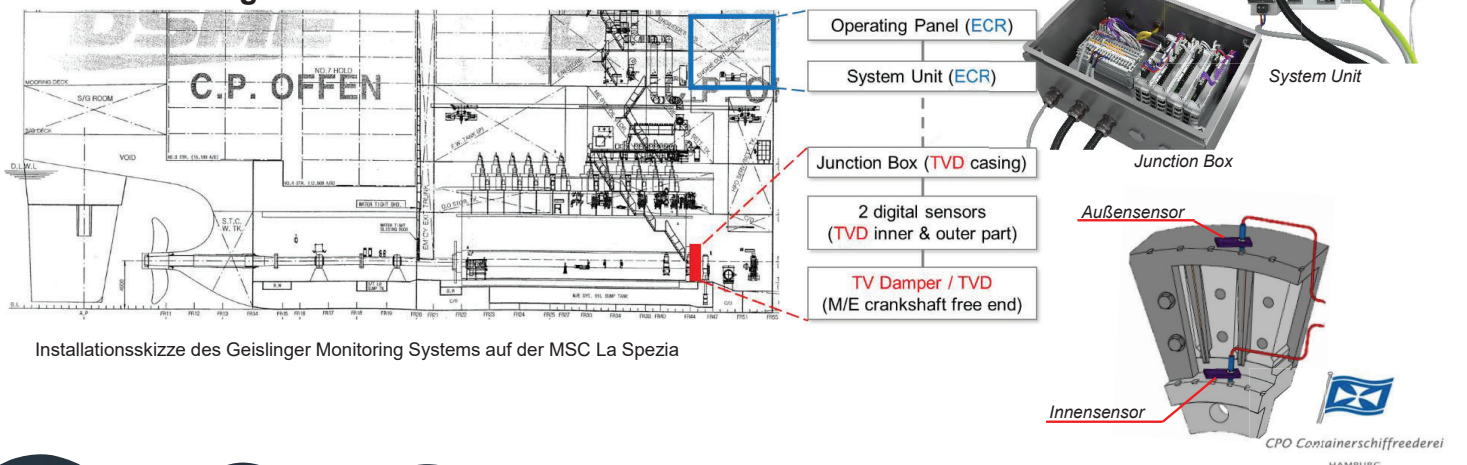


7 | Felderfahrten mit Cloud-basierter Torsionsschwingungsüberwachung bei Schiffsantrieben
44. ISF-Tagung, Flensburg, 23.06.23

GEISLINGER 
POWERTRAIN SOLUTIONS. BUILT TO LAST.

AUFBAU GEISLINGER MONITORING SYSTEM

Aufbau eines Monitoringsystems zur kontinuierlichen Überwachung des Drehschwingungsdämpfers und des Antriebsstrangs



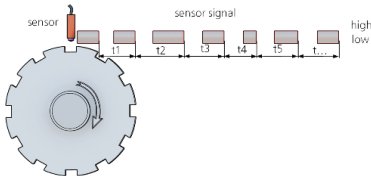
8 | Felderfahrten mit Cloud-basierter Torsionsschwingungsüberwachung bei Schiffsantrieben
44. ISF-Tagung, Flensburg, 23.06.23

GEISLINGER 
POWERTRAIN SOLUTIONS. BUILT TO LAST.

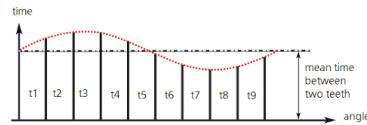
TORSIONSSCHWINGUNGSÜBERWACHUNG

Messprinzip & Signalverarbeitung

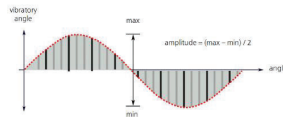
- Digitale Sensoren werden gegen eine Verzahnung montiert
- Als Messgröße werden die Zeitdifferenzen zwischen den passierenden Flanken der Verzahnung gemessen



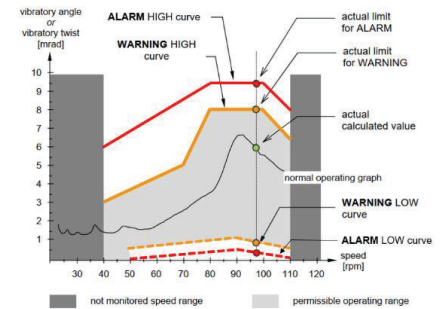
- Aus den gemessenen Zeitdifferenzen wird ein Winkelsignal rekonstruiert



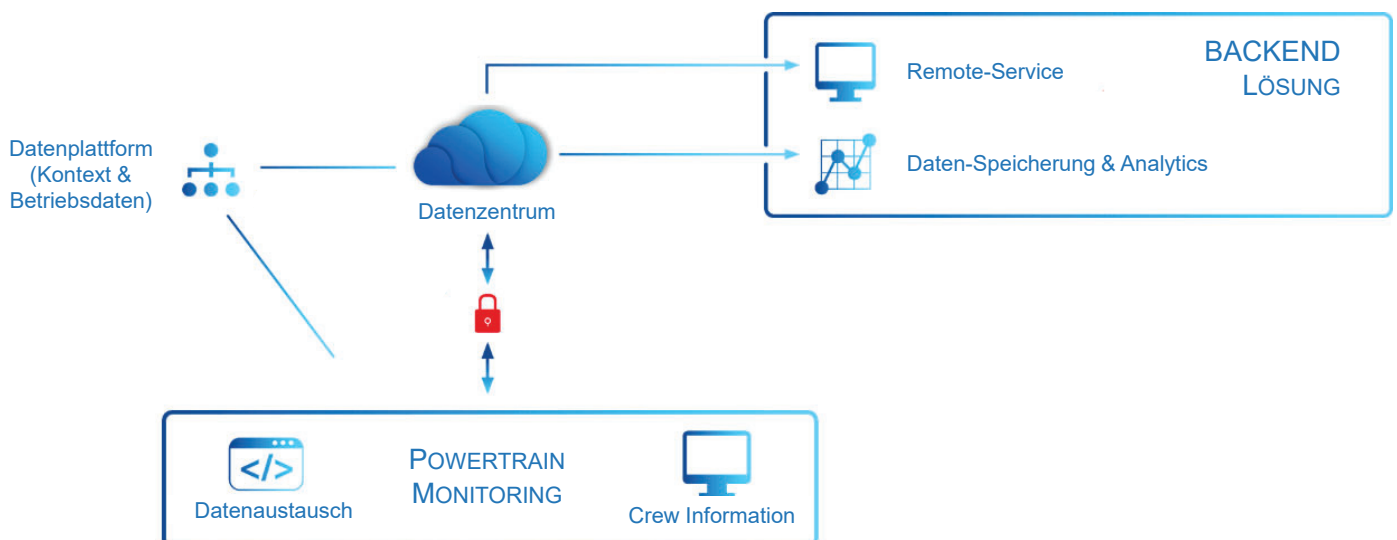
- Durch entsprechende Bandpassfilter werden nur kritische Frequenzbereiche betrachtet
- Berechnungsgröße = Amplitude der Torsionsschwingungen im kritischen Frequenzbereich



- Auf Basis von Drehschwingungsanalysen werden Normal-Betriebszustände und Alarmkurven definiert
- Bei Überschreitung von Alarmgrenzen wird Warnung/Alarm an Crew mitgeteilt



TORSIONSSCHWINGUNGSÜBERWACHUNG 4.0



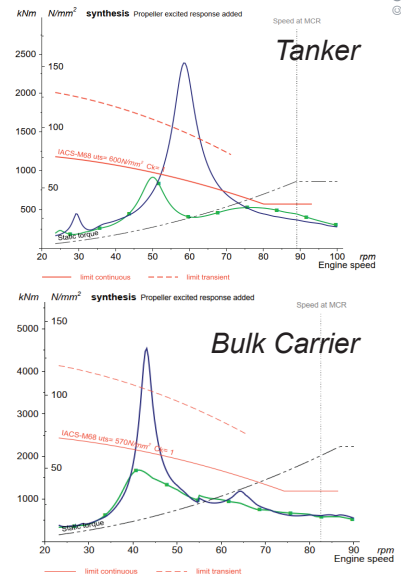
ERKENNTNISSE AUS TORSIONSSCHWINGUNGEN

Fehlfunktion / Verschleiß Dämpfer

- Drehschwingungsdämpfer schützt wichtige Komponenten des Antriebsstrangs (Kurbelwelle, Wellenleitung, Kettenantriebe, ...)
- Fehlfunktion des Torsionsschwingungsdämpfers steigert das Risiko eines Ausfalls der beschützten Hauptkomponenten
- Trendanalyse über mögliche Verschlechterung des Dämpfers durch Cloud-basierte Überwachung
- Kritische, plötzlich auftretende Beschädigungen werden an Bord der Crew unmittelbar per Alarm mitgeteilt

Beispiele

- Spannung/Schwingmoment an der Zwischenwelle (2-Takt-Motor für 5- bzw. 6-Zylinder-Konfiguration)
- Vergleich **Dämpfer im Normalzustand** vs. **Teilausfall/Beschädigung des Dämpfers**
- In beiden Fällen wird ein rascher Ermüdungsbruch der Welle durch Überbelastungen erwartet.



ERKENNTNISSE AUS TORSIONSSCHWINGUNGEN

Torsionsschwingungen stehen in direkter Wechselwirkung zu verschiedensten Randbedingungen und äußeren Einflüssen für das Antriebssystem

Einsatzfelder Torsionsschwingungsüberwachung

- Änderung Torsionsschwingungsverhalten generell
- Ungleichförmige Verbrennungen in den Zylindern
- Ausfall einzelner Zylinder
- Anregungen über Propeller
- ...



GDS FELDERFAHRUNGEN UND REFERENZEN

Aktuelle GDS Felderfahrung

▪ Container (2-stroke)	25
▪ RoPax (4-stroke)	4
▪ Car Carrier (2-stroke)	2
▪ Multi Purpose (4-Stroke)	2
▪ Multi Purpose (2-Stroke)	3
▪ Power Plant (4-stroke)	1

Referenzkunden



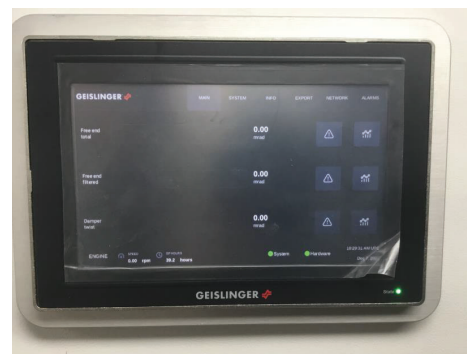
GDS INSTALLATIONSBEISPIEL



Junction Box & Sensor
Installation am Motor



System Unit im
Maschinenkontrollraum

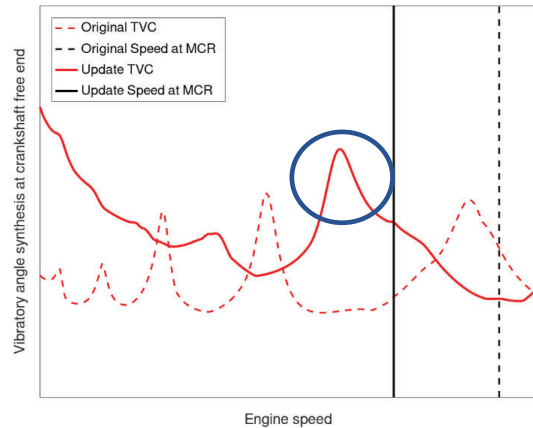


Operating Panel
(variabel platzierbar)

TORSIONSSCHWINGUNGEN & LEISTUNGSREDUKTION

Auswirkungen von Betriebsprofil- und Propellerdesignveränderungen

- Verändertes Betriebsprofil
 - Jede Änderung des Betriebsprofils bedeutet Veränderung der Torsionsschwingungsbelastungen
- Veränderte Torsionsschwingungslage durch Propellerdesign-Optimierung bei Reduzierung der Hauptmaschinenleistung um fast 40 %
 - Propellerauswahl hat signifikante Auswirkungen auf Torsionsschwingungen im Antriebsstrang
 - Trotz Leistungsreduktion steigt die Torsionsschwingungsbelastung in bestimmten Betriebspunkten (siehe Kreis).

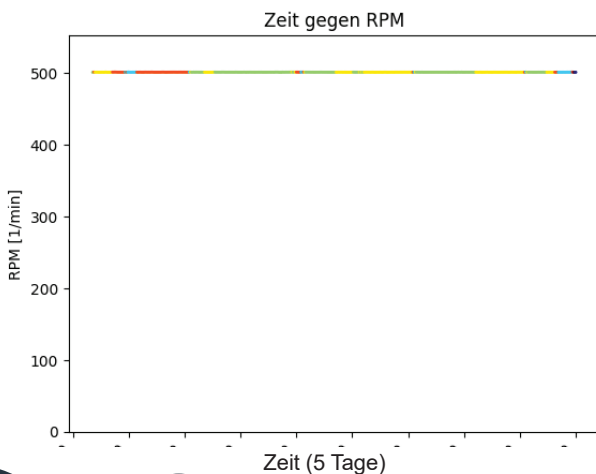


Vergleich der Drehschwingungen am freien Ende der Kurbelwelle vor (Original) und nach (Retrofit) der Umrüstung des Propellers



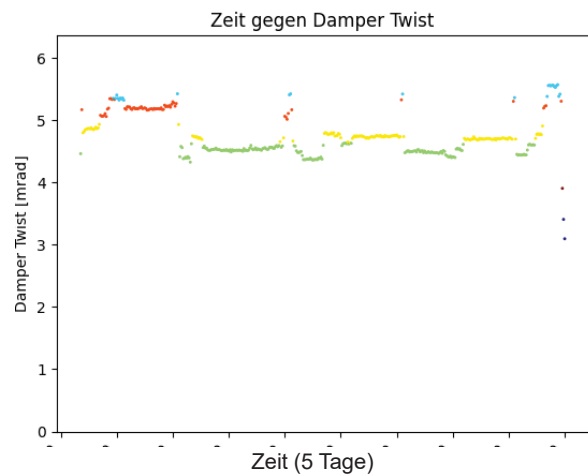
LEISTUNGSINDIKATOR

Beispiel 4-Takt-Anwendung - CPP
Leistungsidentifizierung über Datenclustering und Abgleich Simulation und Messergebnisse



Betrieb bei konstanter Drehzahl – Leistungsindikator durch Clustering von Drehschwingungsdaten identifiziert

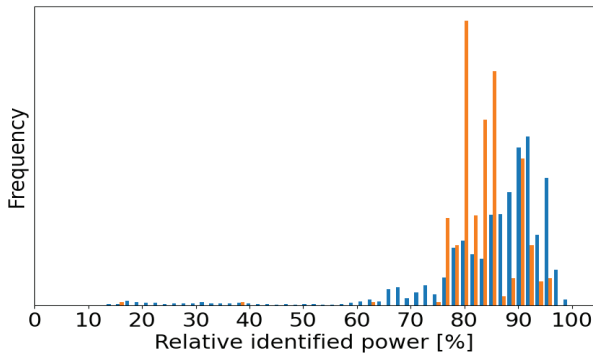
Jeder Farbe entspricht einem spezifischen Leistungsbereich – zur Visualisierung wurden nur 7 verschiedene Bereich gewählt



LEISTUNGSINDIKATOR

Beispiel 4-Takt-Anwendung – CPP

Leistungsidentifizierung über Datenclustering und Abgleich Simulation und Messergebnisse



■ Kurzzzeit-Lastprofil Untersuchungen (7 Tage)
■ Langzeit-Leistungsprofil Untersuchungen (8 Monate)

Untersuchungen zu Leistungsprofilen auf Basis von Drehschwingungsdaten einer Propulsionsanwendung über zwei Zeiträume

Kurzzzeit-Betrachtung entspricht einer Einzelfahrt

ANOMALIE-ERKENNUNG & KONTEXTINFORMATIONEN

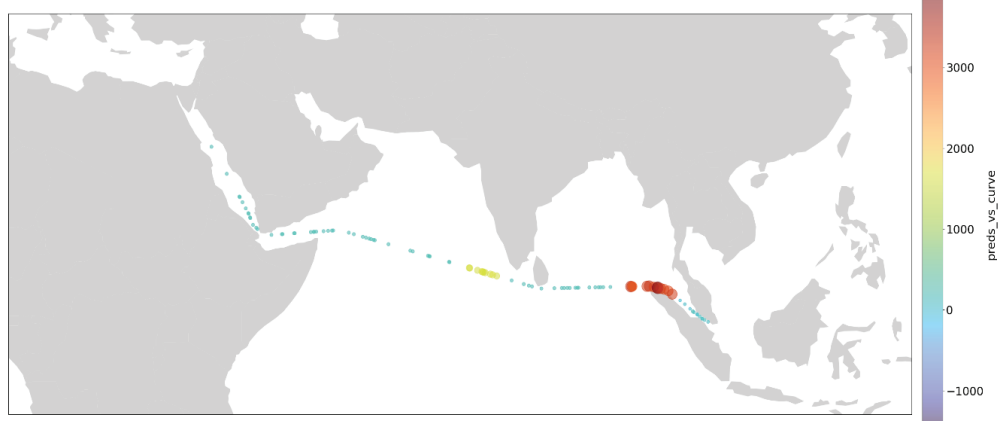
Anomalie-Erkennung

Datenmodelle werden trainiert, um Messergebnisse mit Vorhersagen vergleichen zu können.

- Anomalie detektiert, wenn Abweichung sehr groß

Kontext

Verbesserte Ergebnisse und Interpretationsmöglichkeiten, wenn Drehschwingungsdaten mit Kontextdaten zu Motorbetrieb, GPS, Seegang und anderen Umfelddaten zusammengeführt werden.



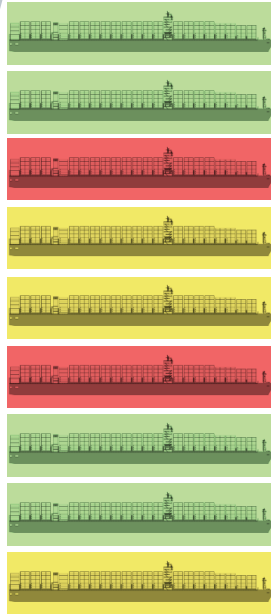
Beispiel Anomalie-Erkennung für Leistungsüberwachung auf Basis der Torsionsschwingungen: Vorhersage der Datenmodelle liegen in **blauen** Bereichen im erwarteten Bereich, **rot** und **gelb** zeigen Anomalien im Betrieb auf wie durch z. B. Schlechtwetter, Messfehler oder unerwartet hoher Leistungsbedarf

SCHIFF VS. FLOTTE

Digitalisierte Monitoring Ansätze



- Trendanalyse
- Anomalie-Erkennung
- Performance-Evaluierung



Vorteile Flottenübersicht

- Vergleichbarkeit innerhalb der Flotte
- Trendanalyse: Flotte vs. Einzelschiff
- Erkennen von Rare Events und strukturellen Anomalien

Erkenntnisse aus Flottenüberwachung

- Obwohl es sich um Schwesterschiffe handelt, können Datenmodelle eines Schiffes nicht 1:1 für 'baugleiche' Schiffe verwendet werden ⇒ individuelle Anpassung der Modelle erforderlich

Unterschiede entscheidend zu Aussagen bzgl. Trend, Anomalien und Performance

GDS BERICHTSBEISPIEL

GEISLINGER®

D 136/10/1/M – ENGINE #1



DAMPER HEALTH



99%

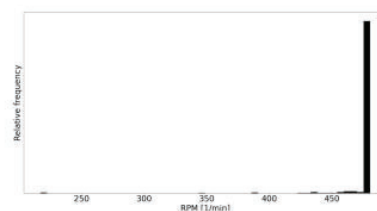
TIME PERIOD	2023-02-09, 06:00 to 2023-02-16, 06:00
OPERATING HOURS	66.65 hours
CONNECTION QUALITY	99%



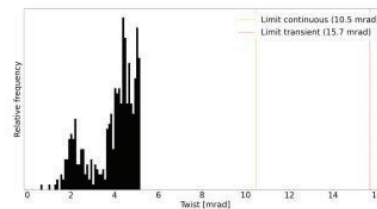
958 HOURS

IN OPERATION

SCHEDULE INSPECTION



DAMPER RPM



DAMPER TWIST



CONCLUSION

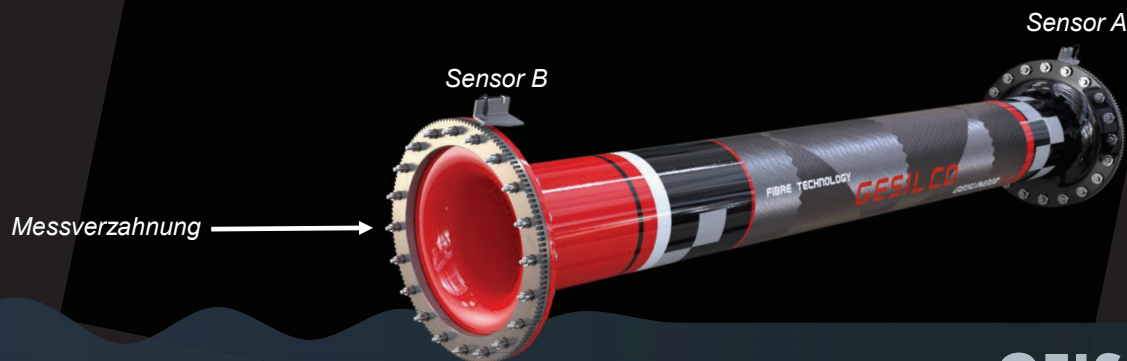
The measured vibratory twist amplitudes match well with the calculated amplitudes of the identified system. The measured vibration amplitudes are well below the warning and alarm limits. Therefore, the system is well protected, and the damper works well.

Ausblick: GEISLINGER POWER MONITORING

Messung und Überwachung von statischem Drehmoment und übertragener Leistung mittels statischer Verdrehungsmessung zwischen zwei rotierenden Zahnkränzen

Zusätzlich: Überwachung des schwingungsbasierten Verdrehwinkels zwischen zwei rotierenden Zahnkränzen

- Ordnungsabhängige Frequenzanalyse des gemessenen schwingungsbasierten Verdrehwinkels
- Erkennung von Drehmoment-Überlastung des Antriebsstrangs (IACS UR M68) oder der Kupplungen
- Verwendung der Messdaten für Begrenzung der Wellenleistung (ShaPoLi) im Rahmen der CII-Regularien



21 | Felderfahrungen mit Cloud-basierter Torsionsschwingungsüberwachung bei Schiffsantrieben
44. ISF-Tagung, Flensburg, 23.06.23

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Zusammenfassung

- Betriebsprofile, Kraftstoffe und Emissionsgrenzwerte von Schiffen ändern sich häufig über die Lebenszeit aufgrund von Markteinflüssen und politischen Rahmenbedingungen
 - ⇒ Antriebsanlage muss von Beginn an entsprechend flexibel ausgelegt sein oder per Retrofit angepasst werden
- Maßnahmen haben deutlichen Einfluss auf Torsionsschwingungsverhalten - guter Indikator zur Überwachung - , aber selbst Leistungsreduzierungen können Verstärkungen der Torsions-schwingungen in einzelnen Betriebsbereichen zur Folge haben
 - ⇒ deshalb permanente Überwachung sinnvoll, um frühzeitig Anomalien zu erkennen, Schäden zu vermeiden und Instandhaltungsaufwand zu reduzieren.
- Geislinger Digital Solutions bieten durch Kopplung von direkten Messdaten des Antriebsstrangs mit Kontextinformationen und modernen, internetbasierten Auswertetechnologien in Verbindung mit digitalen Zwillingen eine zuverlässige Überwachungslösung zur Unterstützung des optimalen und sicheren Betriebs sowie der vorausschauenden Planung von Wartungsarbeiten, aber auch der Abschätzung der Auswirkungen zukünftiger Betriebsszenarios.

22 | Felderfahrungen mit Cloud-basierter Torsionsschwingungsüberwachung bei Schiffsantrieben
44. ISF-Tagung, Flensburg, 23.06.23

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CONTACT US



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mail: info@geislinger.com

web: geislinger.com



44. ISF-Tagung 23. Juni 2023



**BUREAU
VERITAS**

Shaping a World of Trust

BUREAU VERITAS | Marine & Offshore
Veritaskai 1, 21079 Hamburg

Erfahrungen mit Hafenstaatskontrollen

Hajo Gerken

Zur Erfahrung mit Hafenstaatskontrollen führt Herr Gerken aus, dass eine gute reedereiseitige Vorbereitung im Interesse der Schiffsicherheit und des Meeresumweltschutzes unerlässlich ist. Während der Kontrollen wird nicht nur der technische Zustand des Schiffes bewertet, sondern auch inwieweit die Besatzung mit den an Bord befindlichen Anlagen und Einrichtungen vertraut ist. Diese Fähigkeiten sind ein Schlüsselement in Hinblick auf die Erfordernisse des ISM Codes. Es gilt diese, während der Kontrollen angemessen zu kommunizieren und zu demonstrieren, um etwaige Festhaltungen zu vermeiden.



Avoiding port state detentions – where are we today?

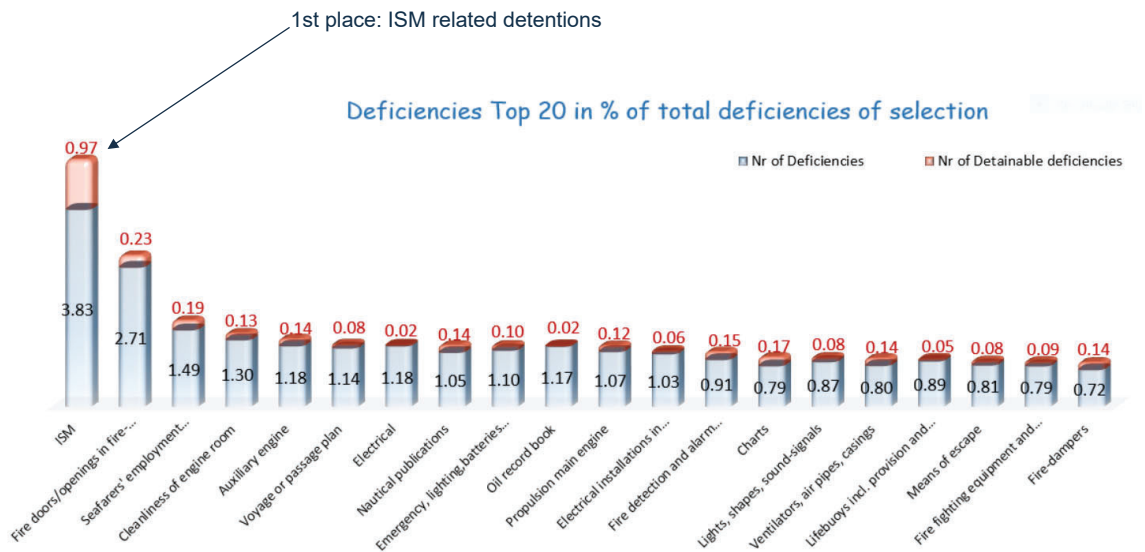


Avoiding port state detentions – where are we today?



What was the most common ground for portstate detentions in Paris MoU during last year (2022)?

Picture: Adobe Stock



1st place: ISM items!

3

ISM related detentions



- ▶ Too many single deficiencies even if mainly of minor nature can be judged as failure of:
- ▶ Maintenance of ship and equipment (element 10 of the ISM code)
- ▶ Resources and personell (element 6 of the ISM code)
- ▶ Masters responsibility and authority (element 5 of the ISM code)
- ▶ Companies responsibility and authority (element 3 of the ISM code)
- ▶ Safety and environmental policy (element 2 of the ISM code)

4

ISM related detentions

- ▶ The ISM code obliges the shipping company:
- ▶ that applicable codes, guidelines and standards recommended by the Organization, Administrations, classification societies and maritime industry organizations are taken into account. (ISM element 1.2.3.2)

Should the Port State Control inspectors in charge have, based on their professional judgement, objective evidence that the company does not fulfil that obligation, it may result in an ISM related detention.



5

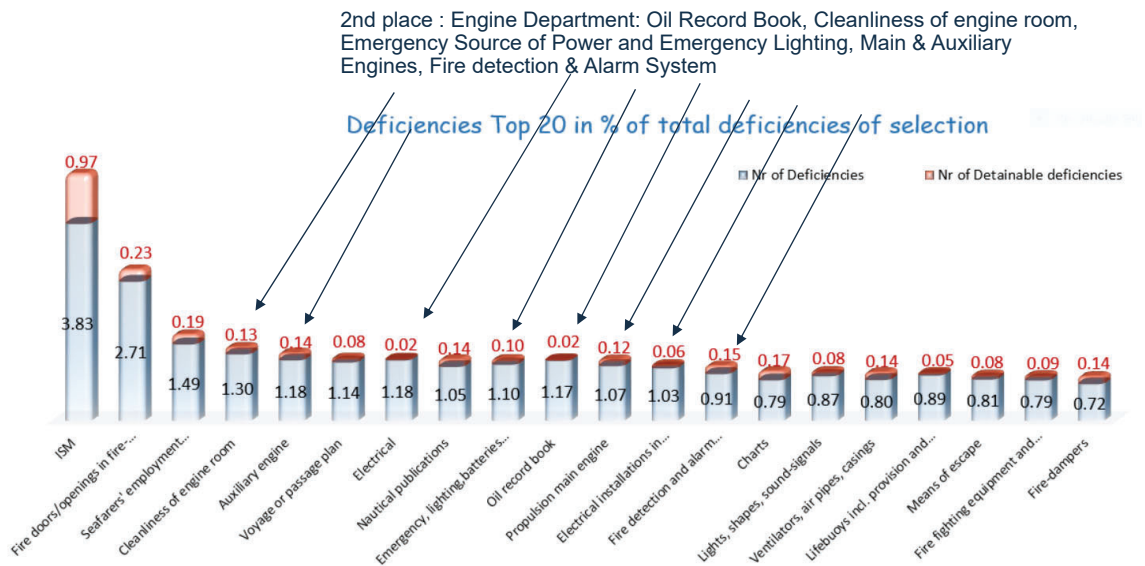
Avoiding port state detentions – where are we today?



Picture: Gebr. Wechler

What were the second most common grounds for portstate detentions in Paris MoU during last year (2022)?

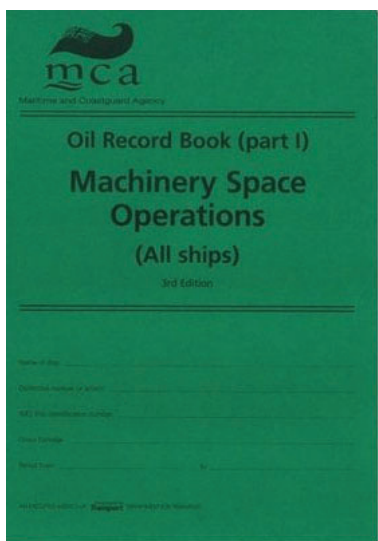
6



2nd place: Machinery items!

7

Oil Record Book



11 Collection of oil residues (sludge).

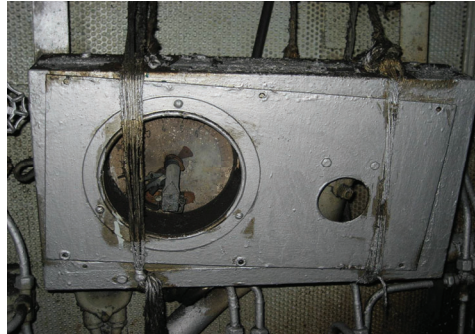
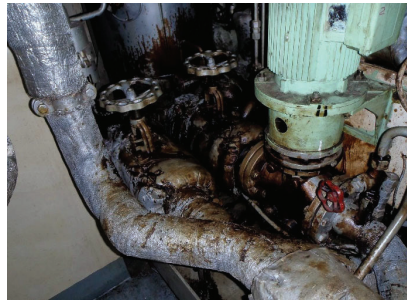
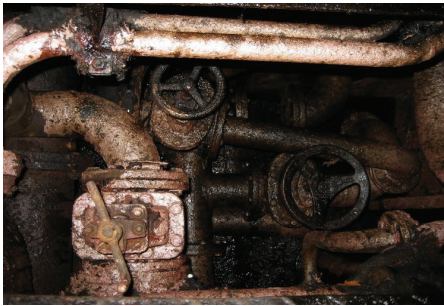
Quantities of oil residues (sludge) retained on board. The quantity should be recorded weekly*:

(this means that the quantity must be recorded once a week even if the voyage lasts more than one week)

* Only those tanks listed in item 3.1 of Forms A and B of the Supplement to the IOPP Certificate used for oil residues (sludge)

8

Machinery Lack of Cleanliness and Maintenance



Machinery Lack of Cleanliness and Maintenance



Machinery Lack of Cleanliness and Maintenance



11

SOLAS II-1 Reg 26.3 Redundancy of essential auxiliaries

Means shall be provided whereby normal operation of propulsion machinery can be sustained or restored even though one of the essential auxiliaries becomes inoperative.

Special consideration shall be given to the malfunctioning of:

12

SOLAS II-1 Reg 26.3 Redundancy of essential auxiliaries



- ▶ .1 a generating set which serves as a main source of electrical power;
- ▶ .2 the sources of steam supply;
- ▶ .3 the boiler feedwater systems;
- ▶ .4 the fuel oil supply systems for boilers or engines;†
- ▶ .5 the sources of lubricating oil pressure;
- ▶ .6 the sources of water pressure;
- ▶ .7 a condensate pump and the arrangements to maintain vacuum in condensers;
- ▶ .8 the mechanical air supply for boilers;
- ▶ .9 an air compressor and receiver for starting or control purposes;
- ▶ .10 the hydraulic, pneumatic or electrical means for control in main propulsion machinery including controllable pitch propellers.

13

Main source of power (SOLAS II-1 Reg. 41)



- ▶ 1.1 A main source of electrical power of sufficient capacity to supply all those services mentioned in regulation 40.1.1 shall be provided. This main source of electrical power shall consist of at least two generating sets.
- ▶ (Reg. 40.1.1) Electrical installations shall be such that all electrical auxiliary services necessary for maintaining the ship in normal operational and habitable conditions will be ensured without recourse to the emergency source of electrical power.

14

Emergency source of power in cargo ships (SOLAS II-1 Reg. 43)



- ▶ 1.1 A self-contained emergency source of electrical power shall be provided.
- ▶ 3.1 Where the emergency source of electrical power is a generator, it shall be:
 - ▶ .2 started automatically upon failure of the main source of electrical power... where the emergency generator is automatically started, it shall be automatically connected to the emergency switchboard...
 - ▶ .3... automatically **started and supplying** the required load as quickly as is safe and practicable subject to a maximum of **45 s**.
 - ▶ 3.4 For ships constructed on or after 1 July 1998, where electrical power is necessary to restore propulsion, the capacity shall be sufficient to restore propulsion to the ship in conjunction with other machinery, as appropriate, from a **dead ship condition** within **30 min after blackout**.

15

SOLAS II-2 Reg. 5 (Fire growth potential)



- ▶ 2.2.3 Means of control shall be provided for **stopping** forced and induced draught **fans**, oil fuel **transfer pumps**, oil fuel unit pumps, lubricating **oil service pumps**, **thermal oil circulating pumps** and **oil separators (purifiers)**. However, paragraphs 2.2.4 and 2.2.5 need not apply to oily water separators.

16

SOLAS II-2 Reg. 5 (Fire growth potential)



4.1 Installation

► A fixed fire detection and fire alarm system shall be installed in:

.1 periodically unattended machinery spaces;

.2 machinery spaces where:

.2.1 the installation of automatic and remote control systems and equipment has been approved in lieu of continuous manning of the space; and

.2.2 the main propulsion and associated machinery including sources of the main sources of electrical power are provided with various degrees of automatic or remote control and are under continuous manned supervision from a control room; and

.3 enclosed spaces containing incinerators.

SOLAS II-2 Reg. 5 (Fire growth potential)



► 5.5 Cargo ships

► Accommodation and service spaces and control stations of cargo ships shall be protected by a fixed fire detection and fire alarm system and/or an automatic sprinkler, fire detection and fire alarm system as follows depending on a protection method adopted in accordance with regulation 9.2.3.1.

► 5.5.2 Method IIC - An automatic sprinkler, fire detection and fire alarm system of an approved type complying with the relevant requirements of the Fire Safety Systems Code shall be so installed and arranged as to protect accommodation spaces, galleys and other service spaces, except spaces which afford no substantial fire risk such as void spaces, sanitary spaces, etc. In addition, a fixed fire detection and fire alarm system shall be so installed and arranged as to provide smoke detection in all corridors, stairways and escape routes within accommodation spaces.

Avoiding port state detentions – where are we today?

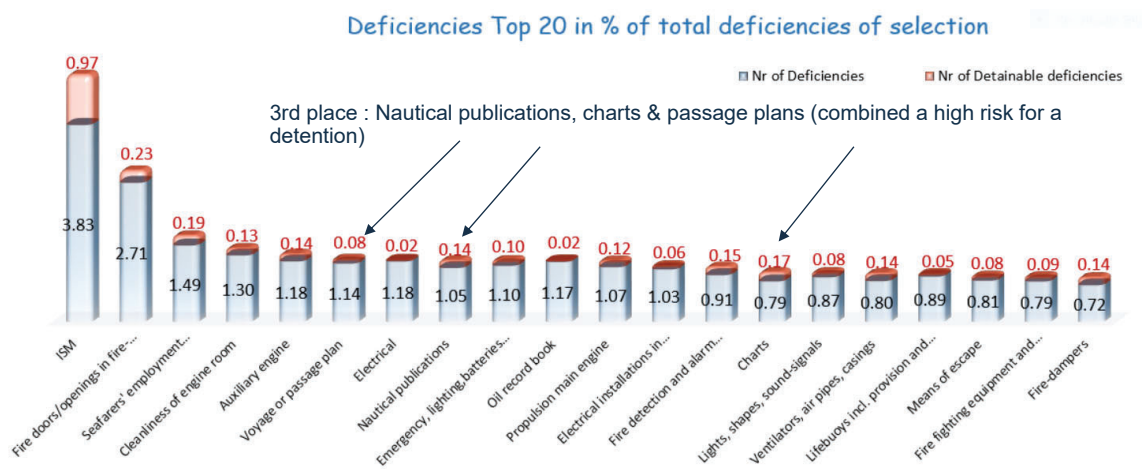


Picture: ZEITRAUMplus

What were the third most common grounds for portstate detentions in Paris MoU during last year (2022)?

19

Paris MoU statistics of 2022



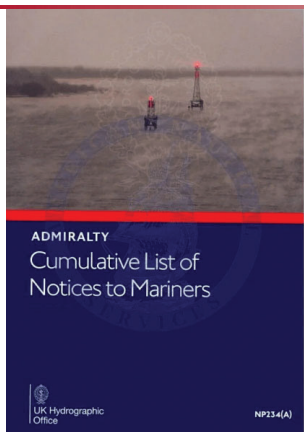
3rd place: Navigational items

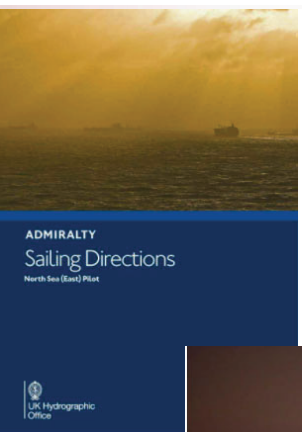
20

- ▶ Regulation 27
- ▶ Nautical charts and nautical publications
- ▶ Nautical charts and nautical publications, such as sailing directions, lists of lights, notices to mariners, tide tables and all other nautical publications necessary **for the intended voyage**, shall be adequate and up to date.

21

Nautical publications





The cumulative List of NtM indicate the last valid version of nautical publications

IB

CURRENT NAUTICAL PUBLICATIONS

(ADMIRALTY Sailing Directions, ADMIRALTY List of Lights, ADMIRALTY Lists of Radio Signals, ADMIRALTY Tidal Publications, ADMIRALTY Reference Publications)

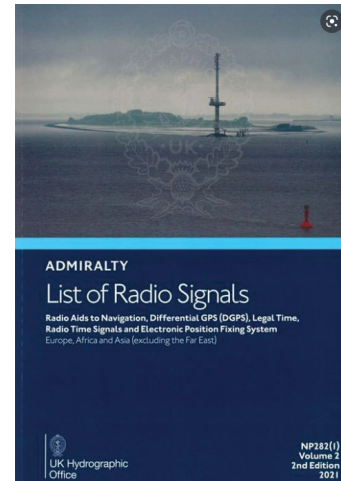
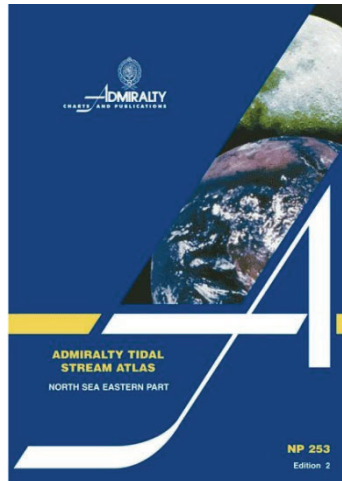
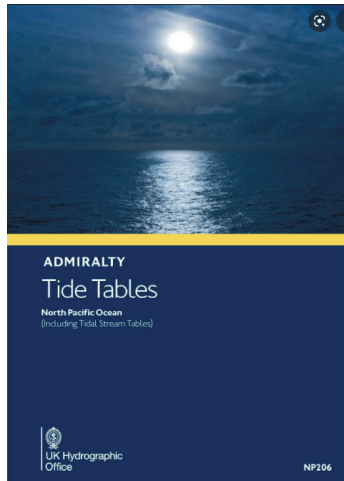
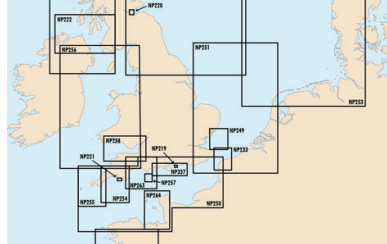
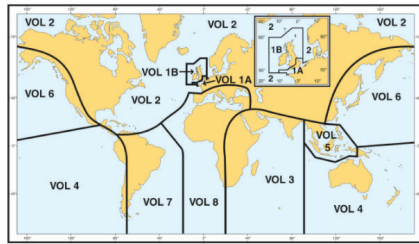
(Updated to 1st July 2021)
(Former Listing dated 1st April 2021 is cancelled)

(1) Current Editions of ADMIRALTY Sailing Directions

NP No	Title	Edition
1	Africa Pilot Volume 1	19th (2020)
2	Africa Pilot Volume 2	18th (2017)
3	Africa Pilot Volume 3	18th (2019)



22



Avoiding port state detentions – where are we today?



And what does other nautical publications beside sailing directions, list of lights, list of radio stations and tidal information adequate and up to date mean?

Picture: Adobe Stock

IAMSAR Volume III, Code of flag signals, ITU publications



25

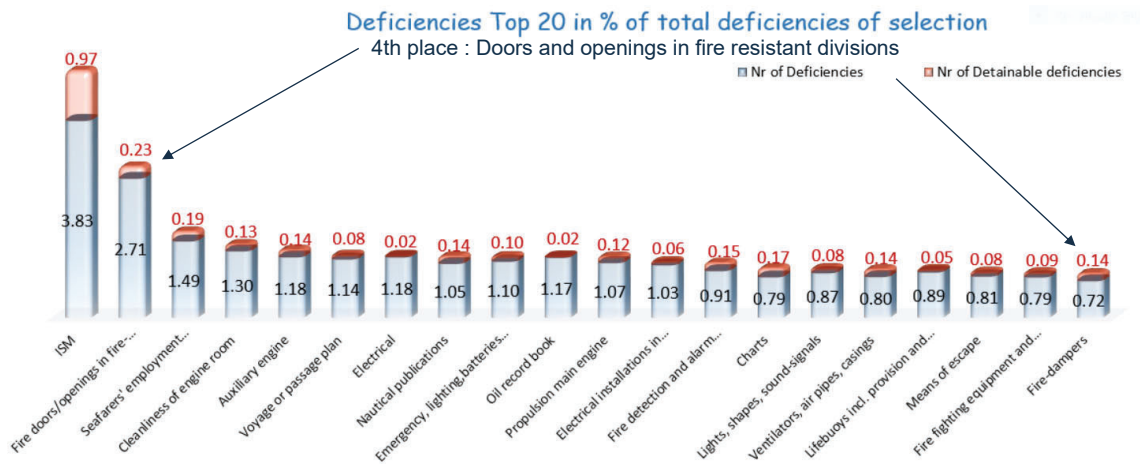
Avoiding port state detentions – where are we today?



Picture: Gebr. Wechler

What were the forth most common grounds for portstate detentions in Paris MoU during last year (2022)?

26



4th place : Doors and openings in fire resistant divisions

27

Doors in fire resistant divisions



Picture: www.safelincs.co.uk

28

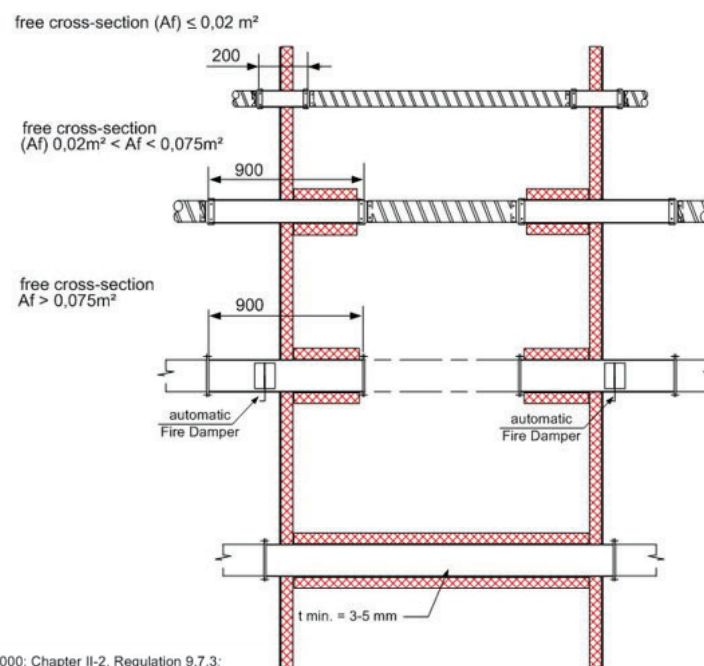
Doors in fire resistant divisions



Picture: www.safelincs.co.uk

29

Openings in fire resistant divisions



SOLAS Amendments 2000; Chapter II-2, Regulation 9.7.3:
Principal construction 'Details of duct penetrations' through "A" class bulkheads

30

A fire damper as per SOLAS II-2, Reg. 9 and MED



Picture: HALTON

Closing appliances and stopping devices of ventilation as per SOLAS II-2 Reg. 5.2.1



Picture: The Institution of Fire Engineers (United Kingdom)

Avoiding port state detentions – where are we today?

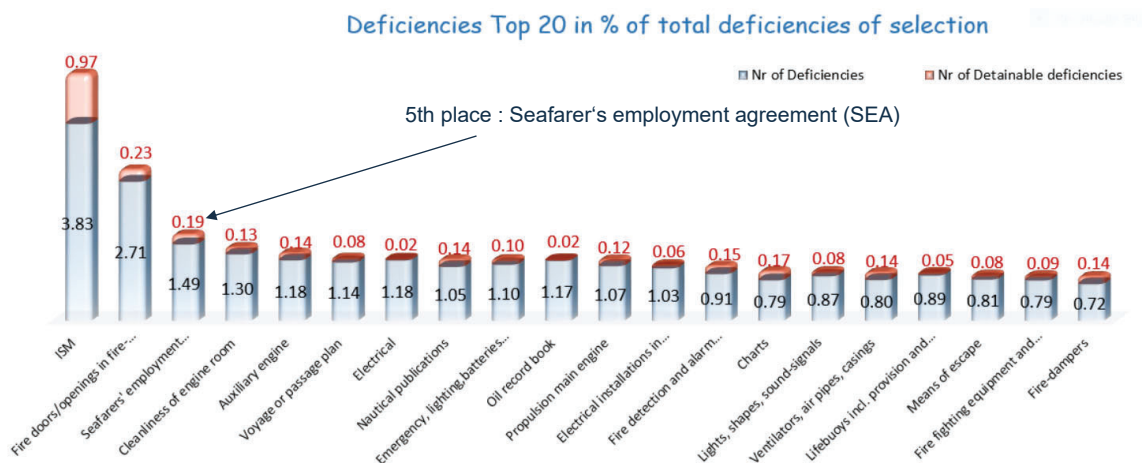


What was the fifth most common ground for portstate detentions in Paris MoU during last year (2022)?

Picture: Adobe Stock

33

Paris MoU statistics of 2022



34

Standard A 2.1.4 of the Maritime Labour Convention (MLC)

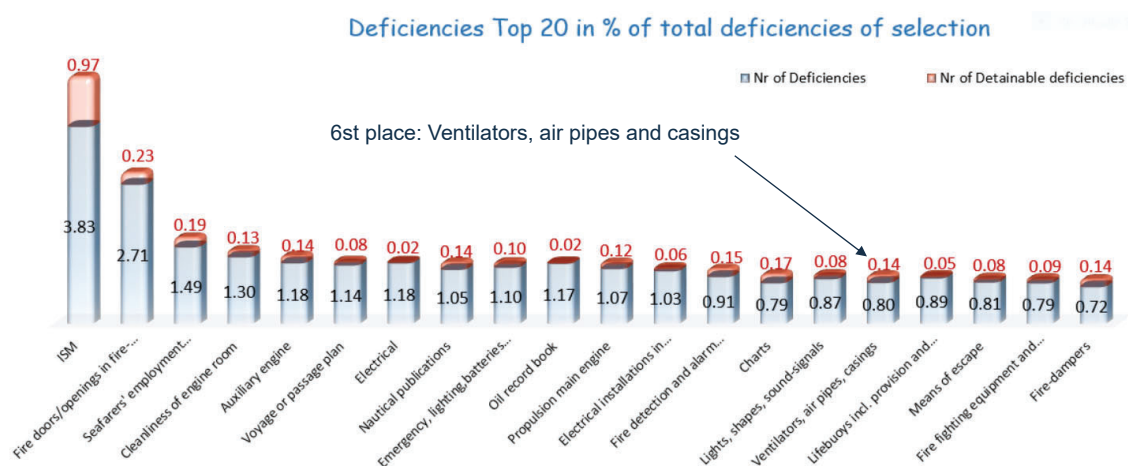
- ▶ Seafarers' employment agreements shall in all cases contain the following particulars:
- ▶ (a) the seafarer's full name, date of birth or age, and birthplace;
- ▶ (b) the shipowner's name and address;
- ▶ (c) the place where and date when the seafarers' employment agreement is entered into;
- ▶ (d) the capacity in which the seafarer is to be employed;
- ▶ (e) the amount of the seafarer's wages or, where applicable, the formula used for calculating them;
- ▶ (f) the amount of paid annual leave or, where applicable, the formula used for calculating it;
- ▶ (g) the termination of the agreement and the conditions thereof

Avoiding port state detentions – where are we today?



Picture: ZEITRAUMplus

What were the sixth most common grounds for portstate detentions in Paris MoU during last year (2021)?

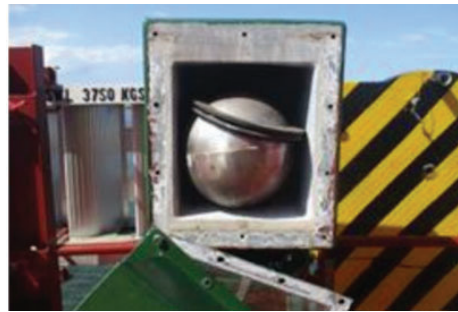


Vent head, and ventilators



Pictures: KENT Marine & MFAME

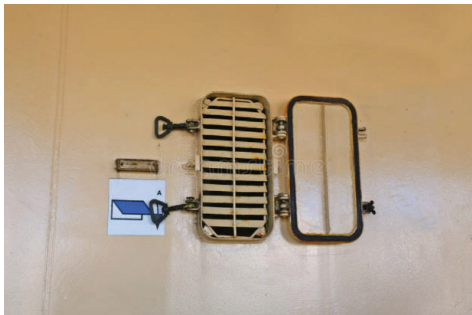
Defective vent heads



Pictures: Prevention at Sea, RMI Marine Administrator , safety for sea

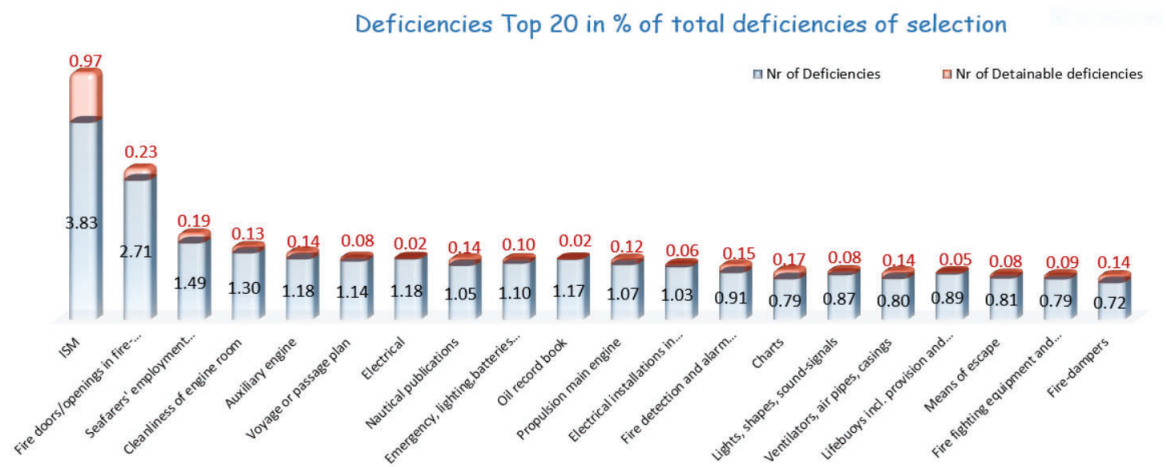
39

Weathertight enclosures of ventilators as they are supposed to be



Pictures: Oldendorff Carriers, dreamstime

40



**BUREAU
VERITAS**

Shaping a World of Trust



44. ISF-Tagung 23. Juni 2023

Wärtsilä, Hamburg

Wärtsilä Methanol Fuel-Plattform
Lucca Ratz

WÄRTSILÄ Methanol Fuel Platform

Lucca Arnim Ratz
Wärtsilä Marine Power

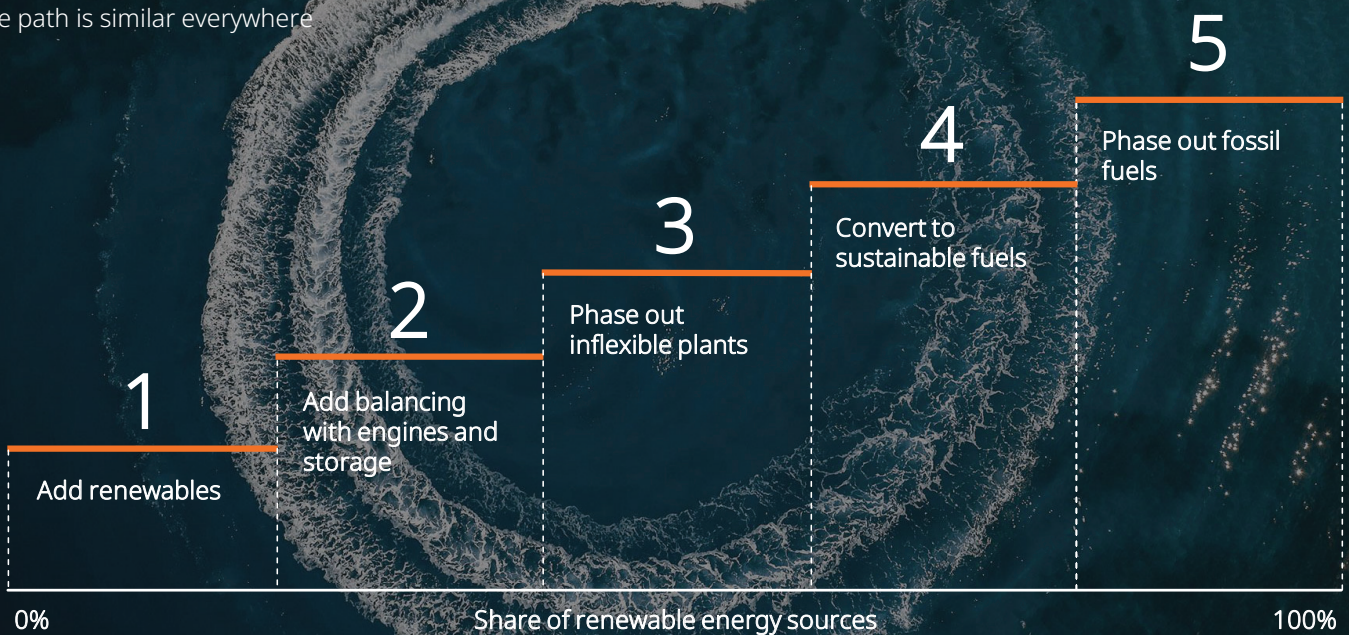
For customer distribution



23 June 2023

New technologies will be needed to support development towards 100 % renewable future

The path is similar everywhere



Kick off – Stena Germanica

Methanol conversion of a RoPax vessel

- Stena Germanica – 240m LOA RoPax vessel
- powered by 4x 8ZAL40S engines running 21kn
- converted 2015 for Methanol operation
 - World's first major marine 4S vessel running on MeOH
- Stena Germanica is Wärtilä's floating Methanol laboratory
- field testing since 2015
- over 9000h testing on board
- providing a lot of data as input for our MethanolFuel Platform



M/V STENA Germanica

Methanol Conversion

- 4x Main engines 8ZAL40S converted for Methanol combustion
- Methanol bunker station PS + SB
- Ballast tanks converted to MeOH fuel tanks
- New pump room and airlock
- Double walled high pressure MeOH fuel pipes
- Inert gas generator
- Docking duration: 6 weeks
- 400m³ MeOH providing 5 days operation
- Bunkering from onshore station at 120 m³/h



Vessel Design Impacts

Engine room and fuel system re-thought

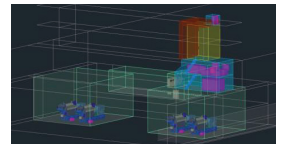
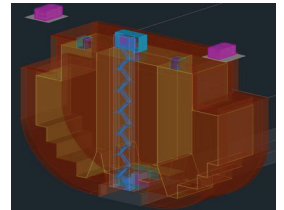
- Engine room installation design principles are identical as Wärtsilä Dual Fuel LNG engines. Means that the engine room can be classified as a gas-safe area / non-hazardous space;
- Double-walled high-pressure piping to special connection block;
- Only engine specific "control & oil sealing unit" situated in engine room.

Engine Room



- For the methanol fuel system, IGF code applies!
- NOTE: Underestimated system complexity of this liquid fuel, stored at ambient conditions > many synergies with a LNG fuel system.
- Toxicity and flammability of methanol introducing other safety focus areas than for LNG;
- Multiple tank arrangements are increasing fuel system complexity;
- Vessel GA to include a dedicated Fuel Preparation Space adjacent to engine room;
- If main bunker tanks are situated elsewhere in vessel, need for a service/day tank;
- Methanol fuel system equipment can (significantly) impact vessels hotel load;
- Nitrogen system is an essential system, serving fuel system instantaneously.

Fuel System



Methanol fuel injection pressure

Why are we injecting MeOH at 600bar?

Wärtsilä has conducted extensive full-scale laboratory testing to achieve lowest fuel consumption in combination with optimum methanol-diesel ratio and methanol injection pressure.

- Testing has validated these test results are in line with the original theoretical design parameters;
- Methanol fuel injection pressure is key to achieve best fuel performance at the various engine loads;
- Optimum injection pressure @ 85% engine load = 600bar;
- A 50% reduction of the injection pressure is resulting in a lower fuel performance of about 15%.

NOTE: Fuel consumption data is subject to final Type approval tests

Methanol injector working principle

Wärtsilä has kept the proven “pilot-fuel-assisted diesel combustion” concept.

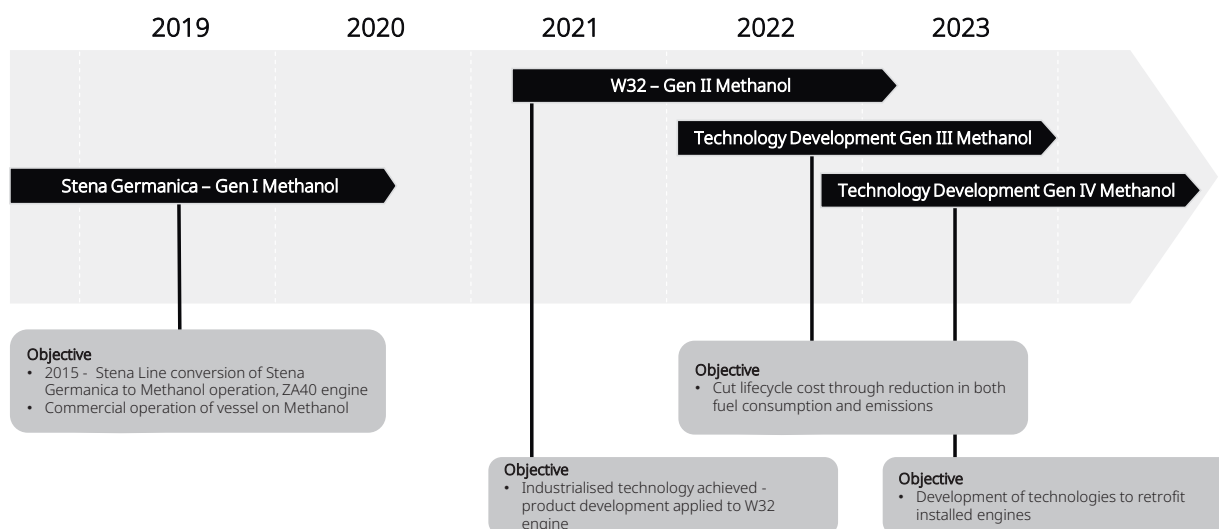
The Methanol injection system is placed side by side to a pilot diesel injection system.

New injector accommodates nozzles for both fuels as well as mechanics and hydraulics for operating both systems seamlessly

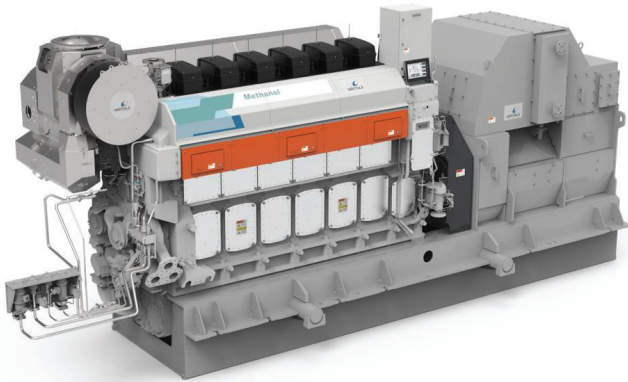
NOTE: Fuel consumption data is subject to final Type approval tests

Marine Power Technology Development – Methanol

A brief history



WÄRTSILÄ's first commercially Methanol engine W32M already available



- Based on proven and reliable W32 engine concept
 - Experience from earlier W32GD engine design, and Sulzer ZA40S methanol
- Back up fuel operation possible (LFO + LBF, HFO)
 - Fuel switch (Methanol ↔ Liquid) can be made without loss of power
- Auxiliary engine (AE), Diesel electric engine (DE), Variable Speed (Single) Main engine
- Following cylinder configurations are available:
 - 6L, 7L, 8L and 9L

W32 versus W32M design base

ENGINE DESIGN PARAMETERS	WÄRTSILÄ 32 Diesel	WÄRTSILÄ 32 Methanol
Cylinder output (720/750 rpm)	560/580 kW	
Mean effective pressure (720/750 rpm)	29 bar	
Fuel injection system	Conventional Jerk pump	Common rail methanol mode, jerk pump diesel mode
Firing pressure, design	230 bar	
NOx emission standard	IMO Tier II / Tier III with SCR	
SCR optimized	Yes	
Available configurations	6,7,8,9,12,16	6,7,8,9

W32 and W32M do have the same design basis with many identical parts

The main differences:

- Multi-fuel injection with an advanced common injector;
- Double-walled common rail MeOH distribution system with electro-hydraulic solenoid valves;
- Methanol fuel connection and leakage block;
- Engine automation and safety concept.



Cylinder head conversion

New cylinder head and injector on our W32M

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IMO Tier III EIAPP certification

Wärtsilä 32 Methanol engine is type approved and has received its EIAPP certificate

IMO EIAPP Tier III certification includes both the Wärtsilä 32 Methanol engine and Wärtsilä NOx reducer system

- Separate engine and SCR manufacturers pose certification-, technical-, reliability- and delivery related risks and uncertainty

IMO Tier III compliancy through the lifecycle is hereby secured

- ✓ Availability of NOx critical components like catalyst elements
- ✓ Lifecycle services
- ✓ System updates
- ✓ Troubleshooting engine and SCR together
- ✓ Reporting compliancy to authorities



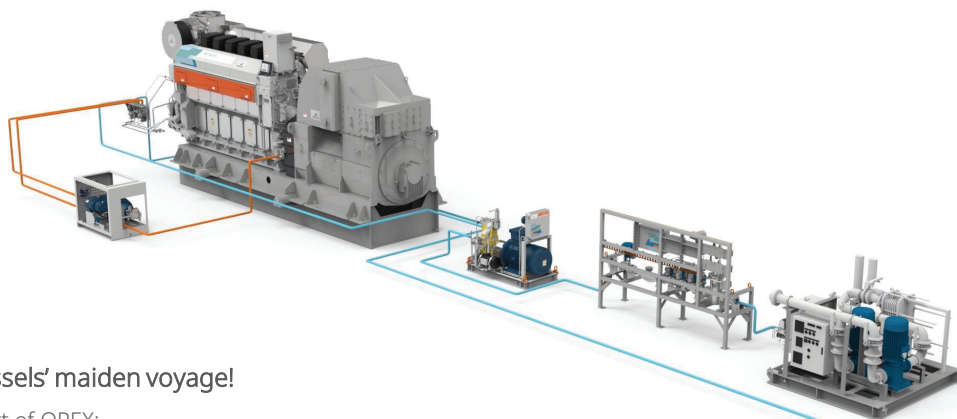
OUR PURPOSE

Enabling sustainable societies through
Innovation in technology and services

Wärtsilä Methanol Fuel Platform

A complete solution – from tank to engine to exhaust system

Thinking
System Solutions



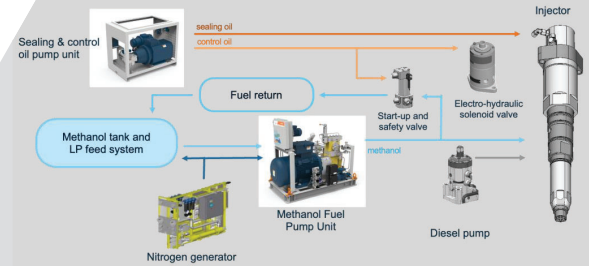
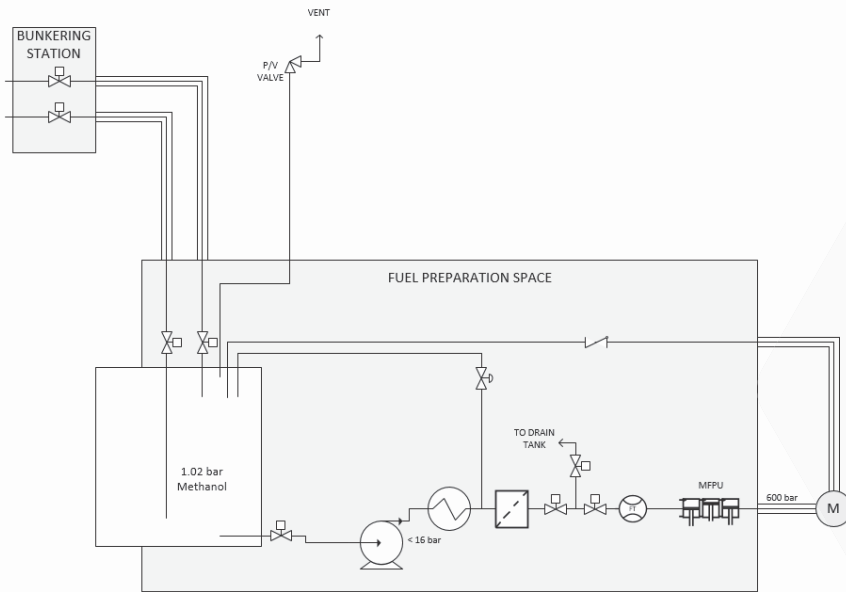
Safety First

The lifecycle starts at vessels' maiden voyage!

- End of CAPEX, start of OPEX;
- Minimizing fuel/energy consumption, while offering competitive transportation;
- Following the decarbonization timeline;
- Data and analytics for optimum performance & reduced maintenance;

Breaking shipbuilding traditions, as an individual equipment approach might “not” bring your vessel to the targeted lifetime of the vessel!

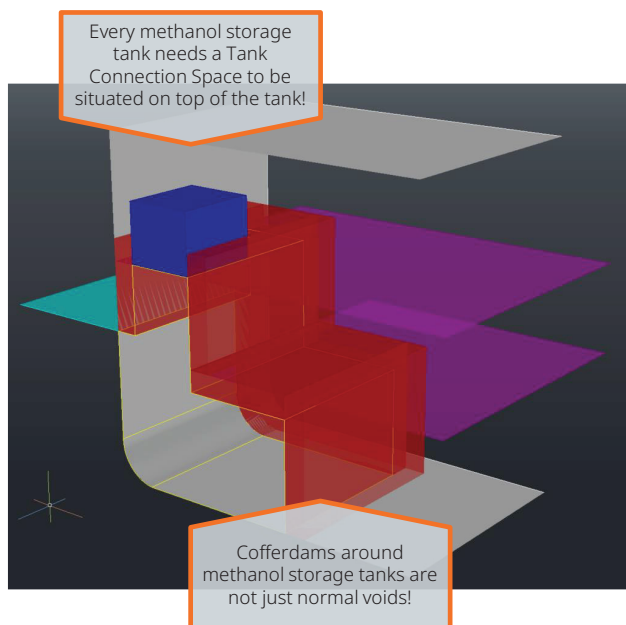
Methanol fuel system can be simple



GD engine concept

- High pressure (600 bar) methanol pump in separate pump room/fuel preparation space
- Low pressure equipment from tank to HP pump
- Return line from engine to handle emergency shutdowns and maintenance
- **Liquid high pressure methanol in engine room**

Methanol storage tanks hull integration aspects



- Methanol can be stored in hull-integrated tanks;
- Tanks shall be coated to prevent corrosion (in case of contaminants or moisture inside methanol);
- Tank shall be kept inerted at all times above fuel liquid level (blanketing/padding);
- For each tank a P/V (pressure/vacuum) relief system shall be considered;
- Storage tank bulkheads can be vessel's shell plating below waterline (no double-bottom required);
- Tank need to be surrounded by a cofferdam if adjacent to non-hazardous spaces and engine rooms;
- If adjacent to a fuel preparation space/pump room, then cofferdam is not required.

Methanol storage tanks

example: container vessel

Bunkering station for liquid filling and vapour return

Tank Connection Space on each tank, including all tank valves and instrumentation for tank monitoring:

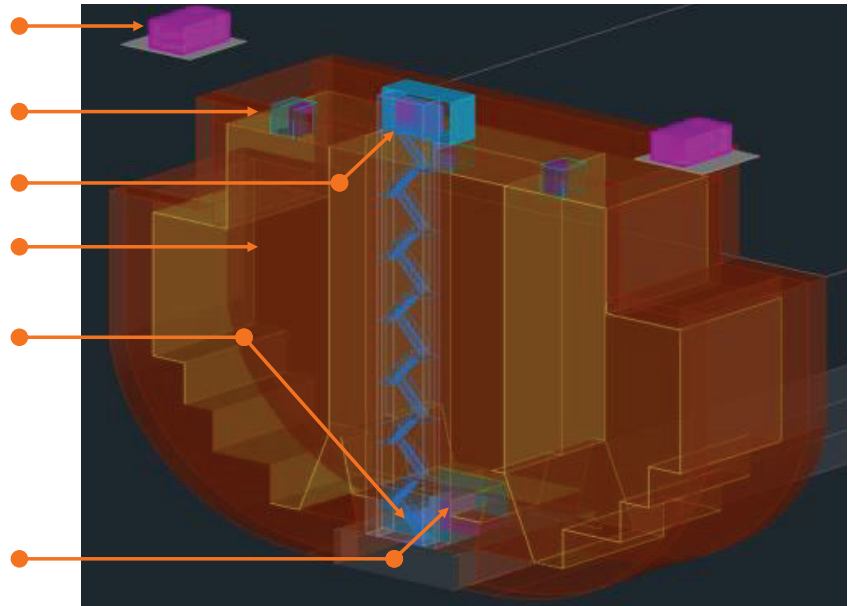
Bunkering Distribution Room

Nitrogen blanketing on top of remaining fuel for each methanol storage tank

Fuel transfer system

- To service/day tank in aft ship
- Between tanks (can also be used for ballasting purposes)
- In case of leakages, emptying a tank
- Pumping to shore via bunker connection.

Drainage tank + discharge pump



Methanol storage tanks

example: container vessel

Tank Connection Space on each tank, including all tank valves and instrumentation for tank monitoring:

Service/day tank –to be situated above LPPS!

Fuel Preparation Room for 4x W32M, including:

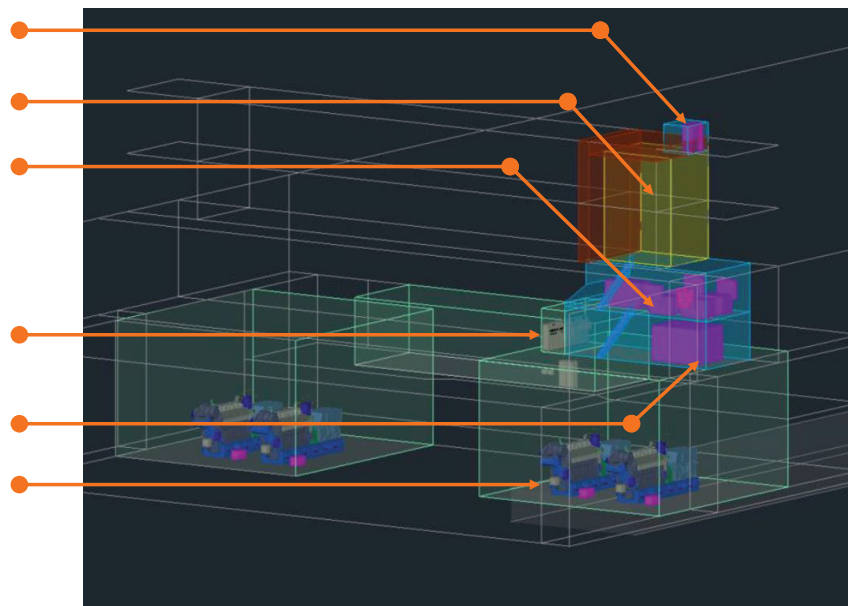
- 1x Combined 2S/4S Low Pressure Pump Skid
- 4x wall-mounted Fuel Valve Trains
- 4x Methanol Fuel Pump

Fuel Control Room, including all methanol fuel system related motor starters, VFD's, control boxes, remote IO and pneumatic valve cabinets

Fuel Preparation Room for 1x 2S main engine

Engines + OPU + motor starter

Drainage tank + discharge pump (location TBD)



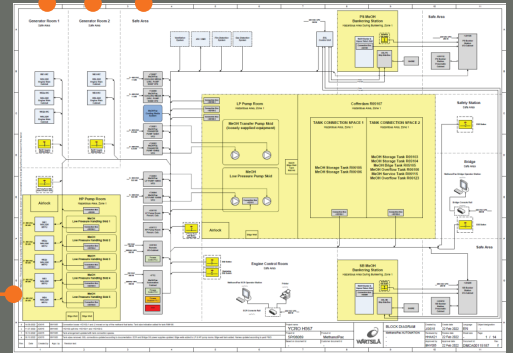
MethanolPac automation & safety system

Fuel supply system – control & safety automation + ESD handling

With IGF as a base for the design of a MeOH fuel system on board a vessel and many similarities to a LNG system setup, Wärtsilä is having by far most experience with the complex automation systems around the fuel supply system!

Aside of complete control of MeOH fuel supply system, Wärtsilä's automation is fully interfaced with all auxiliary systems i.e. ventilation, fire/gas detection, Ship to Shore System, Ship's IAS

- Dedicated fuel supply system automation;
- Fully integrated solution;
- Serial interfacing with IAS;
- Optimized interfacing and auxiliary power consumption with Wärtsilä W32M;



Wrap up

Key technologies – Future Fuel



COMMON RAIL FUEL INJECTION

New generation fuel injection technology with high pressures for optimum combustion. Optimized fuel injection settings for each operating point. Smokeless operation in all conditions.



2-STAGE TURBOCHARGING FOR DF

High efficiency turbocharging with reduced losses for increased engine efficiency and lower emissions. Enabling more power.



VARIABLE VALVE TIMING OPTIONS

Variable inlet and exhaust valve-timing options. Both stepless and on-off type available. Valve timing flexibility is an enabler for future fuels and low emission optimization.



FUEL SYSTEM

Pressure balancing systems for reduced losses and increased accuracy. Quick reaction for dynamic load control.



AUTOMATION SYSTEM

Combining all systems together including safety and controls.

References

MeOH powered vessels



SAL Heavy Lift – Orca class
 WUHU shipyard
 5 vessels confirmed
 2x W6L32M VS CPP
 Wärtsilä NOR SCR
 Wärtsilä MethanolPac
 Maintenance agreement
 Delivery Q3/2023

Van Oord – Jack up vessel
 YANTAI RAFFLES shipyard
 5x W6L32M CS GenSet
 Wärtsilä NOR SCR
 Wärtsilä MethanolPac
 Retractable & Tunnel thrusters
 Delivery Q2/2023



Bunkering Skid

Pre-assembled with bunker & vapour return

Skid design based on Wärtsilä's standard and experience from LNG installations, with SGMF guidelines as a base and adapted to specific needs of methanol-fuelled vessels;

- Standard design diameters* from 2"/DN50 to 8"/DN200;
- Easy expandable with multiple connections for higher bunkering flows;
- Designed for fully remote bunkering operation and purging procedures;
- Class validated purging arrangement, including double block and bleed arrangement;
- Necessary draining connections for safe handling of the fuel;
- Include separate delivery of remote I/O cabinet, pneumatic valve cabinet. Optional Local Operator Panel and Ship-to-Shore Link System (USL/ESD).

NOTE: larger pipe diameters are not recommended – related to hose handling constraints and excessive costs of on-board double-walled piping;

Low Pressure Pump Skid (LPPS)

Function of Low Pressure Pump Skid: Pumping fuel from storage tanks or service/day tank and boost-up the pressure to the required inlet pressure of the high pressure MFPU.

- One skid can serve all engine consumers;
- Dependent on redundancy requirements, the unit includes:
 - 1 or 2 low pressure fuel pumps;
 - Methanol cooler;
 - Remote operated and manual shut-off valves;
 - Manual shut-off valve;
 - Remote operated double block and bleed arrangement;
 - Connection to recirculation line after pumps for excessive flow;
 - Connection box for interfacing to MethanolPac automation. Designed for fully remote-controlled operation.

NOTE: unit to be installed in Fuel Preparation Room – hazardous zone 1

Low Pressure Pump System (LPPS) for 2S ME + 4S AE's

- One skid for all engines (1x main engine and 4x W32M auxiliary generator sets), including:
 - M/E line: 2x pumps (one LP, one booster), methanol heater, filter
 - A/E line: 1x LP pump, methanol cooler
- Pumps can be redundant if required.
- Separate media systems for fuel temperature control:
 - For M/E connected to LT CW system
 - For A/E's connected to a dedicated system with cooling unit

Fuel Valve Train

(FVT) – space saving wall or remotely mounted

Function of Fuel Valve Train: Segregating fuel feed between low pressure pump system and MFPU. Acting as an safety device in case of an Emergency Shutdown (ESD) situation;

- Common duplex filter for all fuel lines to consumers;
- One FVT per fuel line / consumer,
- Completely pre-assembled Fuel Valve Train includes:
 - Remote operated master fuel valves;
 - Manual shut-off valve;
 - Remote operated double block and bleed arrangement;
 - Flowmeter;
 - Connection box for interfacing to MethanolPac automation. Designed for fully remote-controlled operation.

NOTE: unit to be installed in Fuel Preparation Room – hazardous zone 1

Methanol Fuel Pump Unit (MFPU)

Function of Methanol Fuel Pump Unit : Boost-up the fuel pressure to the actual engine load dependent injection pressure.

- Multi-stage piston pump, one for each engine;
- To be installed outside Engine Room, in a hazardous space;
- Delivery pressure up to 600bar;
- VFD* driven by local control cabinet with input from EAS**;
- Leakage collection system included;
- On unit installed lube oil cooler;
- Pulsation damper;
- Special connecting block for double-walled piping.
- Connection box for interfacing to Engine and MethanolPac automation. Designed for fully remote-controlled operation.

NOTE: unit to be installed in Fuel Preparation Room – hazardous zone 1

* Variable Frequency Drive
** Engine Automation System

Sealing & control oil pump unit

- Enclosed unit ready for installation in Engine Room, one for each engine
- Oil inlet from engine's lube oil system
- Sealing oil delivery pressure up to 700 bar
- Control oil delivery pressure up to 400 bar
- Duplex filter before the pumps
- Direct cooling with proper room air ventilation



44. ISF-Tagung 23. Juni 2023



Winterthur Gas & Diesel Ltd., Schützenstrasse 3, 8401 Winterthur, Switzerland

12X92DF Service Experience

Konrad Räss

The X92DF engine is the biggest engine in WinGD's X-DF family and its 12-cylinder version is acknowledged to be the biggest Otto cycle engine in the world, as documented by the corresponding entry into the Guinness book of records. This dual-fuel engine has been developed by Winterthur Gas & Diesel on the basis of the existing X92 Diesel engine platform, adopting proven design principles, concepts and technologies from the successful range of smaller X-DF engines. Same as these, the X92DF can be operated on LNG, distillate, and residual fuels. A fuel sharing mode between gaseous and liquid fuel is also possible.

The scaling up of DF technology to this large engine size was not without challenges; however, teething problems observed on the first engines could be resolved in the context of an extensive validation program, which could be completed successfully before the first 12X92DF engines, rated 63840kW at 80 rpm, were installed in the CMA CGM 23000TEU container vessels of the Jacques Saadé class. A series of nine 23'000 TEU container vessels was built, and the first ship of this series was delivered in Sept 2020.

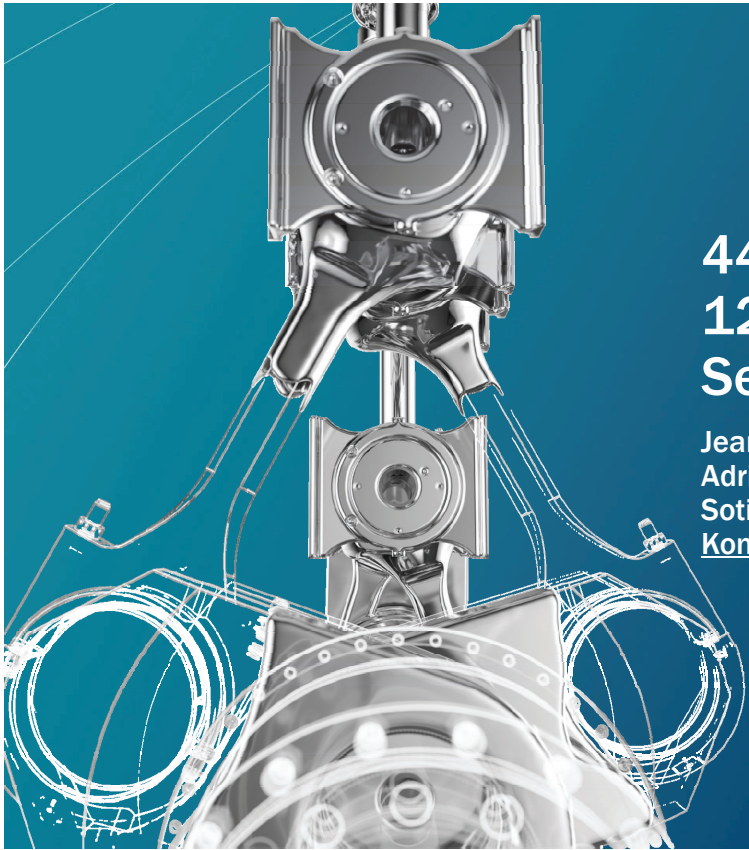
As of January 2023, 16 engines are in service, including 12, 10- and 9-cylinder configurations. These engines have accumulated more than 120,000 running hours, with more than 70,000 hours running on gas.

The engines have been closely observed in operation by board attendance during the first voyages. An extensive field follow-up program was implemented based on regular checks to analyse engine component conditions and running behaviour. The engine performance is monitored by WinGD's Data Collecting Monitoring (DCM) and WiDE system for online data transfer, allowing fast data analysis, root cause identification and definition of countermeasures in case of problems.

So far, no significant issues have been reported requiring a re-design of engine components or features since the engines entered operation. According to expectations, the inspection results reveal good conditions of all mechanical components.

The results even allowed the initiation of a lubrication oil feed rate optimization campaign together with the operators. Under close observation of the engine behaviour the lubrication feed rate could be reduced showing stable operation in both gas and diesel mode, allowing a significant reduction of operational cost.

This presentation will give insights into the service experience of the first X92DF engines in the field. A special focus will be set on the engine performance in the field. It will be shown how the teething problems have been sorted out by dedicated root cause analysis using WinGD's WiDE system for the local and remote data collection and analysis. Finally, the cylinder oil optimization programme test results and achievements will be described.



44. ISF 12X92DF Service Experience

Jean Noel Constantin
Adrian Siegfried
Sotiris Topaloglou
Konrad Räss

WIN GD

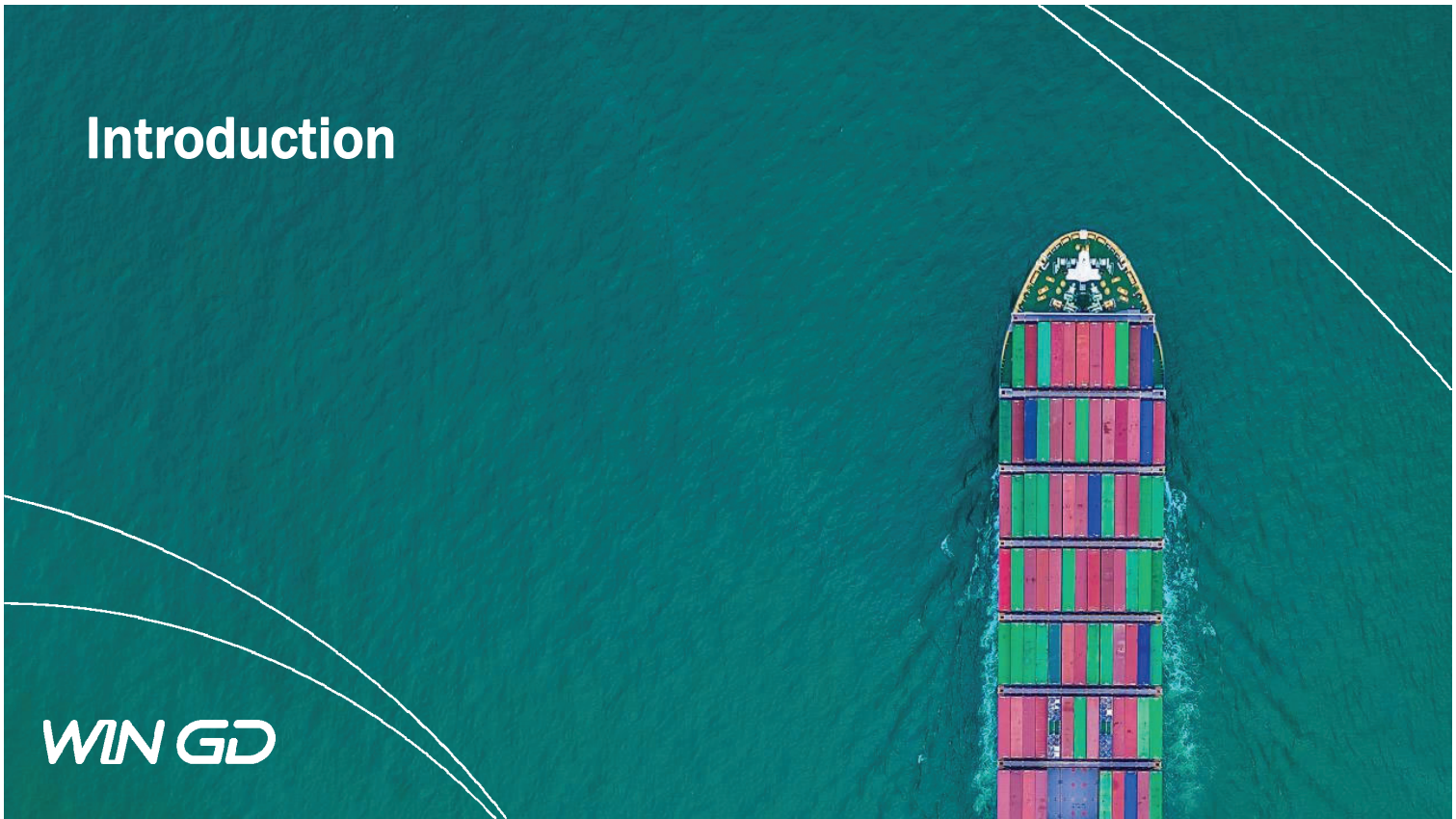
Presentation Outline

WIN GD

- | | |
|---|---|
| 1 | Introduction |
| 2 | Insights into a our root cause analysis process (RCA) |
| 3 | Service experience |

Introduction

WIN GD



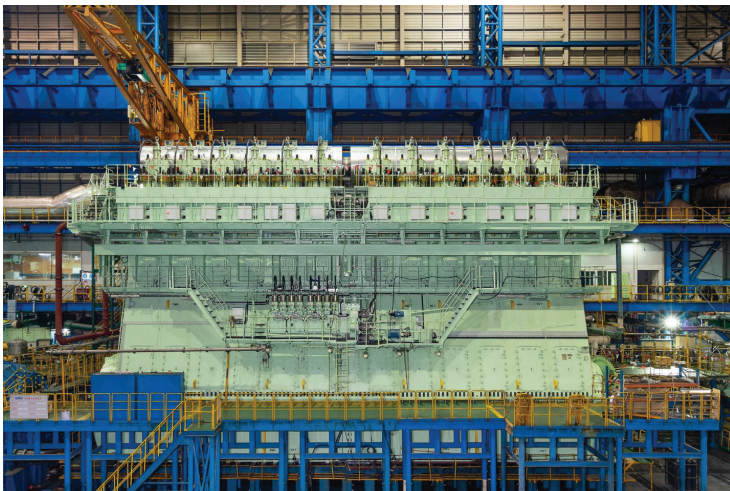
12X92DF Service Experience

WIN GD

Introduction

Engine at CMD

Start service from Hudon Zhonghua SY, Sept. 2020



Approx. 15'000 running hrs (Mai 2023)

12X92DF Service Experience

WINGD

Introduction

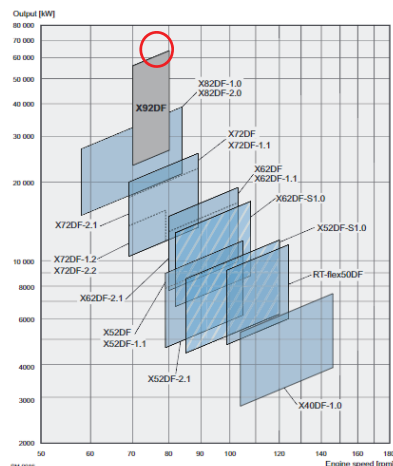
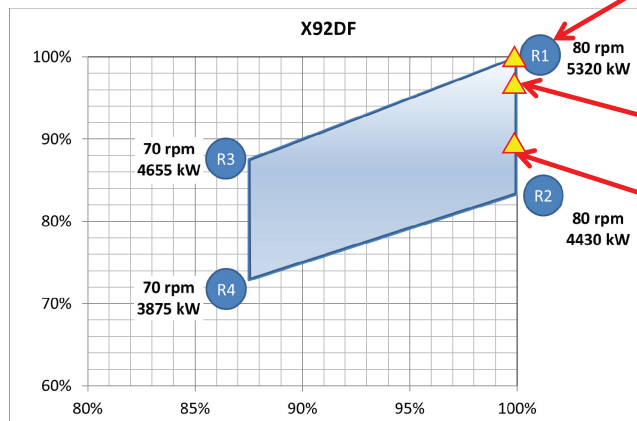


Figure 1-1 Power/speed range of the WinGD X-DF engines



9x 12X92DF

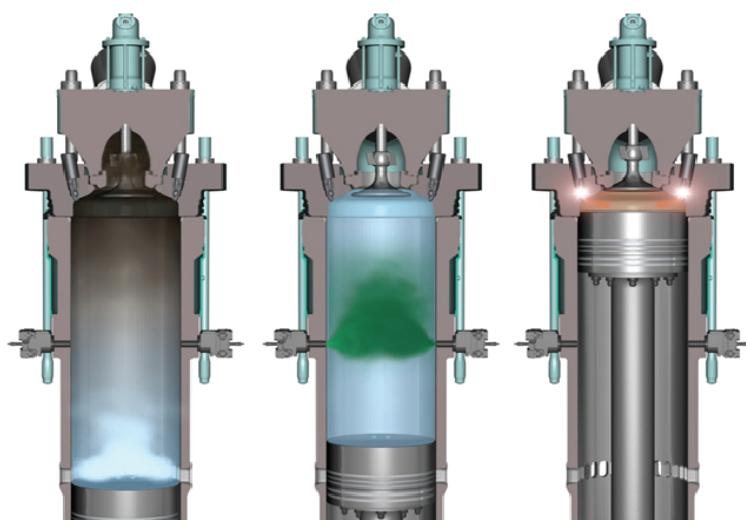
5x 10X92DF

2x 9X92DF

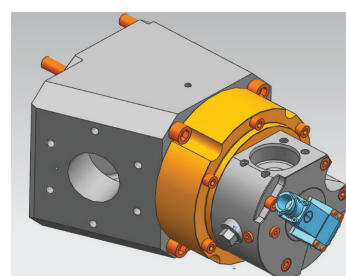
12X92DF Service Experience

WINGD

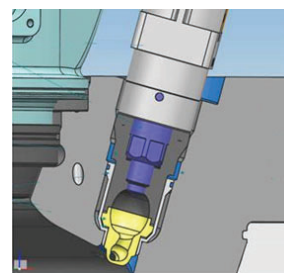
Introduction, Dual-fuel (DF) principle



WinGD DF Otto cycle principle



Gas Admission Valve (GAV)

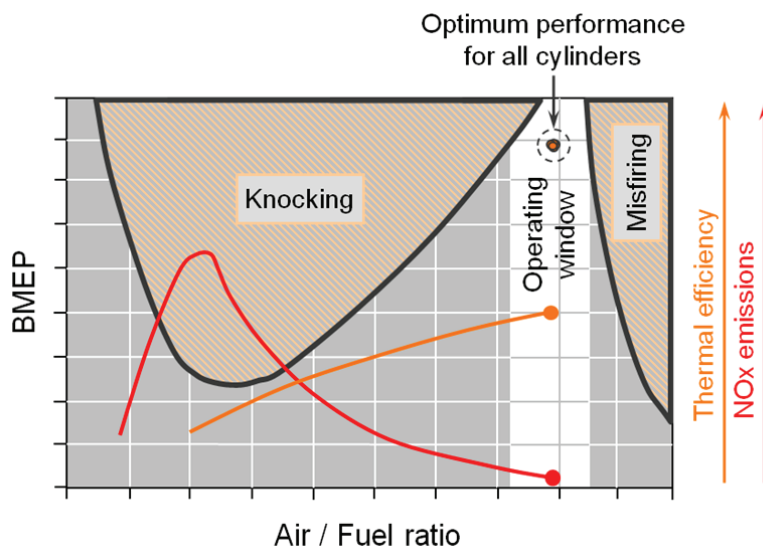


Pilot injector with pre-chamber

12X92DF Service Experience

WINGD

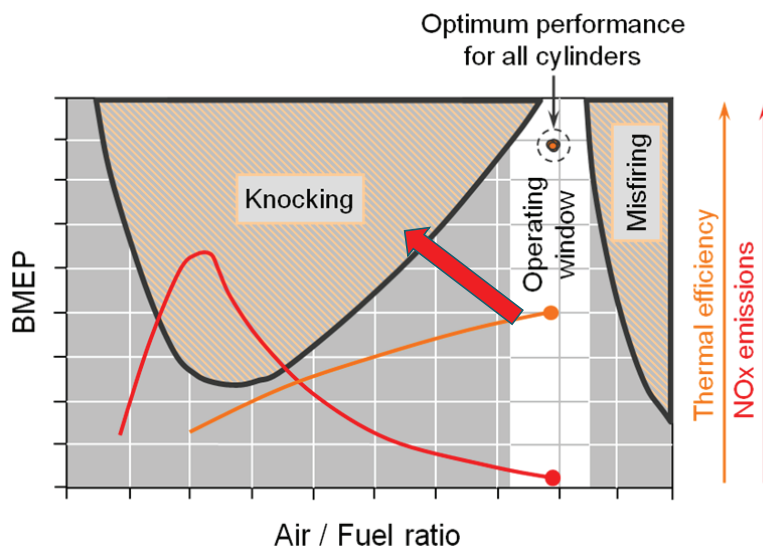
Introduction, air to fuel ratio (Lambda) requirements



12X92DF Service Experience

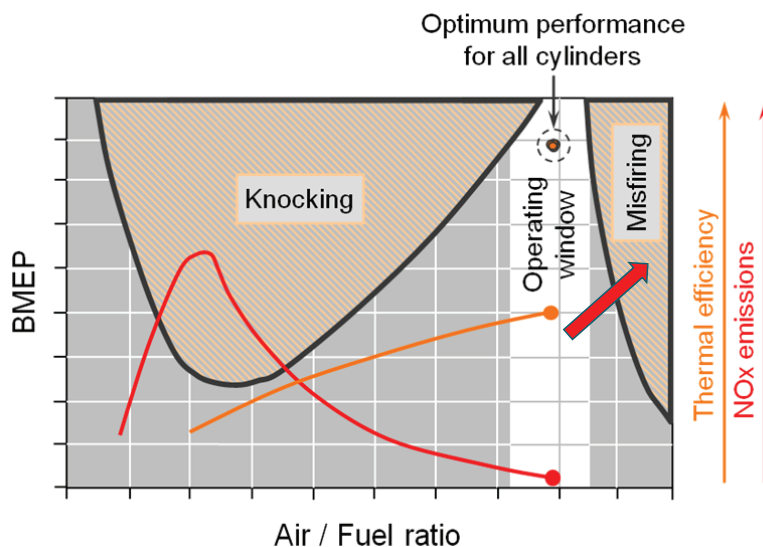
WINGD

Introduction, air to fuel ratio (Lambda) requirements



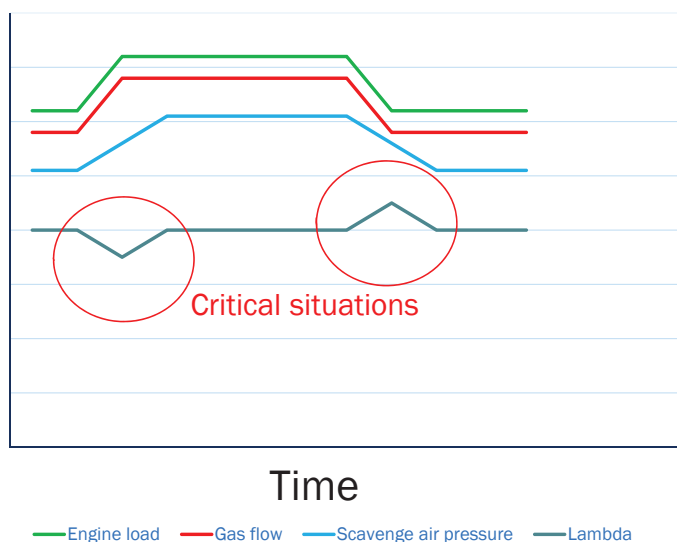
12X92DF Service Experience

Introduction, air to fuel ratio (Lambda) requirements



12X92DF Service Experience

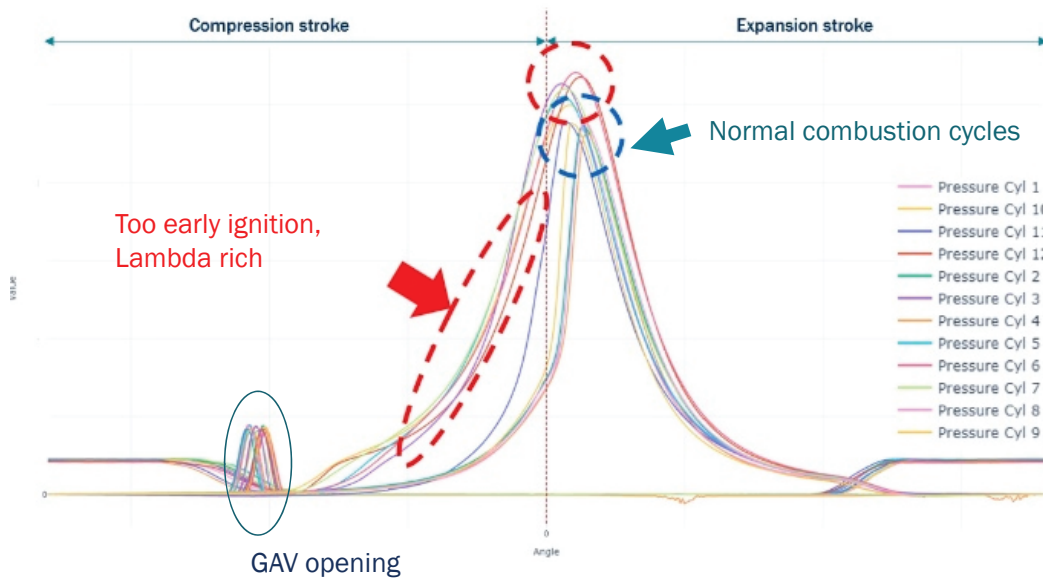
Impact of sudden load changes on the air to fuel ratio (Lambda)



12X92DF Service Experience

WINGD

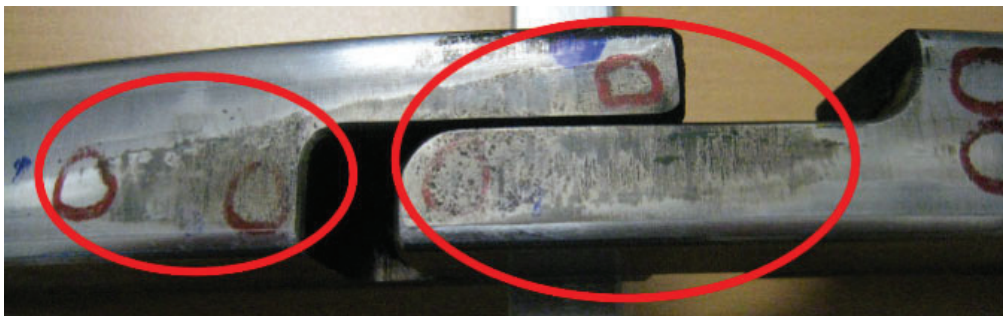
Introduction, example of early ignition cycles



12X92DF Service Experience

WINGD

Introduction, impact of too high thermal load on top piston ring



Abrasive and adhesive wear of piston rings and cylinder liners after combustion instability events

Insights into our root cause analysis process

WIN GD

12X92DF Service Experience

WIN GD

WiCE control system

Similar modular design and functional units as with UNIC and WECS-9520

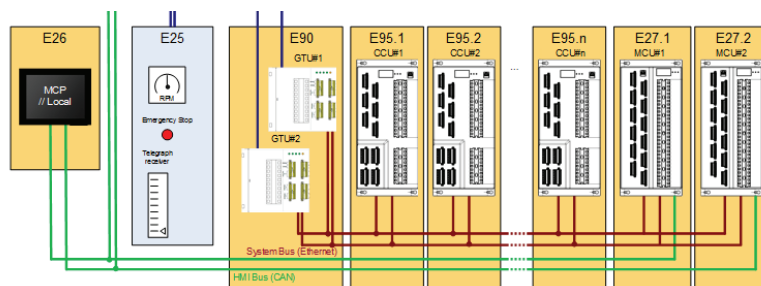
Advantages of WiCE

Modern electronic components with increased CPU power

Improved user interface

Enables remote monitoring

First time introduced on 12X92DF, since then rollout to portfolio.



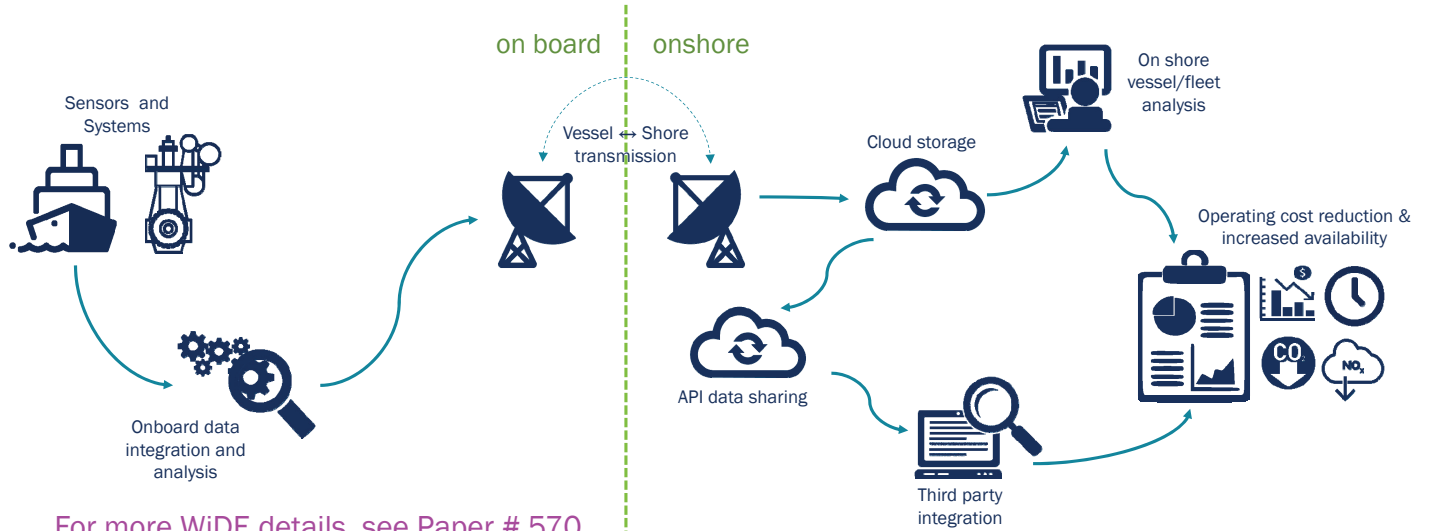
See paper no. 165,
Cimac congress 2019

12X92DF Service Experience

WINGD

WiDE, providing constant support on board and onshore

>500 signals continuously collected and used for real time monitoring and advisory



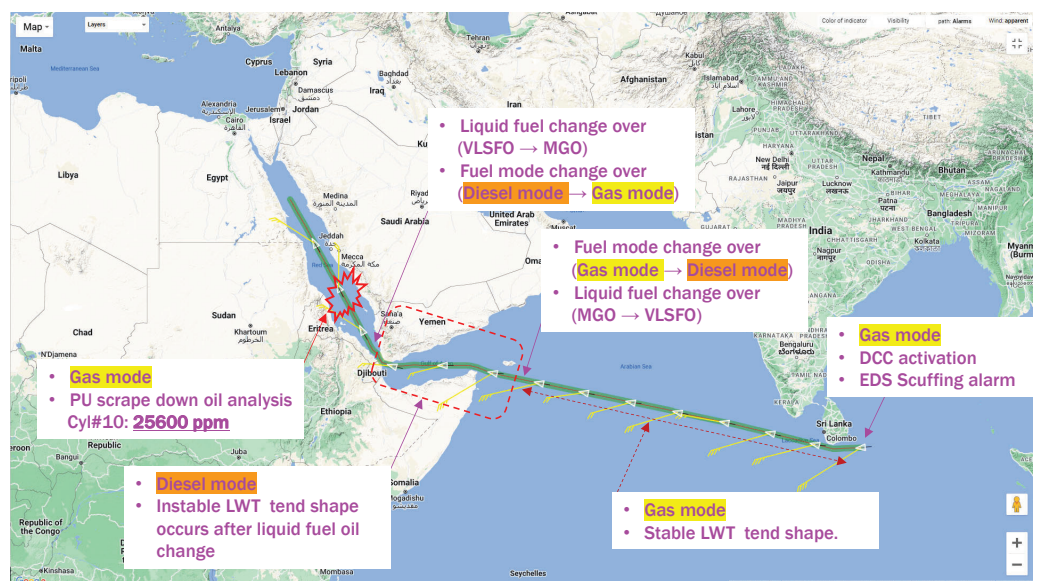
For more WiDE details, see Paper # 570

12X92DF Service Experience

WINGD

WiDE, event summary on map, example A

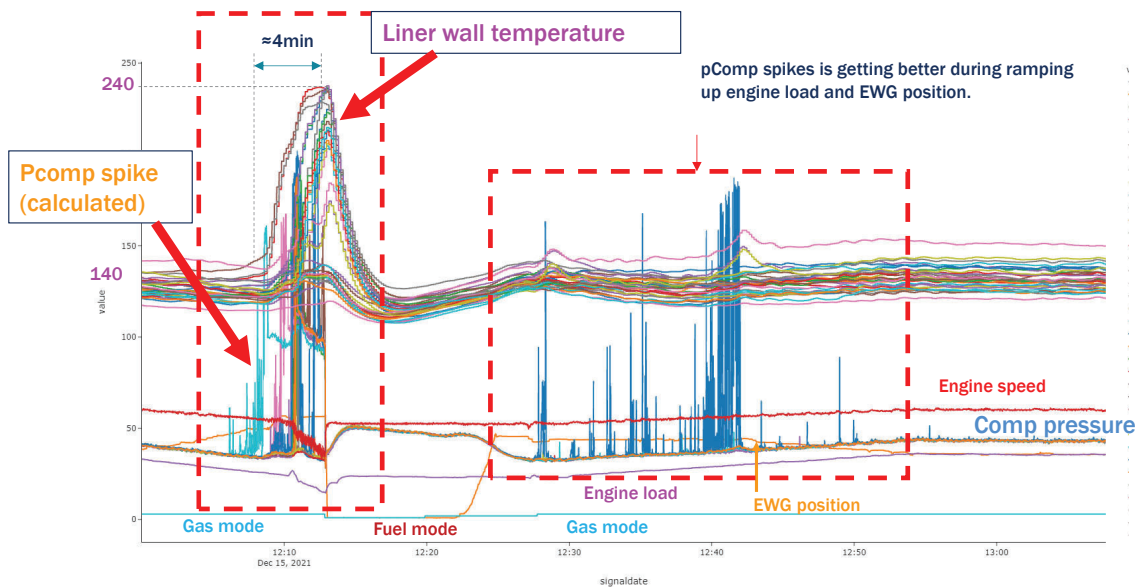
- Using WiDE data, all possible signals were evaluated
- Various data patterns were identified
- The triggers identified fast ruder changes, related many times to the sailing route
- The root cause was identified to be related to combustion instability events



12X92DF Service Experience

WINGD

WiDE, event summary, example B

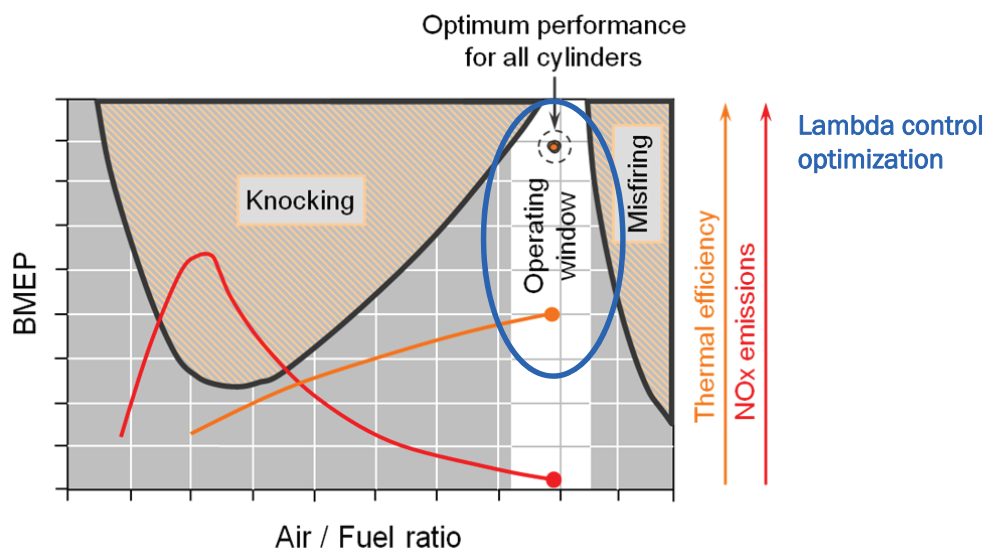


- Data evaluation after an event
- Abnormalities detected in the red-dotted points
- Combustion instability in gas mode, coupled with spikes of 100 °C within a few minutes
- Thermal stress on engine components
- Scuffing was reported shortly after

12X92DF Service Experience

WINGD

Solution, stabilisation of lambda values by improved software control function



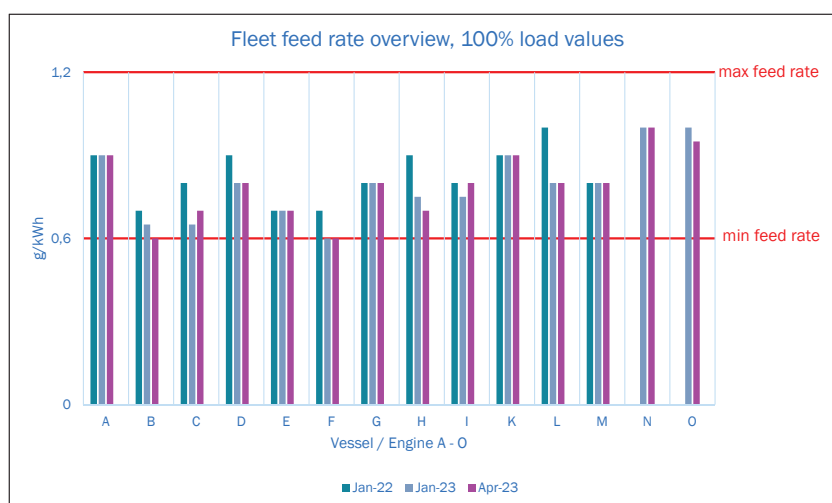
Service experience

WIN GD

12X92DF Service Experience

WIN GD

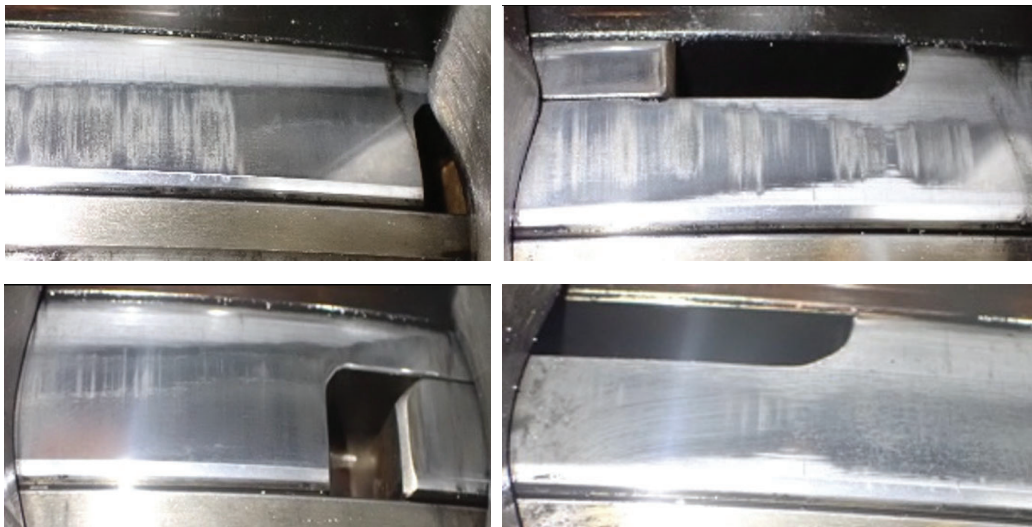
Less oil feed is more (less costs and deposits)! BN40 – 60 cylinder oils in use



12X92DF Service Experience

WINGD

Improvements, Piston Ring Recovery, MEH 12'370h (Jan 23)



12X92DF

Scoring and hard contact marks

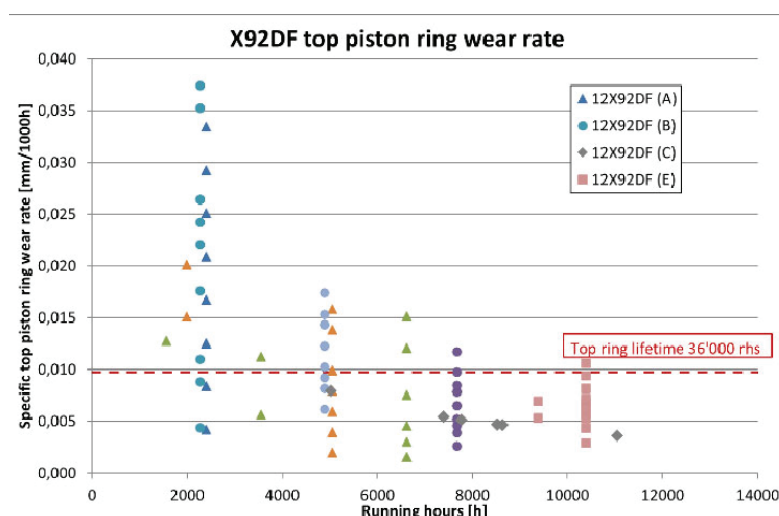
2'748 h later

Well recovered

12X92DF Service Experience

WINGD

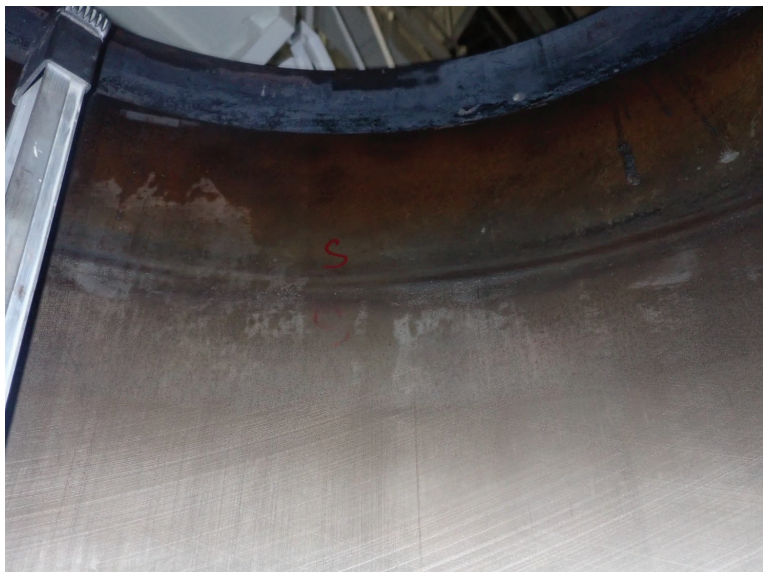
Improvements, Piston Ring wear rate trends



12X92DF Service Experience

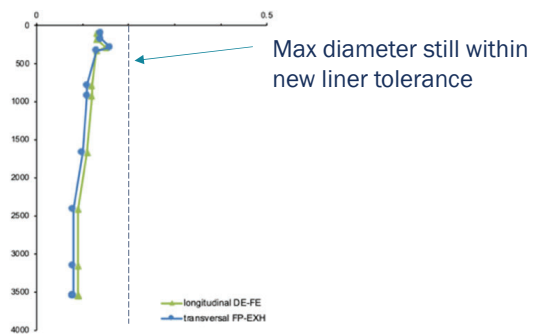
WINGD

Cylinder liner, lowest wear rates, MEH 12'370h (Jan 23)



12X92DF

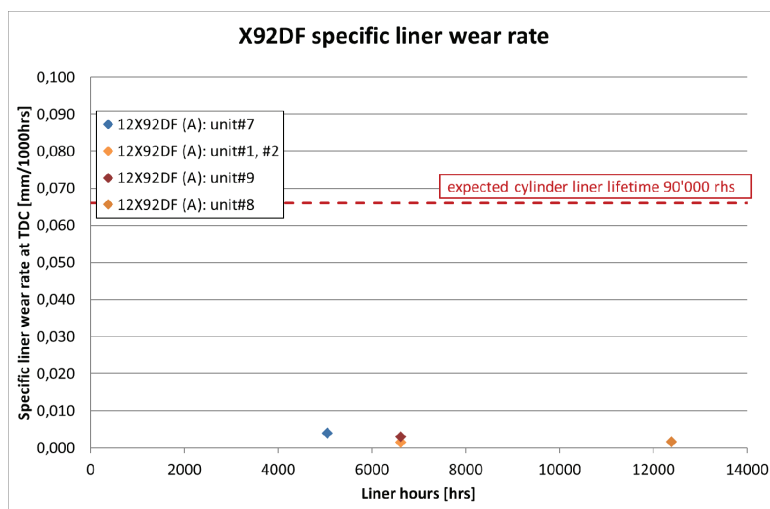
- Honing marks visible near to the top
- Liner wear rate 0.002 mm/1000h
- Estimated lifetime. 3'000'000 h



12X92DF Service Experience

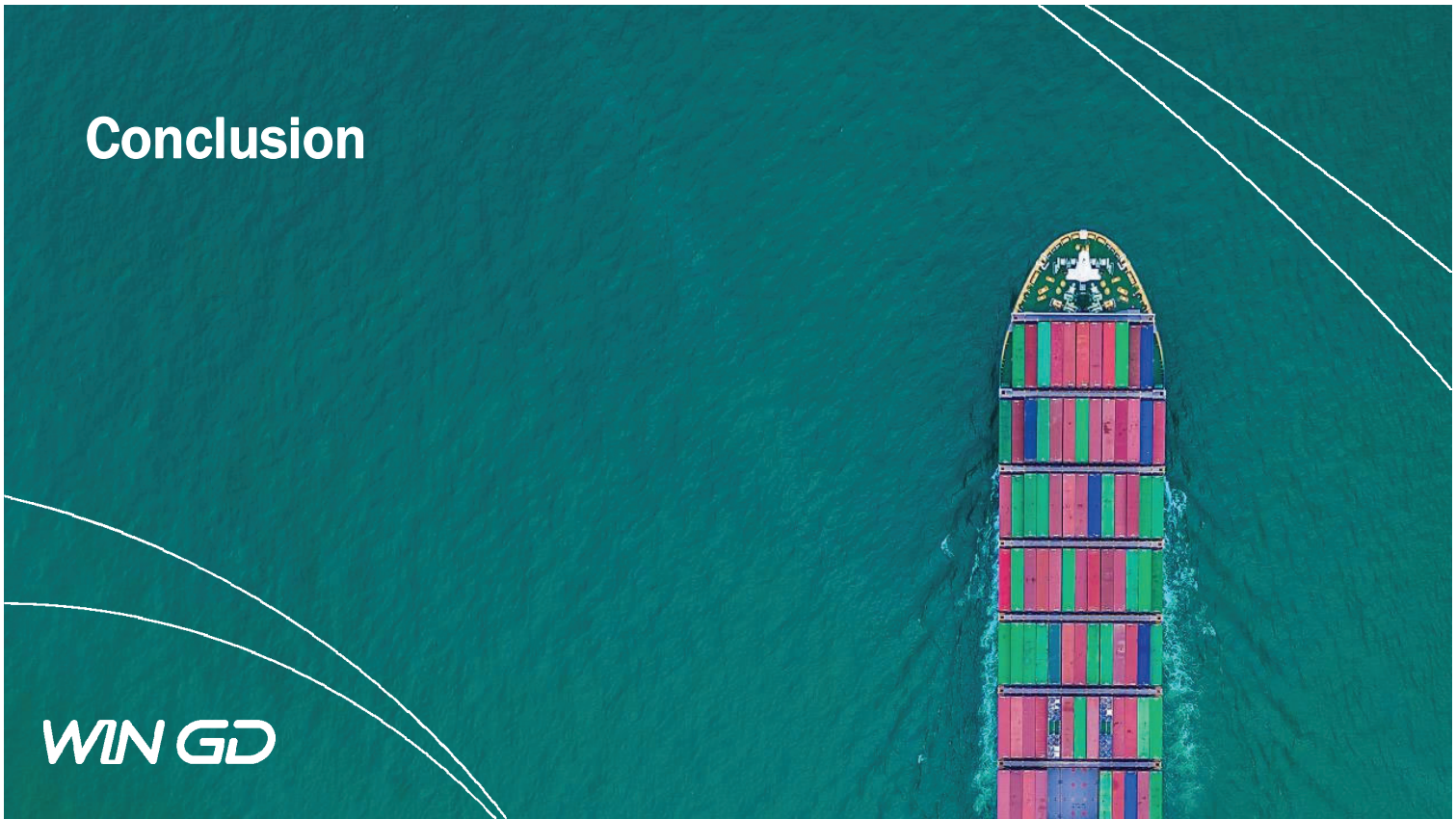
WINGD

Cylinder liner, lowest wear rates



Conclusion

WIN GD

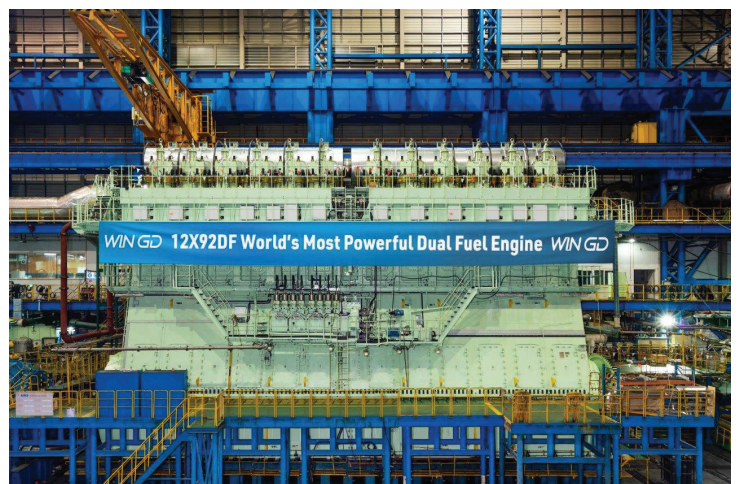


12X92DF Service Experience

WIN GD

Conclusion

- There will always be technical challenges with newly developed engines. Working together including all stakeholders is a must
- Investigations and conclusions must always be based on facts and data, WiDE is a great help
- No redesign of mechanical components was necessary
- The findings from the X92-DF have been included in the design of other engines



12X92DF Service Experience

WINGD

Final remarks from Customer

Quote

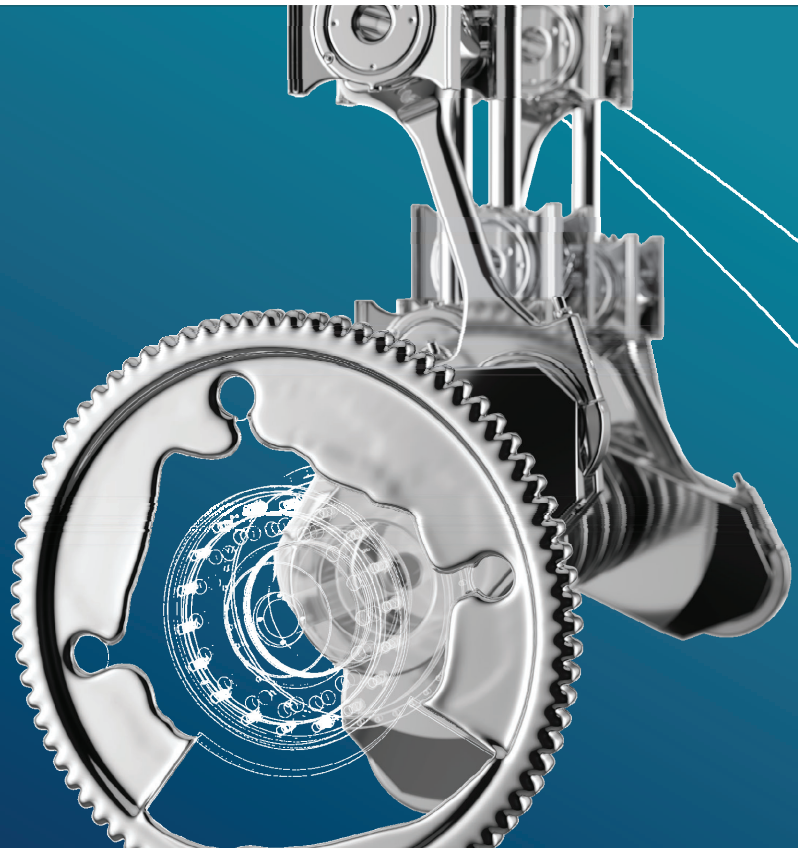
“We are proud to own and operate our 14 LNG vessels fitted with X92DF engines. The fine tunings faced at the delivery are now behind us and the engines can be operated at every load without any issue.”

CMA CGM, 10.02.2023

Thank you

Konrad Räss
WinGD Ltd.
Schützenstrasse 3
8400 Winterthur, Switzerland
Konrad.rass@wingd.com
www.wingd.com

WINGD





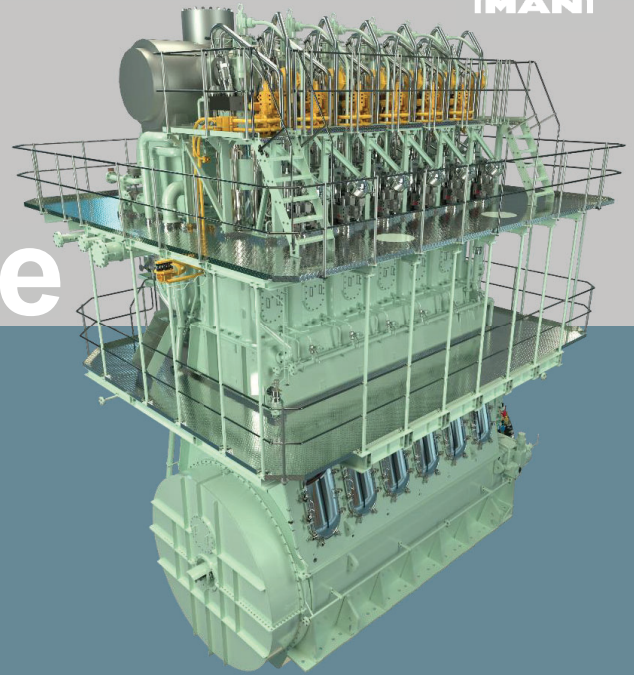
44. ISF-Tagung 23. Juni 2023

MAN SE Copenhagen, DK

Latest service experiences of lubrication oil and wear of conventional and dual fuel engines
Kristian Mogensen

ISF Conference

Service experience
with low S% fuels

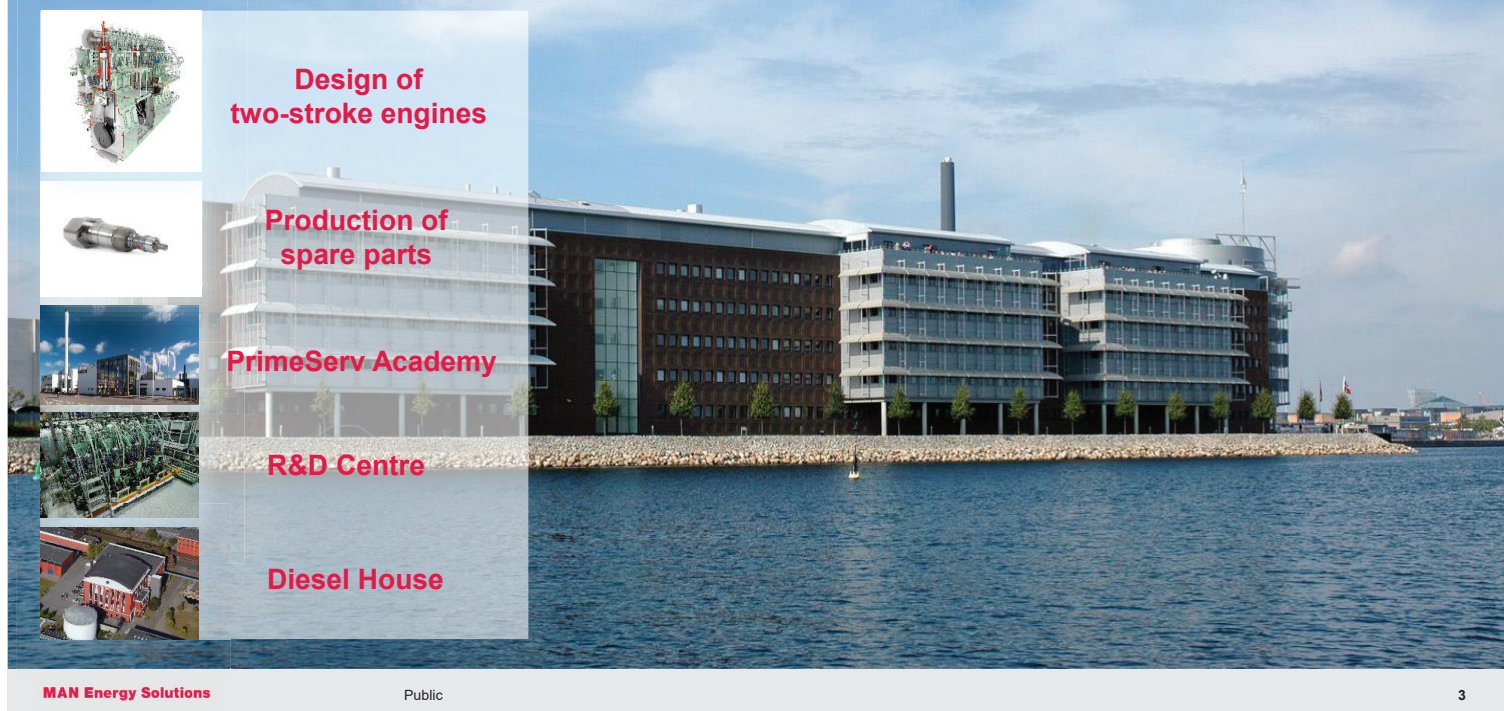


Agenda

- 1** Introduction to MAN-ES (two-stroke)
- 2** Status on low Sulphur operation



The world's leading designer of two-stroke Diesel engines



Design of two-stroke engines

Production of spare parts

PrimeServ Academy

R&D Centre

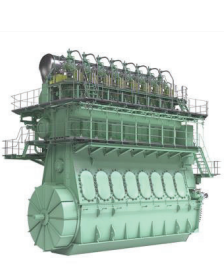
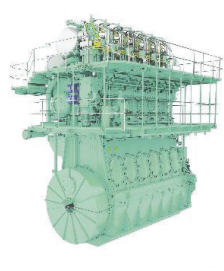
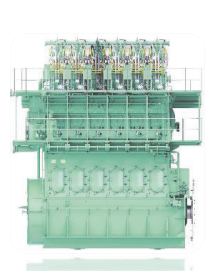
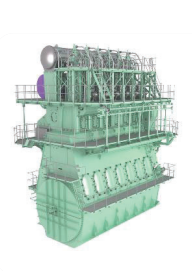
Diesel House

MAN Energy Solutions

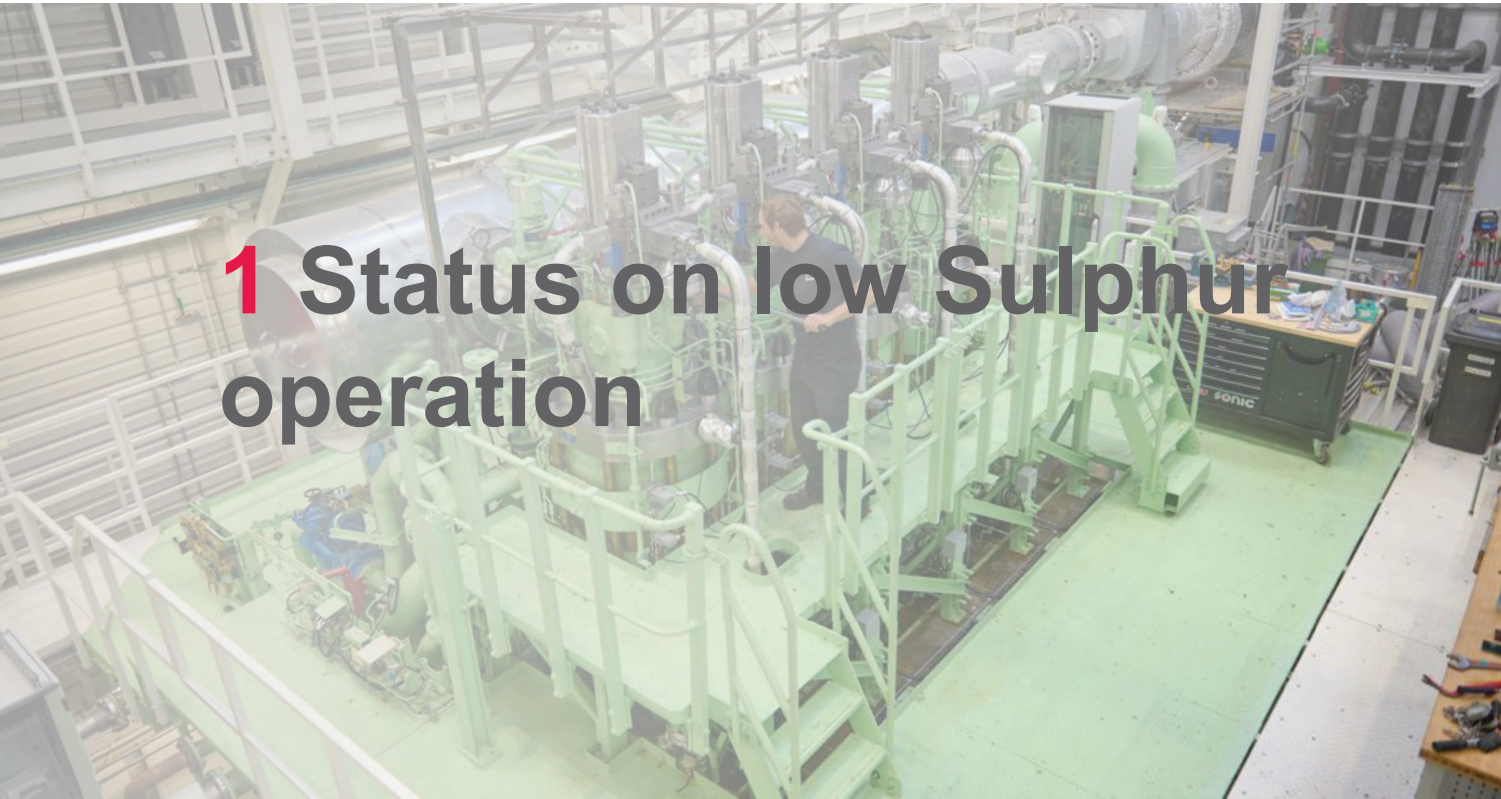
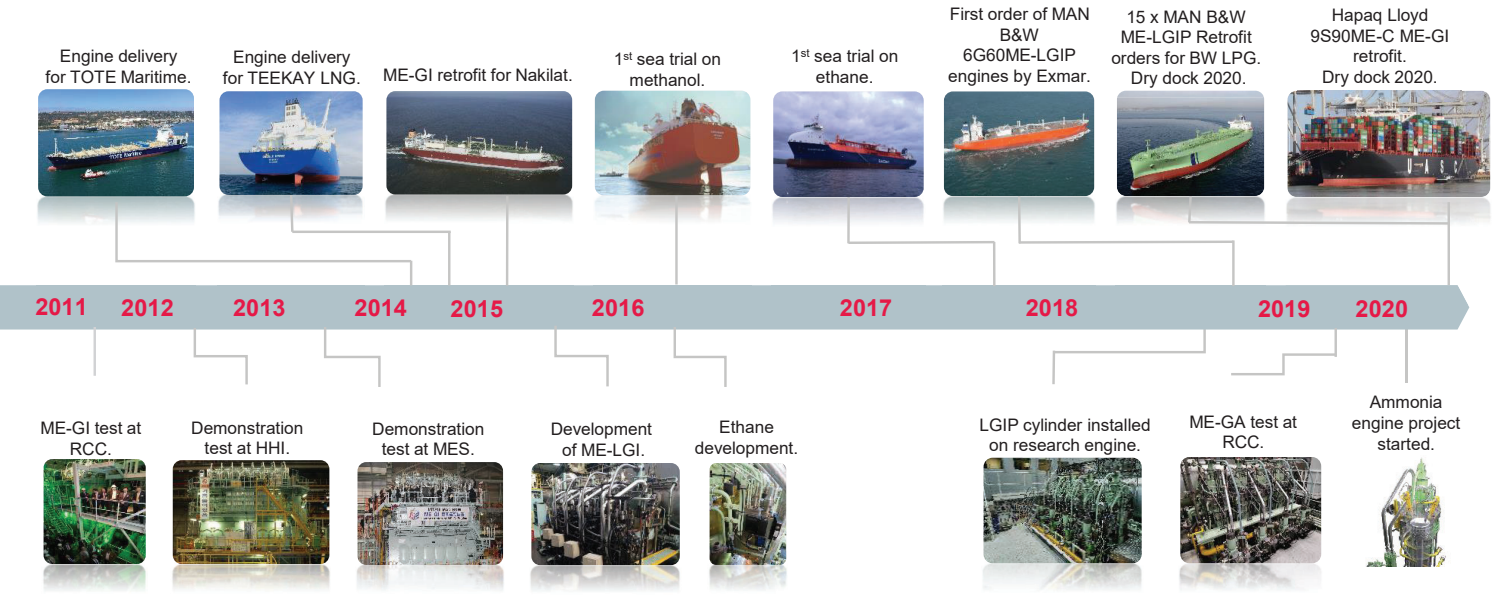
Public

3

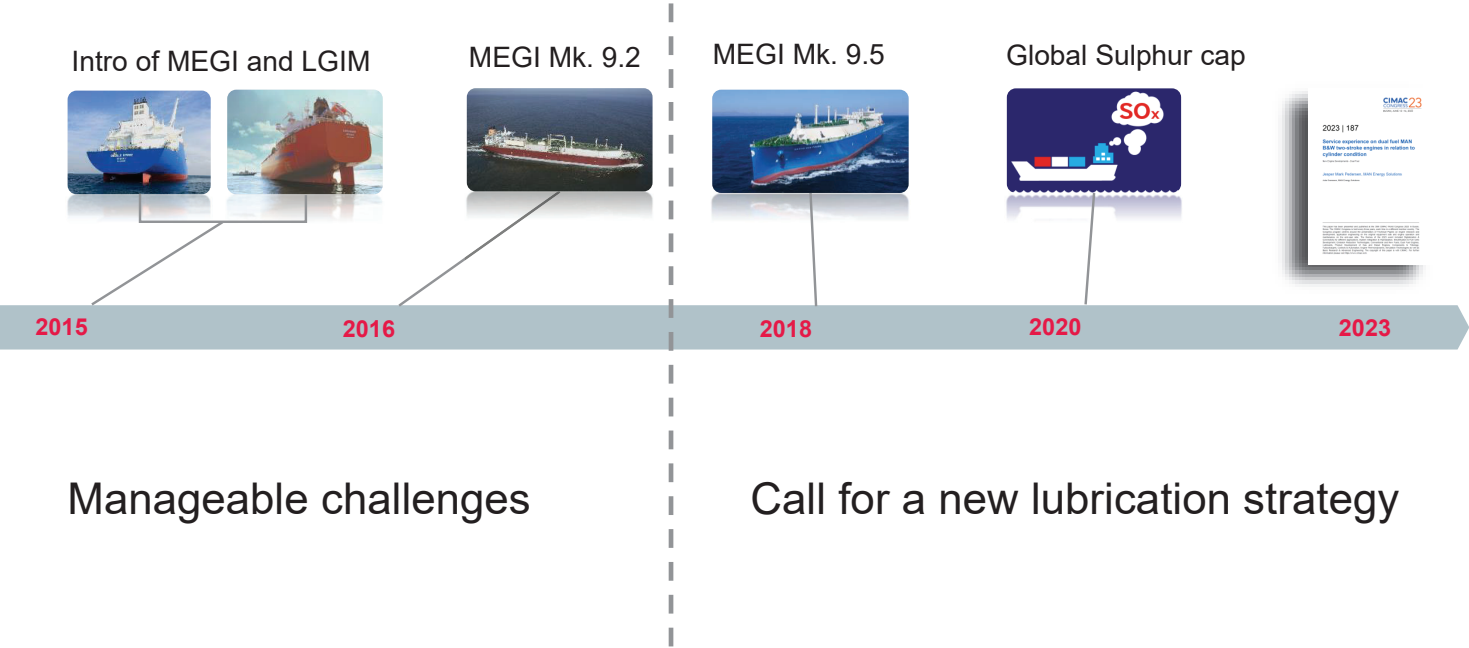
ME-GA in the aspect of the MAN B&W dual fuel portfolio

LNG		Ethane	Methanol	LPG	Ammonia
ME-GI	ME-GA	ME-GIE	ME-LGIM	ME-LGIP	→ 2024
					

MAN B&W two-stroke engines for alternative fuels

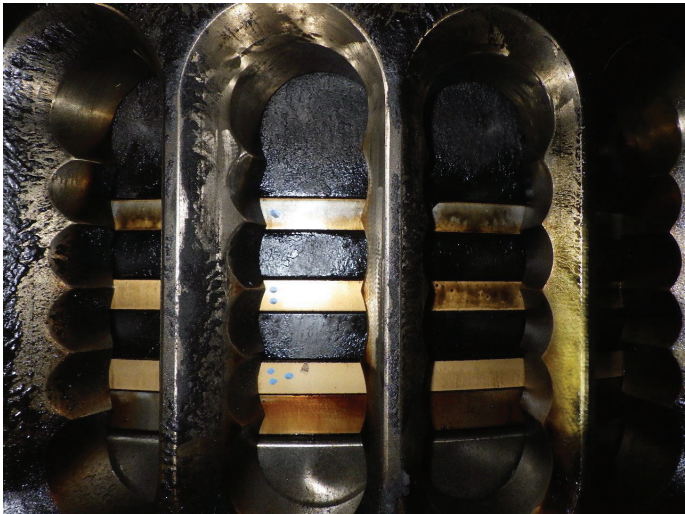
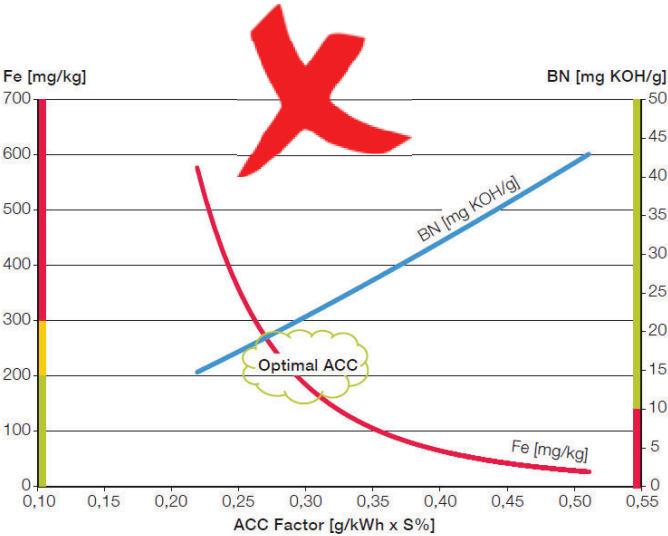


Introduction of low Sulphur fuels as predominant fuel



New fuel era, New focus area

Detergency as dominant factor of evaluation



Limitations

New challenges

- Stuck piston rings,
- build up of deposit in ring grooves

Leading to premature piston ring exchange



Solutions

New challenges

Engine Design solutions

New piston ring configuration, aiming at less gas flow into the ring package.

- Less gas
- Less oil stress (Thermal)
- Less pressure loss

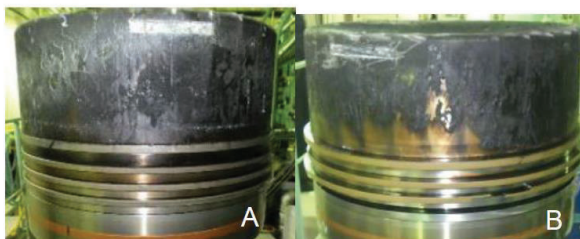


Figure 2: Comparison between A. a four ring-pack and B. a three ring-pack on a ME-GI engine. The cleanliness is improved by the change of ring-pack.



Figure 1: Example of condition after test bed. A. using a low-BN cylinder oil. B. using a 70BN cylinder oil.

Cylinder Oil solutions

CLO Cat. 2

- Stronger cylinder oils
- Higher detergency

Solutions

Cylinder oil

The Step to Cat.2 meant to break the relationship between BN and cleanliness.

Giving lower BN grades same level of cleanliness as the higher grades have.

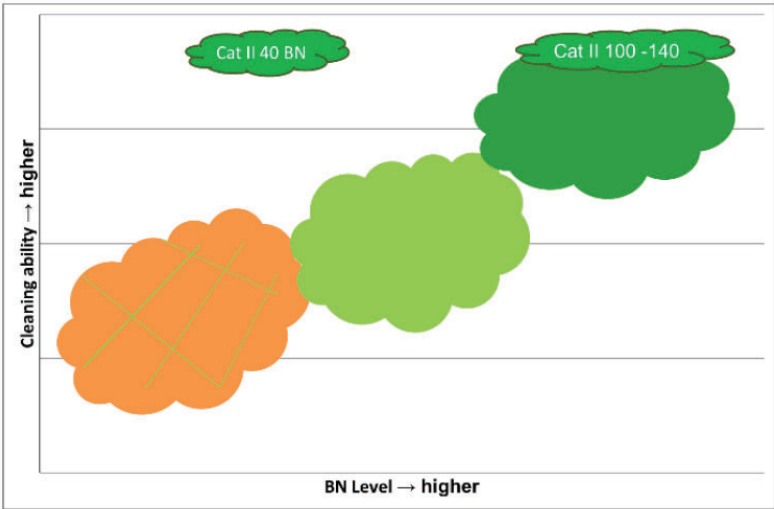
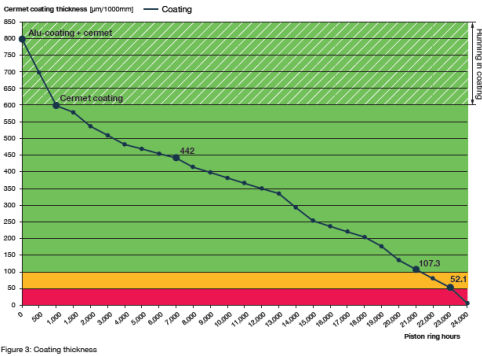
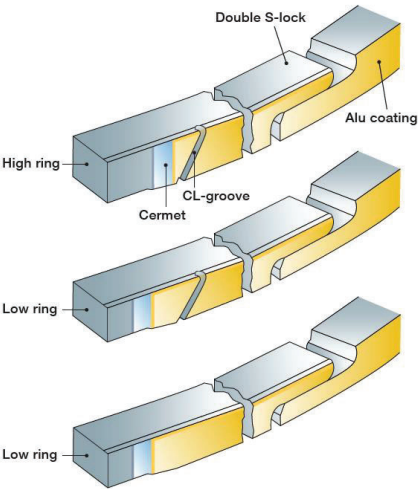


Figure 3 Schematic representation of the perceived relationship between BN level and cleanliness and the new category II 40 BN, 100 BN and 140 BN lubricants.

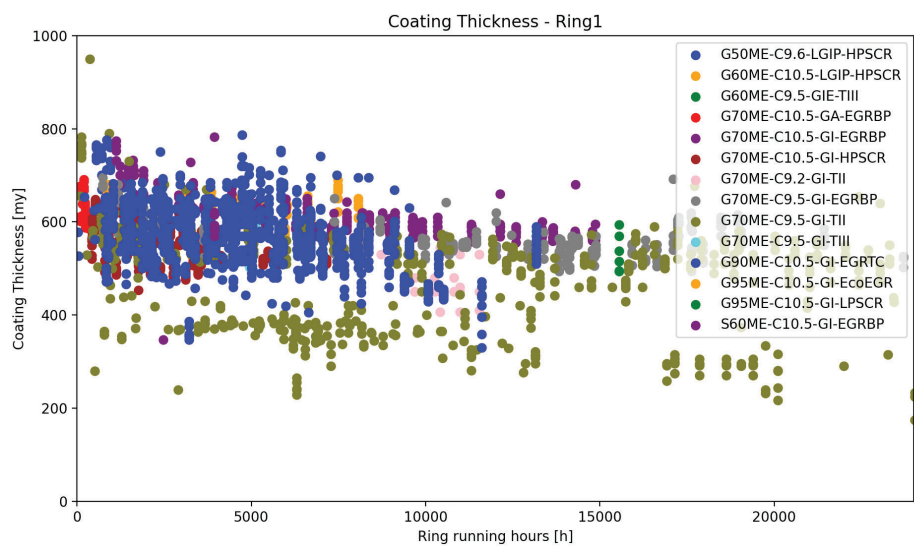
Solutions

Piston rings



Service Experience

Dual Fuel Time Between Overhaul (TBO)



Plot of top ring coating measurements for all Dual fuel engine types, over 24.000 piston ring running hours

Service Experience

Dual Fuel Time Between Overhaul (TBO)

TBO for piston units for 70 Bore Dual Fuel were increased from 16.000 RH to 24.000 RH in 2020 in light of the low wear seen.

But in fact the condition of the piston rings during overhaul at close to 24.000 RH show the possibility to go even further.

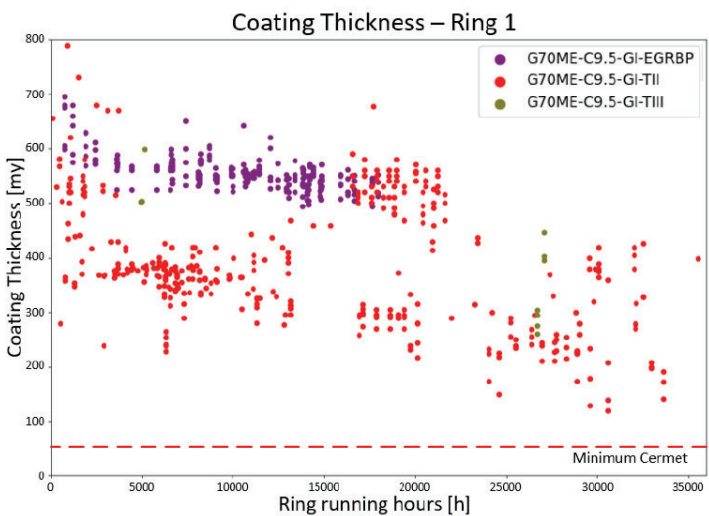
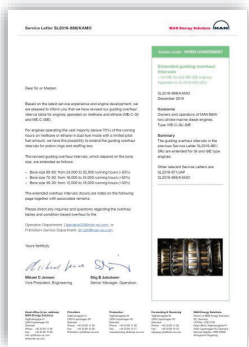


Figure 5 [G70ME-C9.5-GI] Cermet coating thickness on the 1st piston ring. Data points from 9 vessels which give 17 engines and a total of 85 cylinder units during 5 years in service.

Service Experience

Dual Fuel Time Between Overhaul (TBO)

Corrective Maintenance

Running until piston ring failure cannot be recommend as a maintenance strategy. Broken, collapsed or stuck rings increase risk of scavenge fire or other consequential damage.

Preventive Maintenance

This strategy is time based. The aim is low wear rates and the possibility to operate within the planned maintenance period, e.g. until dry-dock. A preventive maintenance strategy is to prefer when high availability of the ship is important or where main engine maintenance is difficult to arrange on short notice.

Condition Based Maintenance

The aim is to make the most possible use of the wearing parts, such as the piston rings. This strategy requires a trained crew that can record wear-down during inspections, and a supervision system that can record the measurement and evaluate the condition. This strategy is mainly for vessels where maintenance can be performed on short notice without interfering with the ship schedule.

Service Experience

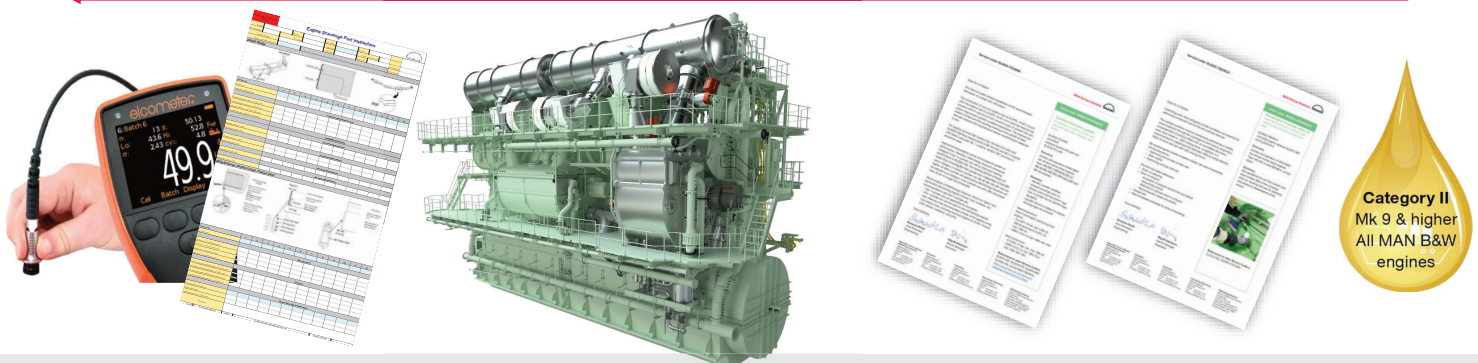
Dual Fuel Time Between Overhaul (TBO)

Observation
by Crew

Condition
assessment

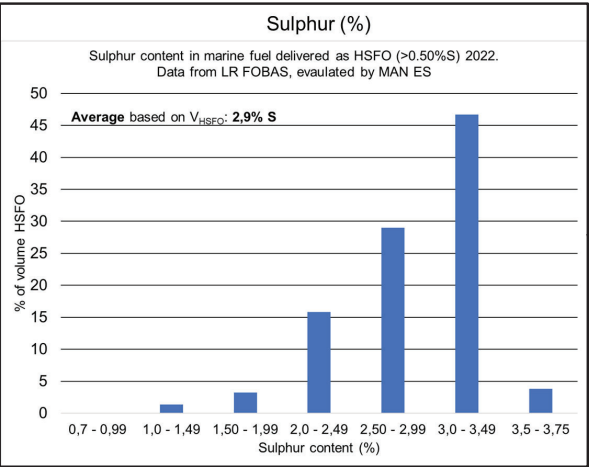
Condition
analysis

Corrective measures
(If needed)



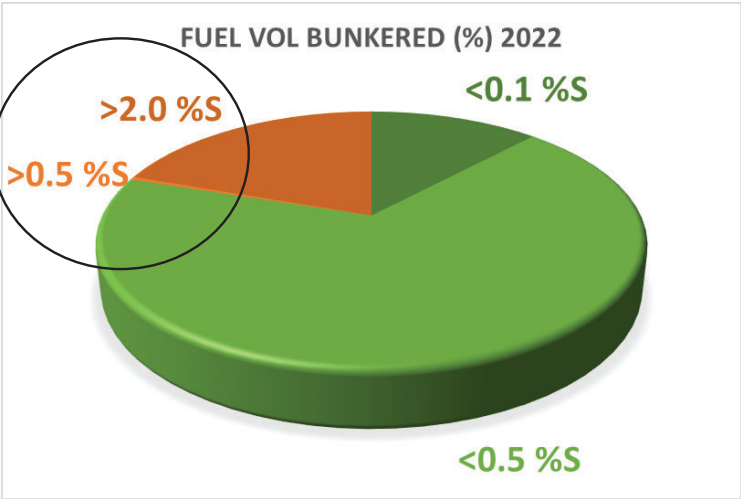
Fuel situation

Bunkered fuels 2022



Fuel bunkered in 2022:

- 20% >0.5%S
- 80% <0.5%S



Data from LR FOBAS evaluated by MAN ES

Disclaimer

All data provided in this document is non-binding.
This data serves informational purposes only and is especially not guaranteed in any way.
Depending on the subsequent specific individual projects, the relevant data may be subject to changes and will be assessed and determined individually for each project. This will depend on the particular characteristics of each individual project, especially specific site and operational conditions.