IMO What's next

October 2, 2013

Programma

• 13.30 – 13.40	Opening	Eelco Leemans
• 13.40 – 13.50	Ballast water introduction	David Anink
• 13.50 – 14.20	Ballast water Possible solutions	Matthijs Schuiten
• 14.20 – 14.30	Bio fouling Introduction	Evert van Rietschoten
• 14.30 – 15.00	Bio fouling possible solutions	Evert van Rietschoten
• 15.00 – 15.25	Break	
• 15.25 – 15.40	Underwater noise Introduction	Edo Donkers
• 15,40 – 16.05	Underwater Noise Possible solutions	Mr Bosschers
• 16,05 – 16.15	Black Carbon Introduction	Paul Altena
• 16.15 – 16.45	Black carbon Possible solutions	Göran Hellen
• 16.45 – 17.15	Forum Discussion	
• 17.15	Drinks	

HOLLAND SHIPBUILDING association

BALLASTWATER REQUIREMENTS
AN INTRODUCTION

Ballast Water

What is the problem?

Invaders from the sea (IMO-BBC Documentary)

Ballast Water

What is being done?

Ballast Water

IMO Ballast Water Management Convention

Ballast Water

IMO Ballast Water Management Convention

Entry Into Force:

- *12 months after ratification of 30 contracting states*
- *35% of world tonnage*

Status of ratification (31-7-2013):

- *37 contracting states*
- *30,32 % of world tonnage*

HOLLAND SHIPBUILDING association

BALLAST WATER MANAGEMENT CONVENTION

REGULATION B-3 IMPLEMENTATION SCHEDULE

Construction date	Ballast Water capacity	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Reg.
Before 2009	Between 1,500 m^3 and 5,000 m^3	**D-1** or **D-2** *						**D-2** *						B-3.1.1
	Less than 1,500 m^3 or greater than 5,000 m^3	**D-1** or **D-2** *								**D-2** *				B-3.1.2
In or After 2009	Less than 5,000 m^3	**D-2**												B-3.3
In or After 2009, but before 2012	5,000 m^3 or more	**D-1** or **D-2** *								**D-2** *				B-3.4
In or After 2012		N/A		**D-2**										B-3.5

* not later than the first intermediate or renewal survey, whichever occurs first, after the anniversary date of delivery of the ship in the year of compliance with the standard applicable to the ship.
#

Draft IMO Assembly Resolution

Construction date	Ballast Water capacity	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Reg.
Before 2009	Between 1,500 m^3 and 5,000 m^3	**D-1** or **D-2**						**D-2** First Renewal Survey following the anniversary date of delivery of the ship in the year of compliance with the standard applicable to that ship / or first renewal survey following date of entry into force when entry into force after 2014						B-3.1.1
	Less than 1,500 m^3 or greater than 5,000 m^3	**D-1** or **D-2**								**D-2** First Renewal Survey following the anniversary date of delivery of the ship in the year of compliance with the standard applicable to that ship / or first renewal survey following date of entry into force when entry into force after 2014				B-3.1.2
In or After 2009	Less than 5,000 m^3	**D-2** First Renewal Survey following the date of entry into force of the Convention												B-3.3
In or After 2009, but before 2012	5,000 m^3 or more	**D-1** or **D-2**								**D-2** First Renewal Survey following the anniversary date of delivery of the ship in the year of compliance with the standard applicable to that ship / or first renewal survey following date of entry into force when entry into force after 2014				B-3.4
In or After 2012		**N/A**	**D-2** First Renewal Survey following the date of entry into force of the Convention											B-3.5

Ballast Water

Regional legislation:

- USCG Ballast Water final rule

- EPA Vessel General Permit 2013

BALLAST WATER

IMPLEMENTATION SCHEDULE
USCG BW FINAL RULE + EPA VGP 2013

	Ballast water capacity	Date constructed	Vessel's compliance date
New vessels	All	On or after 1 December 2013	On delivery
Existing vessels	Less than 1500 m^3	Before 1 December 2013	First scheduled drydocking after **1 January 2016**
	1500-5000 m^3	Before 1 December 2013	First scheduled drydocking after **1 January 2014**
	Greater than 5000 m^3	Before 1 December 2013	First scheduled drydocking after **1 January 2016**

BALLAST WATER

DIFFERENCES
USCG BW FINAL RULE / EPA VGP 2013

	USCG BW Final Rule	EPA VGP 2013
Extension	√	?
Alternate Management System (AMS)	?	√
Type Approval	not yet	not required

Ballast Water

Which hurdles?

Ballast Water

Which hurdles?

-The robustness of the IMO testing (G8/G9)

Ballast Water

Which hurdles?

-The robustness of the IMO testing (G8/G9)

-Port State Control inspections for compliance

Ballast Water

Which hurdles?

-The robustness of the IMO testing (G8/G9)

-Port State Control inspections for compliance

-How can certain ship types comply?

Ballast Water

Which hurdles?

-The robustness of the IMO testing (G8/G9)

-Port State Control inspections for compliance

-How can certain ship types comply?

  -Unmanned seagoing barges

Ballast Water

Which hurdles?

-The robustness of the IMO testing (G8/G9)

-Port State Control inspections for compliance

-How can certain ship types comply?

  -Unmanned seagoing barges

  -Small vessels without space in technical rooms

David Anink

Sector manager

Holland Shipbuilding Association

dan@scheepsbouw.nl

Niels van de Minkelis

Policy Advisor Operational Affairs

KVNR

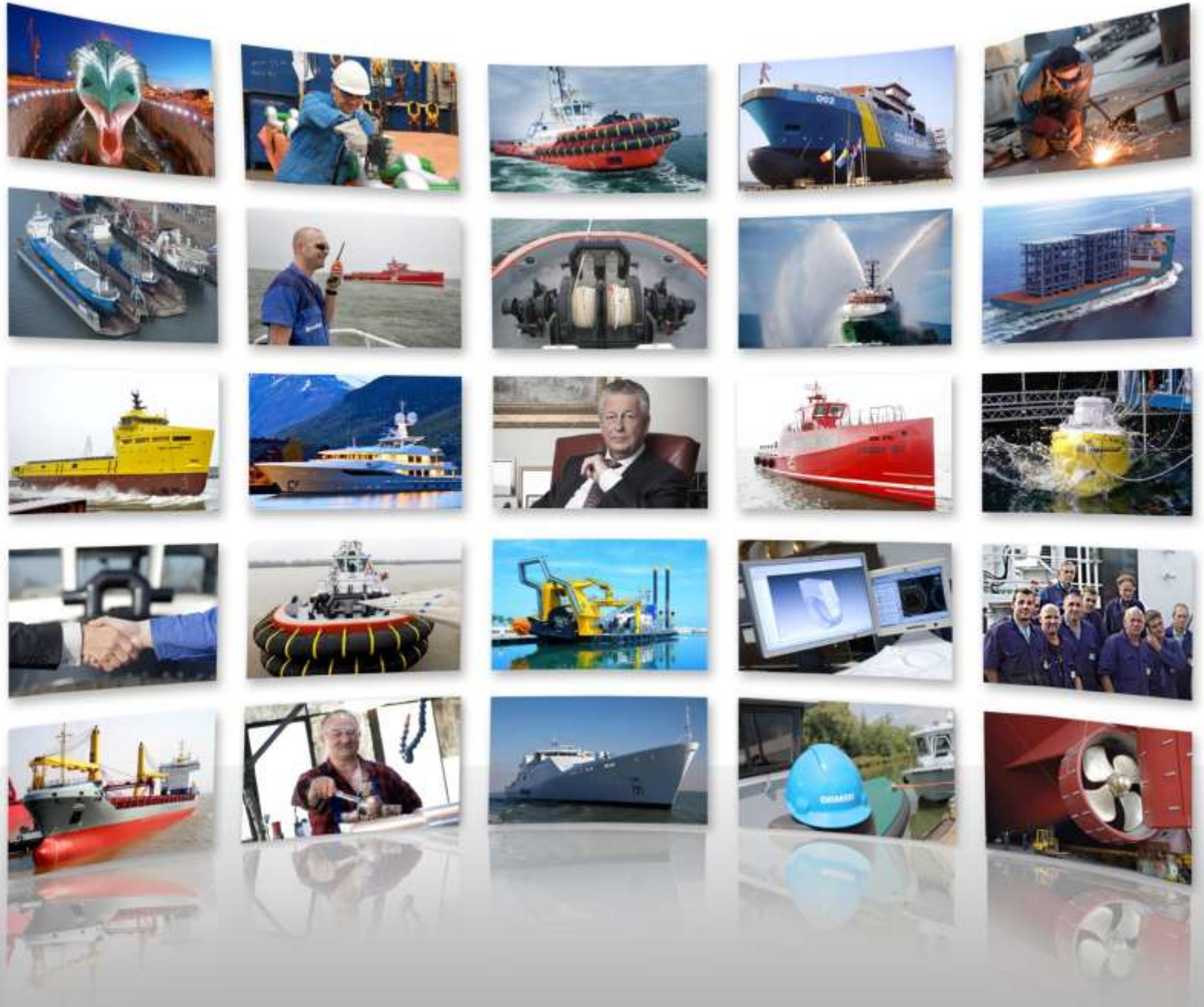
minkelis@kvnr.nl

waddenfonds

DAMEN

DAMEN SHIPYARDS GROUP

2013



GLOBAL PRESENCE

DAMEN YARD 21 + 12

BUSINESS COOPERATION 8

PARTNER YARD > 40

REPAIR

REFIT

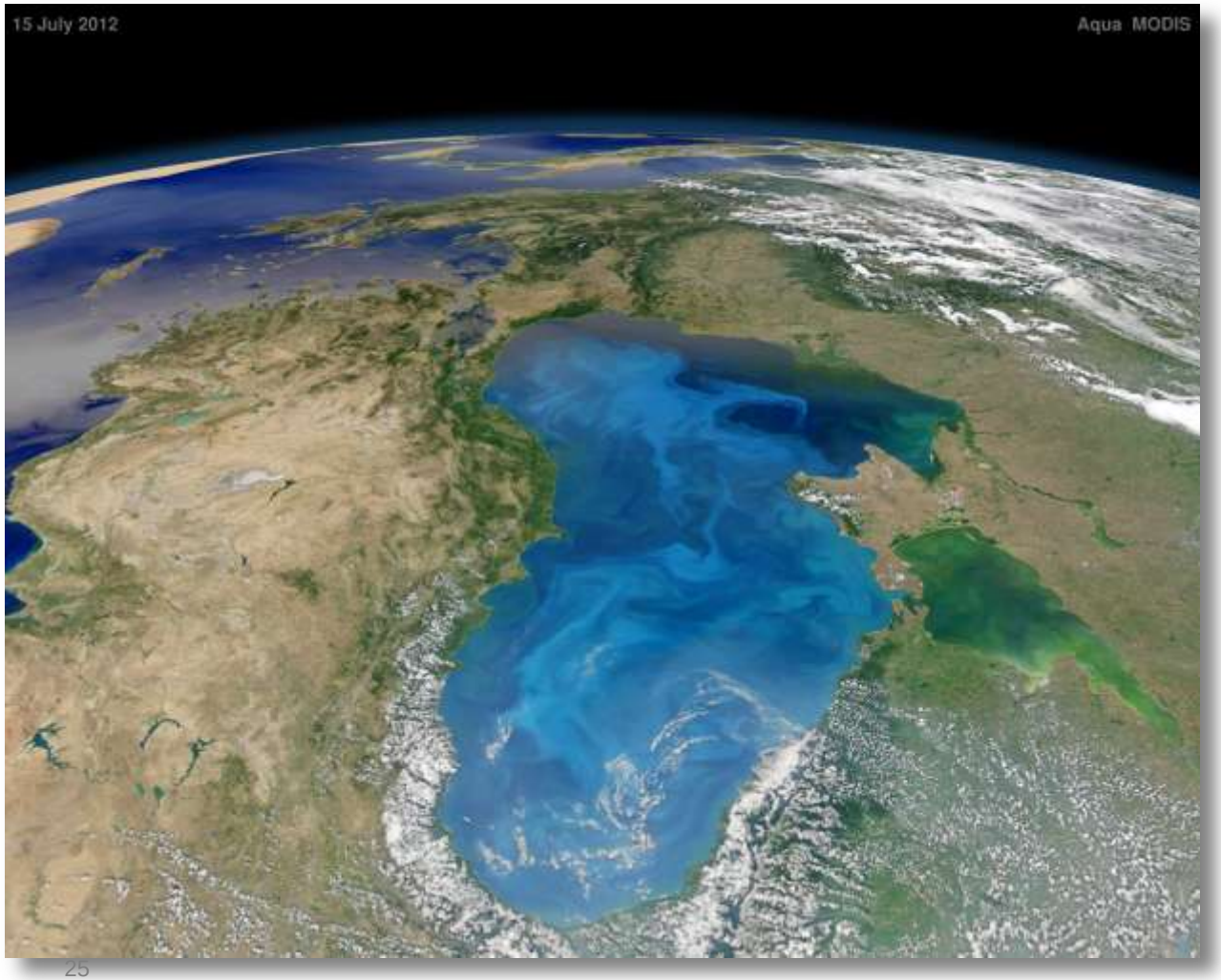
CONVERSION

MAINTENANCE

Ballast water regulations to prevent bio-invasions.

Enforced:

- USA, Dec 2013
- IMO, 2014/15
  37 countries
  signed 30,3%



70,000

70,000

vessels need a BWTU

40,000,000,000

40,000,000,000

Total costs for a BWTU on board of the world fleet

What if there was a mobile solution?

- Avoid high investment costs in a BWTU for vessels sailing fixed routes
- Deck connection costs are a fraction of the BWTU installation
- Prevent long downtime of the vessel in case of a malfunctioning BWTU
- Stop discharging untreated ballastwater in the Waddensea

MOBILE BALLAST WATER TREATMENT


GRONINGEN SEAPORTS
WADDENZEE
WERELDERFGOED

GRONINGEN SEAPORTS

DAMEN

waddenfonds

IMARES
WAGENINGEN UR

van Gansewinkel

evers manders
subsidieadviseurs

MEA-NL
MARINE ECO ANALYTICS

ROYAL WAGENBORG

Goal:

Stop the alien species invasion a.s.a.p. in the Waddenzee.

Introduce an IMO approved mobile ballast water treatment unit.

waddenfonds

TESTING AT THE WADDENZEE

TESTING AT THE IJSSELMEER

Q2 2015	• Mobile ballast water treatment IMO certified in Groningen Seaports
Q3 2014	• Finalize main tests
Q4 2013	• Finalize pre tests

Reach us: Green@damen.nl

Matthijs Schuiten, project manager

Tel.: +31 183 63 9212

Roel van Eijle, Sales manager

Tel.: +31 183 63 9433

Total solution provider

Fantastic company

Customer oriented

Best quality

Development /R&D

Ship repair

Vessels & Services

Entrepreneurial

Achieving clients' goals

Ship building

Committed/proud

WORLDWIDE COMPANY

Building on-site

Standardization

Family business/values

Partnership

Ambitious

Dutch

Reliability/trust

Best ship builder



Milieuregelgeving Zeescheepvaart
Introductie Biofouling

Job Klijnstra **TNO Maritime Materials Performance Centre**

- IMO AFS Conventie (2001) – Alleen nog tin-vrije verfsystemen
  Lang over gediscussieerd in jaren ‘90 en begin deze eeuw
- Na 2003 zijn alle wereldwijde leveranciers vrijwillig gestopt met levering van tin-houdende systemen
- Vanaf 2008 certificaat verplicht IAFS of State of Compliance (SoC)
  Certificaten worden o.a. afgegeven door Classes
- Type goedkeuring van Antifouling Systemen (AFS) door bijv. Classes.
  Schiet doel voorbij omdat na 2003 alle verven tin-vrij zijn
- Register/ Lijst van geverifieerde tin-vrije systemen



Europa - REACH

- Regelgeving voor productie en handel in chemische stoffen
- Relevant voor fabrikanten/ importeurs/ distributeurs/ gebruikers
- Producten/ componenten voor antifoulingverven vallen hier ook onder
- Geen specifieke regelgeving voor AF producten, maar in product-ontwikkelingstraject rekening houden met veiligheid, toxiciteit, etc.
- Hier niet verder te bespreken (maar wellicht dat volgende spreker nog op enkele specifieke punten in gaat)



Europa - Biocidenrichtlijn

- Vanaf 1998 Biocidenrichtlijn (Biocidal product Directive BPD) voor gebruik van biociden en biocide-houdende producten
- Harmonisatie van toelating van stoffen en producten
- Twee sporen:
  - werkzame stoffen moeten zijn toegelaten
  - producten waarin werkzame stoffen zijn opgenomen, moeten toelating hebben
- 23 verschillende product-typen afhankelijk van de toepassing;
  PT21 betreft antifouling producten; PT8 houtverduurzaming; etc.

- Vanaf 1 september 2013 is Biocidenrichtlijn vervangen door Biocidenverordening



Europa - Biocidenverordening

- Voor een aantal PT's kan nu een Europese aanvraag voor toelating worden gedaan in plaats van nationale aanvraag
- Voor PT21 (Antifouling producten) is dat nog niet het geval. Heeft te maken met feit dat nog niet alle stof-PT combinaties zijn goedgekeurd.
- Lopende aanvragen voor PT21 vallen nog onder overgangsrecht (Ctgb Wageningen kan dit nader toelichten)

Enkele andere nieuwe aspecten in deze Biocidenverordening zijn:

- Producenten van stoffen en producten moeten in lijst bij ECHA worden opgenomen; bedoeld om "free riders" te voorkomen!
- Laag risico-stoffen kunnen in vereenvoudigde procedure worden behandeld
- Nieuwe regels voor biocide-producerende producten en "treated articles" (producten behandeld met biocides) opgenomen
- Meer centrale rol voor ECHA (European Chemicals Agency) ondermeer met een centraal register voor aanvragen van biocidehoudende producten



Europa – IMO – Toekomstige ontwikkelingen?

- Voor koper en koperoxide als actieve stof in PT21 is de reviewprocedure nog niet afgerond; lopende aanvragen vallen onder overgangsrecht

- Op korte termijn nog geen verbod op koper voorzien:
  - Koper is zeer effectief tegen (met name dierlijke) aangroei
  - Na ban op organotin is ontwikkeling van verfsystemen vooral gericht op bindmiddelen die met koper voldoende lange dokkingsintervallen geven waar de markt om vraagt;
    additioneel wordt vaak een 2^{e} biocide toegevoegd om breed-spectrum activiteit te verkrijgen.
  - Gevolg is marktaandeel van koperhoudende verven > 90 % in zeescheepvaart
  - Huidig beschikbare gif-vrije antifoulingverven zijn qua werkzaamheid en mechanische bestendigheid nog niet geschikt voor alle typen schepen en vaarprofielen.



Europa – IMO – Toekomstige ontwikkelingen?

Brandstofbesparing zeescheepvaart

- Driving force voor de begrippen EEDI, EEOI en SEEMP
- Hull fouling = Frictieweerstand: minimaliseren!
- Gebruik van minder effectief AFS geeft toename in brandstofverbruik en dus broeikasgas-emissies: trade-off tussen emissies naar water en lucht?
- “Slow steaming” belangrijke component om tot emissiereductie te komen. Echter:
  - Bij gebruik van zelfslijpende antifouling coating is “polishing rate” wellicht niet optimaal bij langzaam varen
  - Bij gebruik van gifvrije Fouling Release Coating is foul release gedrag van de coating wellicht niet optimaal bij langzaam varen

Mogelijke consequentie:
Selectie van antifouling coating heroverwegen/aanpassen.



Europa – IMO – Toekomstige ontwikkelingen?

Werkzaamheid antifouling in relatie tot brandstofbesparing

- Internationaal initiatief om te komen tot Standaard voor het meten van “Hull en Propeller Performance” (Bellona Foundation)

- Complexe materie waarin met name verzamelen van betrouwbare real time scheepsdata nog een grote uitdaging is

- In relatie tot biofouling zijn de volgende aspecten van belang:
  - Meten van drag performance van rompcoatings met en zonder fouling (Friction Disk Machine)
  - Selectie van geschikte rompcoatings voor vaarprofiel van het schip
  - Monitoren van coatingruwheid en rompconditie gedurende het dokkingsinterval (inspecties)
  - Hull Maintenance & Cleaning protocollen ontwikkelen die optimale drag performance geven en risico op “invasive species” via de romp verminderen



Maritime Materials Performance Centre

Contact: Job Klijnstra Senior Scientist Corrosion and Antifouling Job.Klijnstra@tno.nl







BIOFOULING, MOGELIJKE OPLOSSINGEN

IMO WHAT'S NEXT – SEMINAR SCHEEPSBOUW NEDERLAND

Evert van Rietschoten | October 2, 2013

SIGMA COATINGS
A PPG Brand

PPG Protective & Marine Coatings
Bringing innovation to the surface.™

CONTENTS

- Personal Introduction
- Market trends and challenges
- Technologies for Fouling Protection
- Discussion
- PPG PMC strategy

CONTENTS

- Personal Introduction
- **Market trends and challenges**
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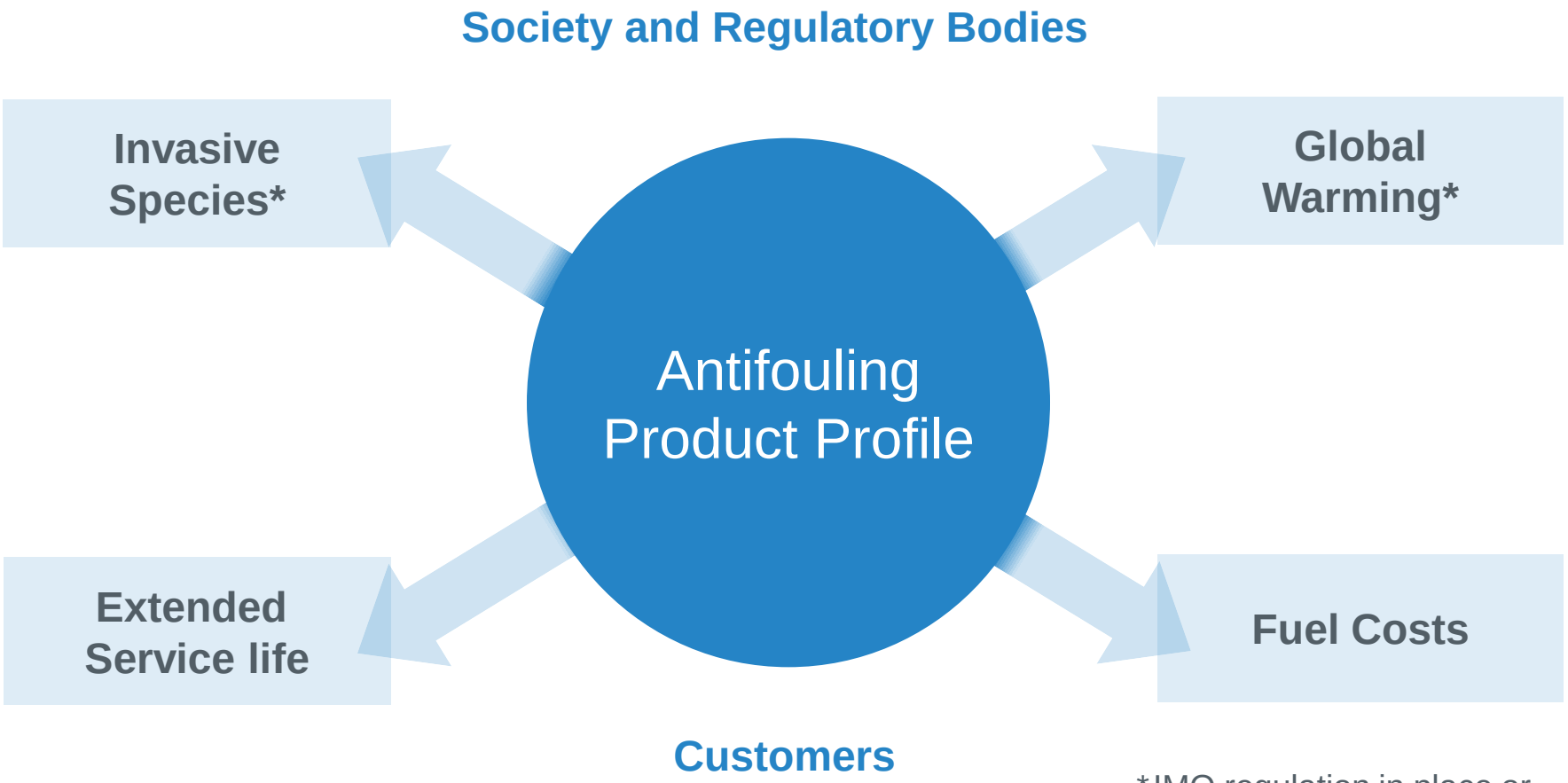
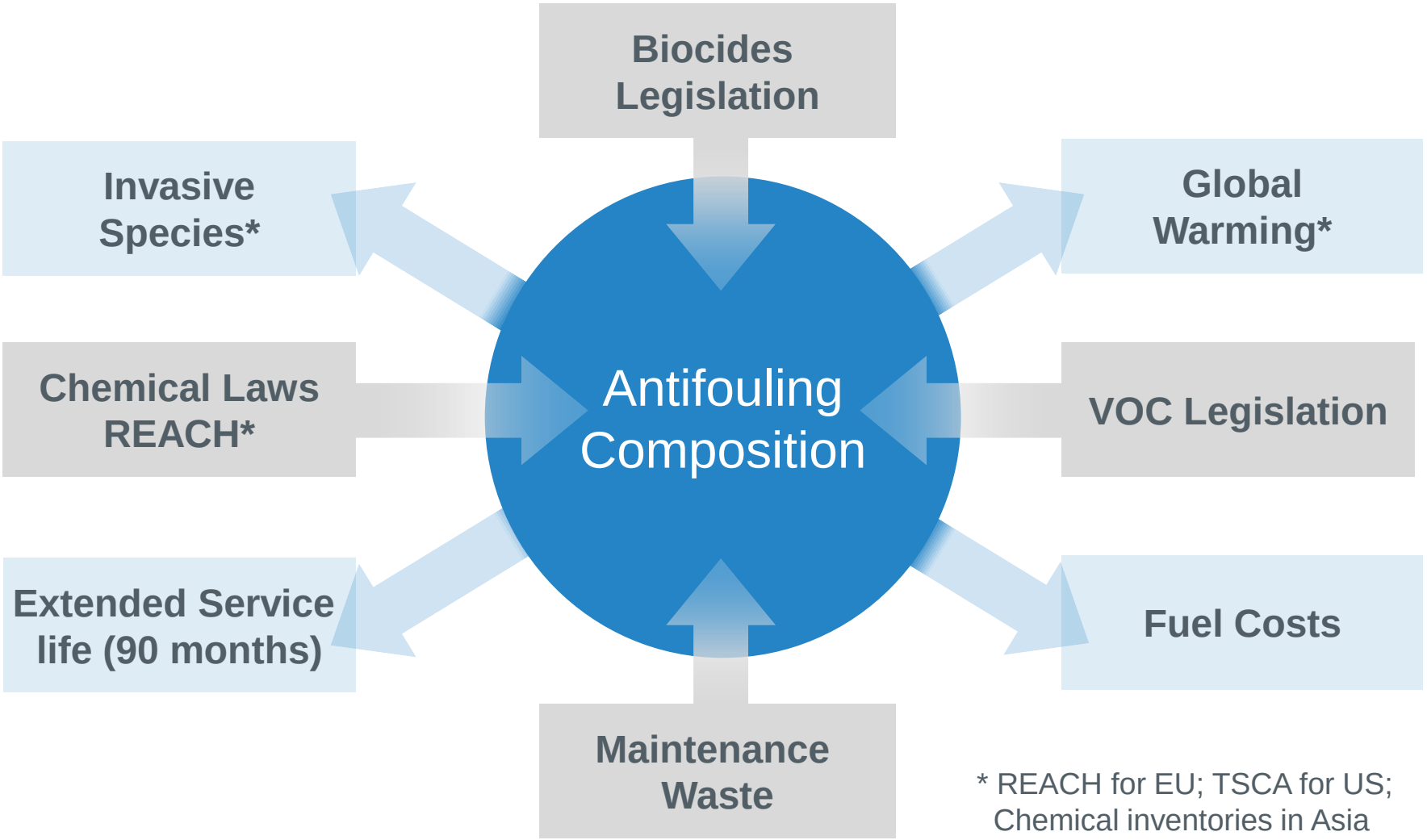
MARKET TRENDS AND CHALLENGES



*IMO regulation in place or in preparation

MARKET TRENDS AND CHALLENGES



* REACH for EU; TSCA for US; Chemical inventories in Asia

MARKET TRENDS AND CHALLENGES

Antifoulings have specific building blocks
- Binder
- Biocides

Biocide and Antifouling are subject to strict legislation
- Costly
- Timely
- Delays and uncertainty (BPD)

Must be registered in most countries where sales take place (read: application)
- Laws vary by country and region

Actives

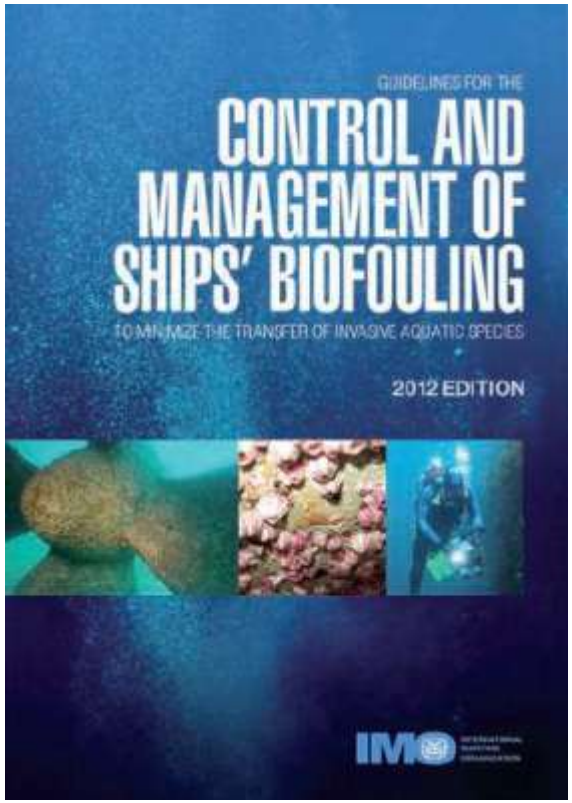
Products

RESULTING IN HIGH COMPLEXITY, COSTS AND LIMITATIONS FOR INNOVATION

IMO Resolution MEPC.207(62)
- Adopted on July 25, 2011

Basic Principles
- Biofouling management plan and record book
- Antifouling installation and maintenance
- In-water inspection, cleaning and maintenance
- Design and construction

Evaluation
- Development of guidance document (BLG 17, 2013)



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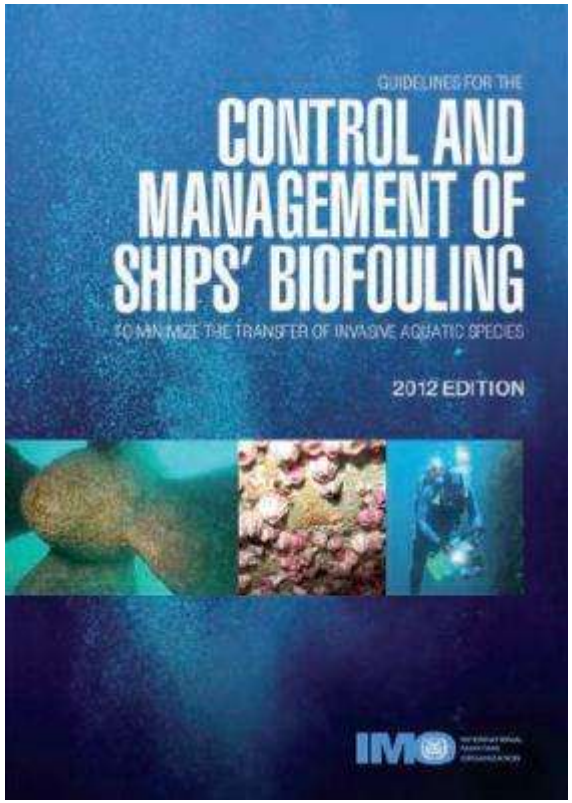


Non-mandatory – however, pressure on mandatory instruments will increase if current guidelines are not followed

Control and management of ships' biofouling

Consequences

- Further focus on fouling protection
- Special attention for sea chests, dry docking support strips, bow and stern thrusters etc.
- Increase in water inspection, cleaning and maintenance
- Changes in ship design and construction

CONTENTS

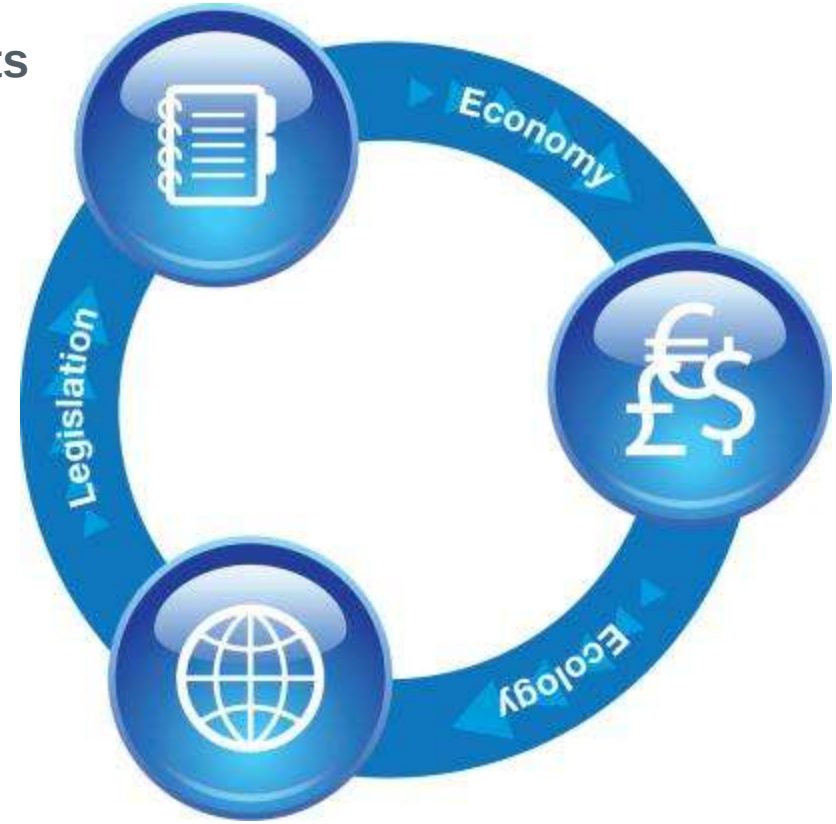
- Personal Introduction
- Market trends and challenges
- **Technologies for Fouling Protection**
- Discussion
- PPG PMC strategy

UNDERWATER HULL COATINGS

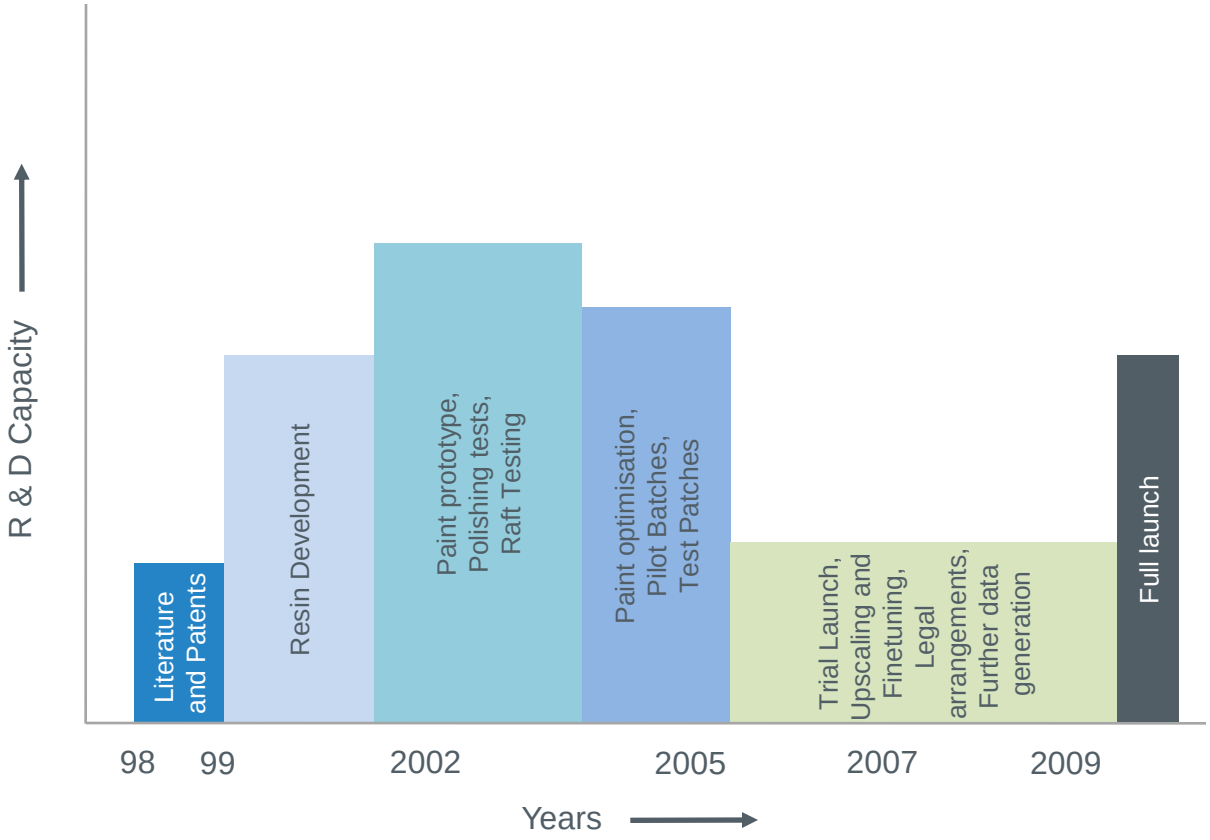
Dynamic decade (2000-2010)

Major game changers and developments

- Legislation (TBT ban, BPD, IMO)
- Diversification of technologies
- Increasing oil prices
- ‘Green’ drivers



ANTIFOULING DEVELOPMENT – a lengthy process



SIGMA COATINGS
A PPG Brand

TECHNOLOGIES FOR FOULING PROTECTION –
BEST SOLUTION WILL DEPEND ON VESSEL OPERATIONAL PROFILE

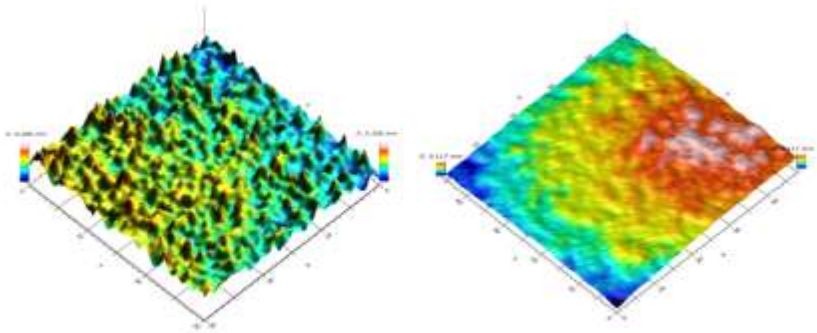
- Antifoulings
- Silicone Fouling Release coatings
- Other
  - Hard coatings (+ cleaning)
  - Biomimitecs

LARGE INVESTMENT IN RESEARCH AND DEVELOPMENT

TECHNOLOGIES FOR FOULING PROTECTION

Functions

- Fouling protection (primary)
- Optimize smoothness
- Other
  - Surface texture
  - Air bubbles/Air sheets



REDUCTION OF SKIN FRICTIONAL DRAG – REDUCED FUEL CONSUMPTION

TWO PROVEN PREMIUM TECHNOLOGIES

Self-polishing and self-smoothing antifoulings

- Development of smoothness through hydrolysis
- Tailored active ingredients for fouling protection

Silicone Fouling Release coatings

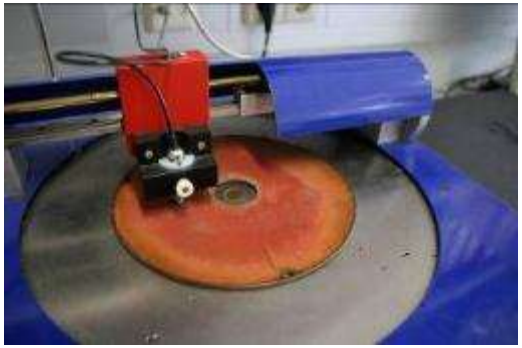
- Initially smooth due to silicone physics
- Hydrophobicity improves hydrodynamics
- 'Non-stick' mechanism (biocide-free)

INTRODUCTION TO ANTIFOULINGS

SIGMA SYLADVANCE™ 800
SILYL-ACRYLATE ANTIFOULING

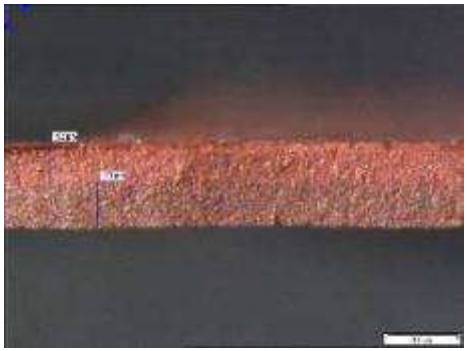
SELF-POLISHING ANTIFOULING

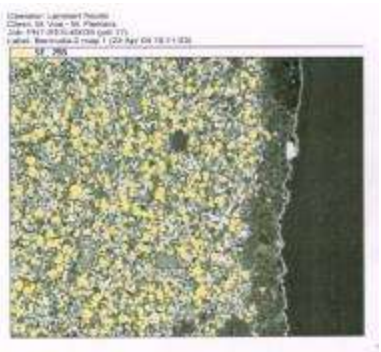
Polishing – controlled decrease of film thickness in time to facilitate the release of active ingredients



Polishing measurement

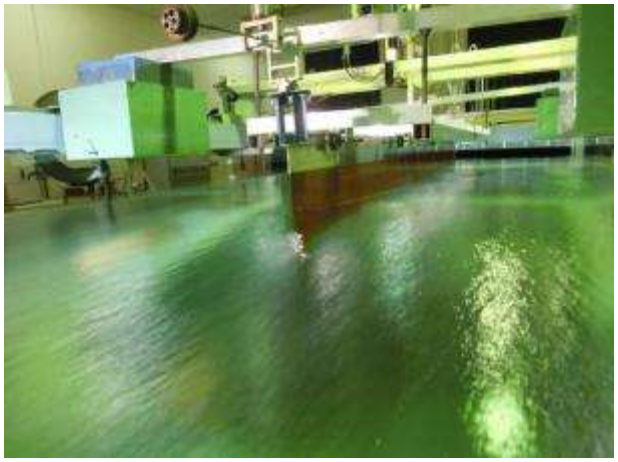
Surface profile measurement





Leached layer measurement/surface analysis

JAPANESE SHIPYARD TESTING



UNIVERSITY TESTING

TESTING SETUP

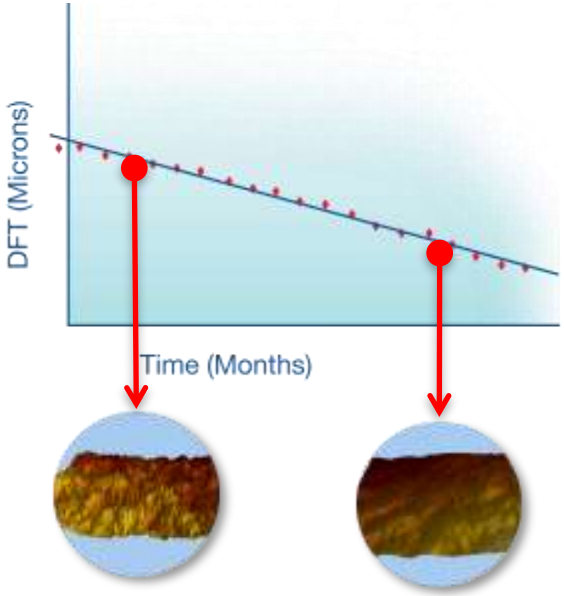
•Rotor tester with artificial seawater at 25ºC constant
•Power measurements at 500 RPM (~15 knots) – initial taken after 3 and 6 months' rotation

REDUCTION OF TORQUE WITH – 4.5%

PREMIUM ANTIFOULING SMOOTHING IN PRACTICE

Application

Polishing rate of SIGMA SYLADVANCE™ 800



In-dock condition

PREMIUM ANTIFOULINGS

Benefits

- Consistent behavior
- Predictable performance
- Durable performance
- Long service lifetime
- Fuel savings (self-smoothing)

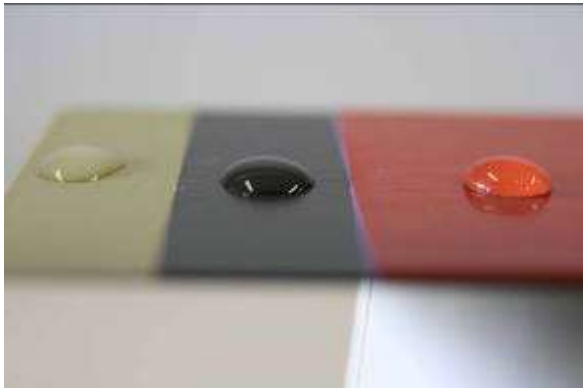
3 YEARS IN SERVICE

INTRODUCTION TO FOULING RELEASE COATINGS

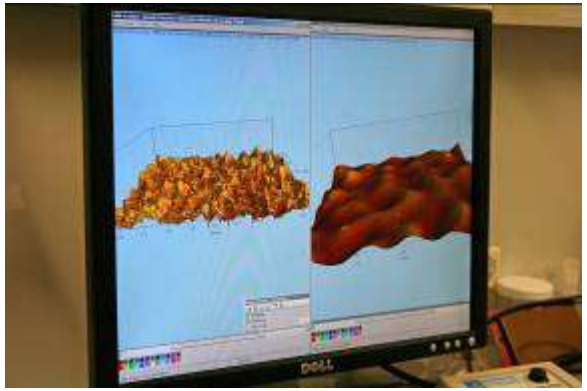
Ultra Smooth/Non Stick

SIGMAGLIDE® 990
FOULING RELEASE COATING

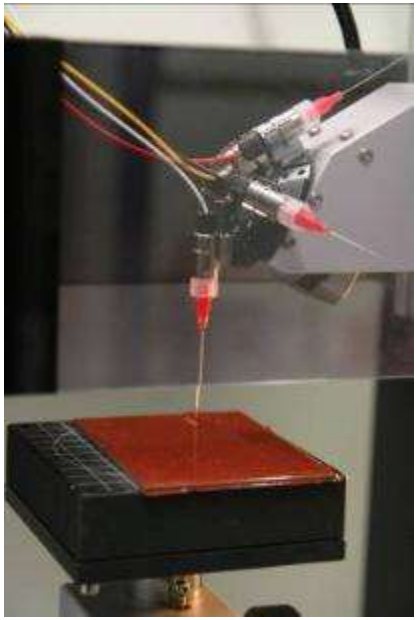
FOULING RELEASE COATINGS
Qualititive



Contact angle measurement



Surface profile measurement



Surface tension measurement

FOULING RELEASE COATINGS
Qualititive

Untreated Disk
2 years' exposure

SIGMAGLIDE® Disk
2 years' exposure

SIGMAGLIDE® Disk
After rotating at
17 knots

PPG
Test Facilities

FOULING RELEASE COATINGS
Quantitative

Skin frictional drag

Tests performed at an external laboratory are used to determine the release of fouling and quantify potential effects

SIGMAGLIDE®: 20 YEARS' SUCCESSFUL INNOVATION

> 250 vessels applied

***SIGMAGLIDE* LSE**

1990s

***SIGMAGLIDE* 890**

2004

***SIGMAGLIDE* 990**

- **Third generation**
- **Advanced**

2009

FOULING RELEASE COATINGS

SIGMAGLIDE®
LNG carrier 3 years' service
Deep sea
19 knots

SIGMAGLIDE®
VLCC 3 years' Persian Gulf
Low-activity coastal
Max 12 knots

FOULING RELEASE COATINGS
Benefits

- Fuel savings (optimal smoothness)
- Durable performance
- Long service lifetime
- Fewer coats
- Reduced weight
- Reduced maintenance costs
- Reduced dry dock time

THANKS FOR YOUR ATTENTION.
ANY QUESTIONS?

Onderwatergeluid vanuit de zeevaart

Platform Schone Scheepvaart 2 oktober 2012

Edo Donkers, Stichting De Noordzee

Fylakopi Milos Griekenland

The North Sea Foundation

Een (groot) probleem?

Stichting De Noordzee (SDN/NSF):

- Milieuorganisatie sinds 1980
- 15 fte, 18 medewerkers
- Bestuur (6 leden)

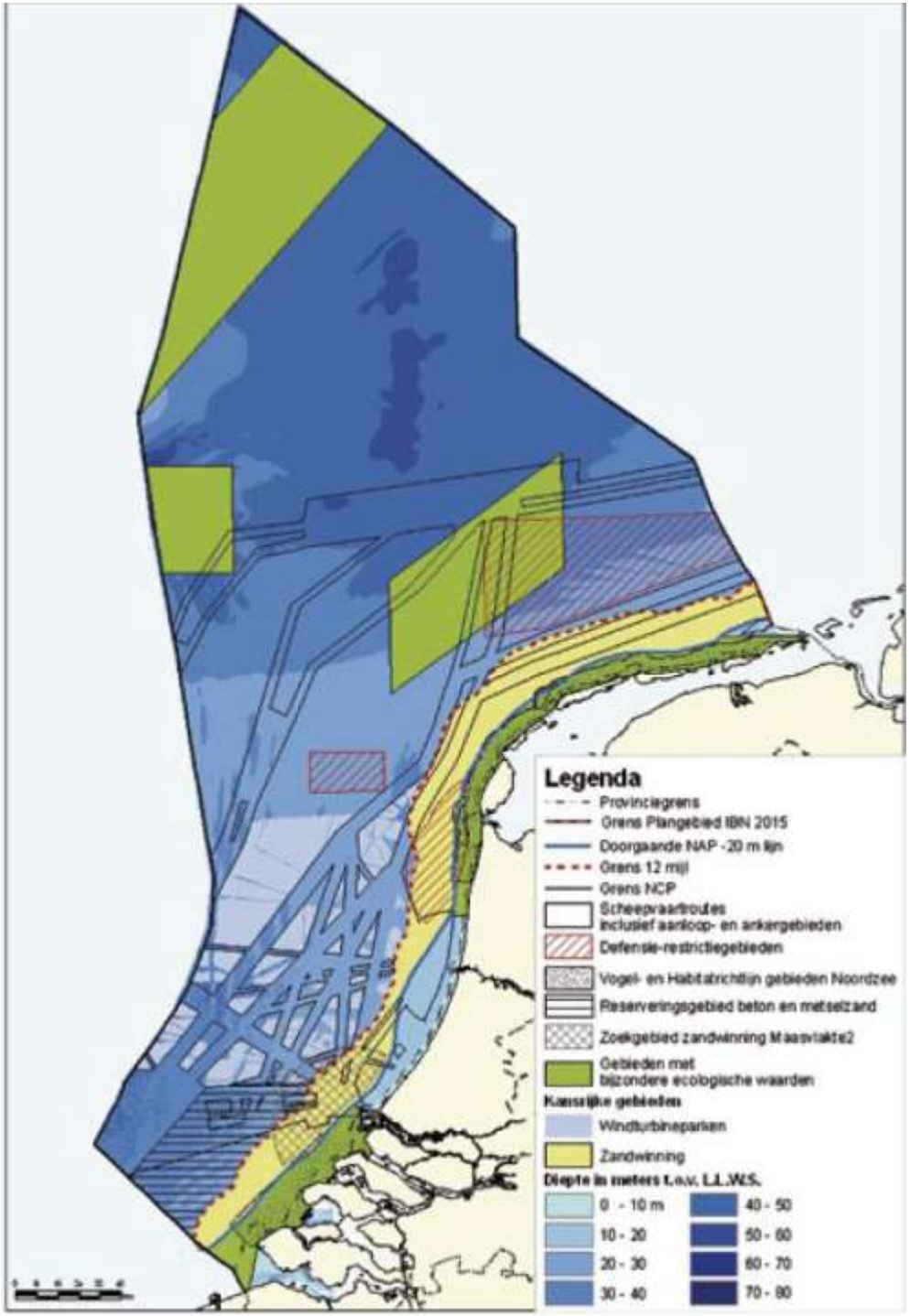
*Oplossings*gericht
Constructief en op *Dialoog* gericht
Actie waar nodig
Op wetenschap gebaseerd

De Noordzee

- De Noordzee = 575.000 km2.
- Grootste Nederlandse natuurgebied
- Economisch belang en gebruik neemt toe
    - 260.000 scheepsbewegingen
    - 96 windturbines aan de NL kust
    - Bijna 1000 olie- en gas platforms (143 in NL)
    - hoge intensiteit van (boomkor) visserij
    - 450 stuks afval per 100 meter strand

Onze missie:

Streven naar een duurzaam gebruik van de Noordzee


Legenda
Provinciegrens
Grens Plangebied IBN 2015
Doorgaande NAP -20 m lijn
Grens 12 mijl
Grens NCP
Scheepvaartroutes
inclusief aanloop- en ankergebieden
Defensie-restrictiegebieden
Vogel- en Habitatrichtlijn gebieden Noordzee
Reserveringsgebied beton en metselzand
Zoekgebied zandwinning Maasvlakte2
Gebieden met
bijzondere ecologische waarden
Kansrijke gebieden
Windturbineparken
Zandwinning
Diepte in meters t.o.v. L.L.W.S.
0 - 10 m
10 - 20
20 - 30
30 - 40
40 - 50
50 - 60
60 - 70
70 - 80

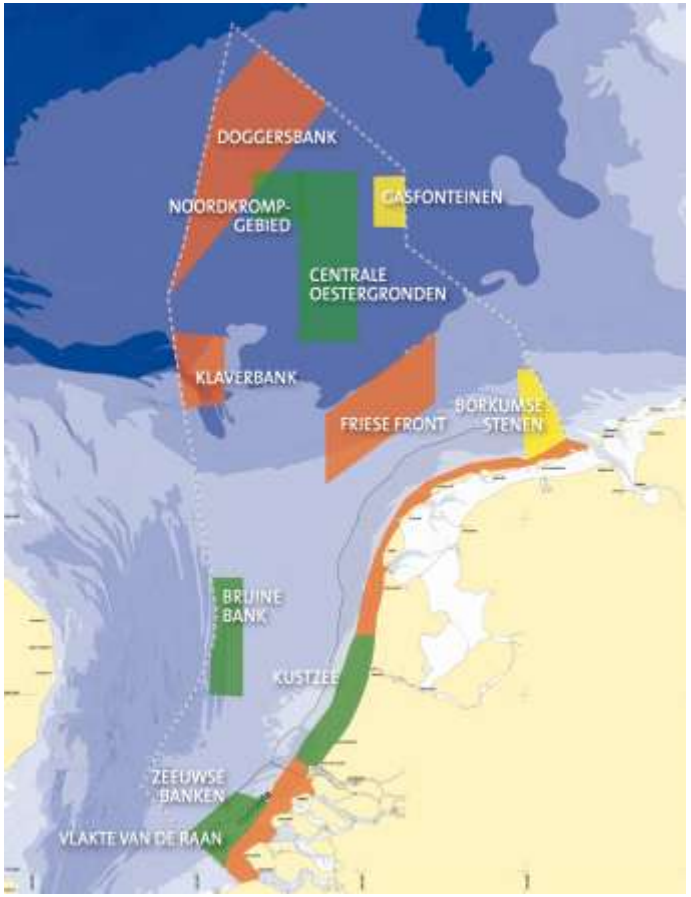
The North Sea Foundation

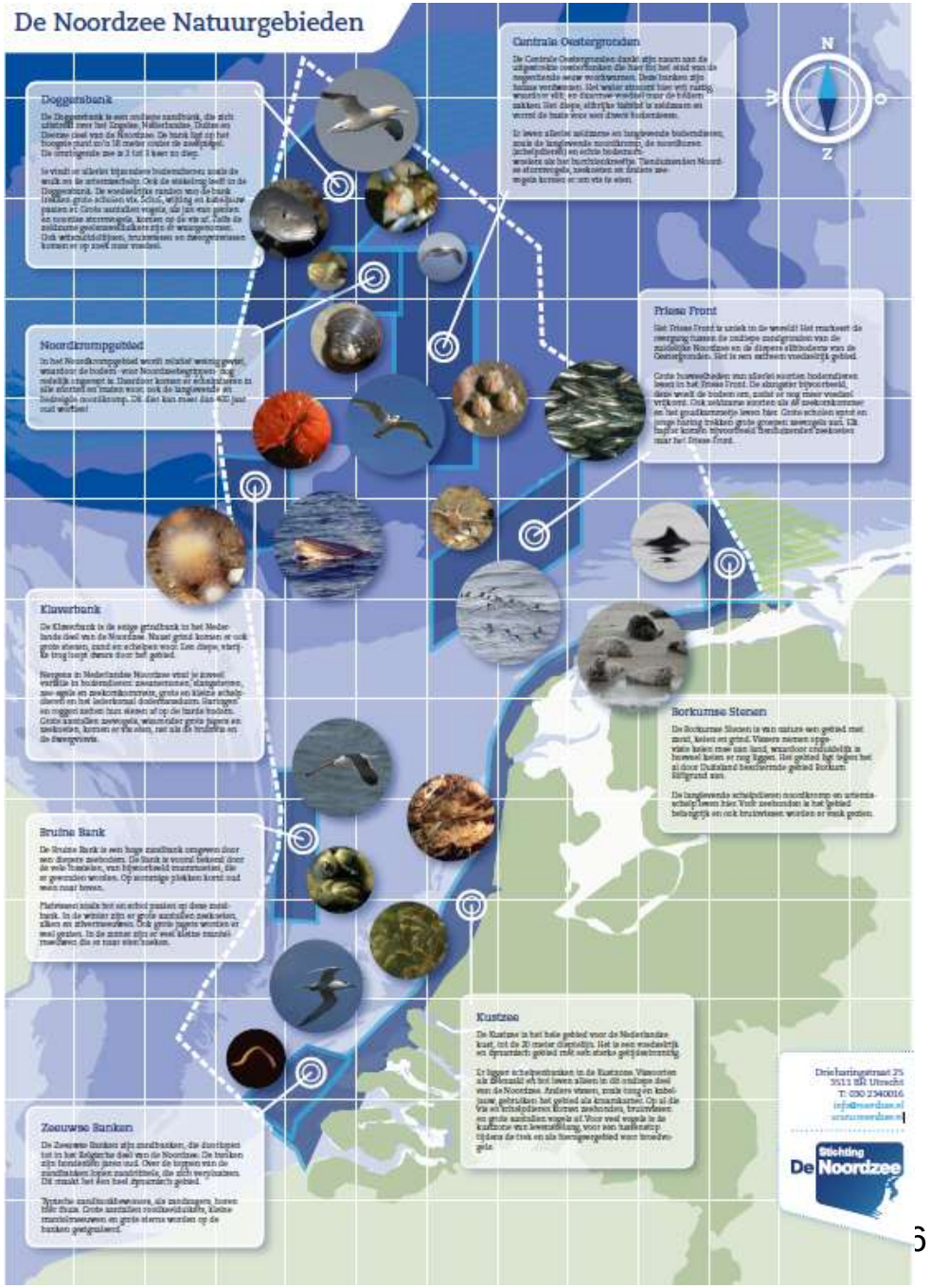
Aandachtsgebieden (o.m.):

- Duurzame visserij (VISwijzer, Award 2010)
- Clean Shipping (Sustainability Award 2010)
- MyBeach
- Marine Protected Areas

MY BEACH @DeNoordzee

The North Sea Foundation





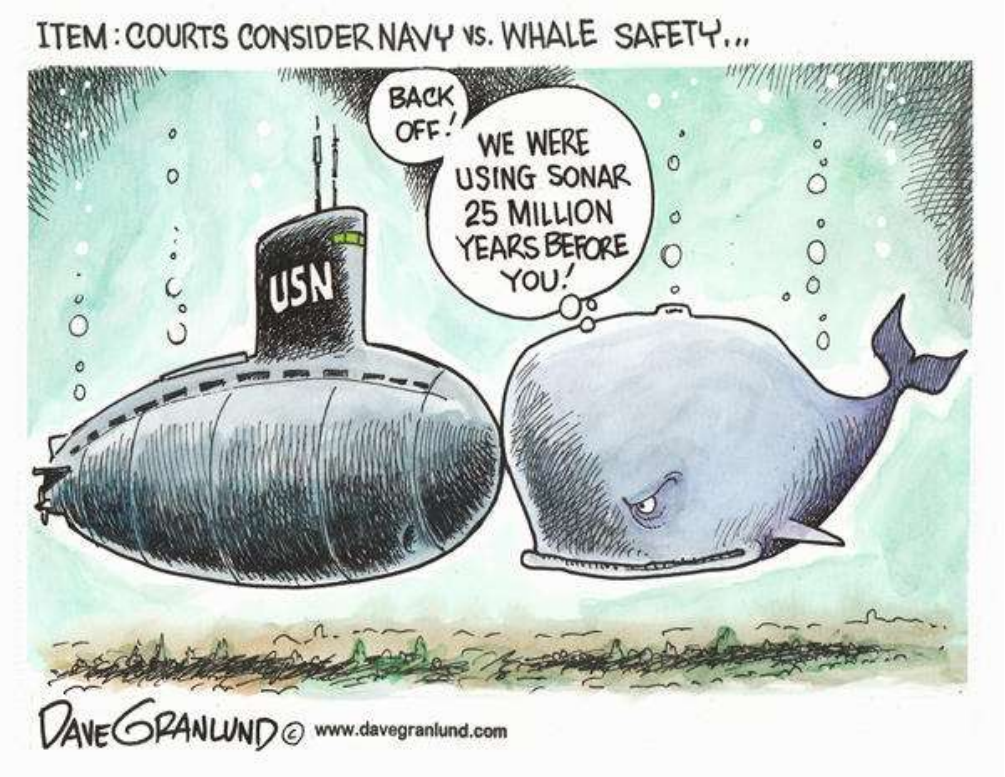
Dwergvinvis (Minke Whale)

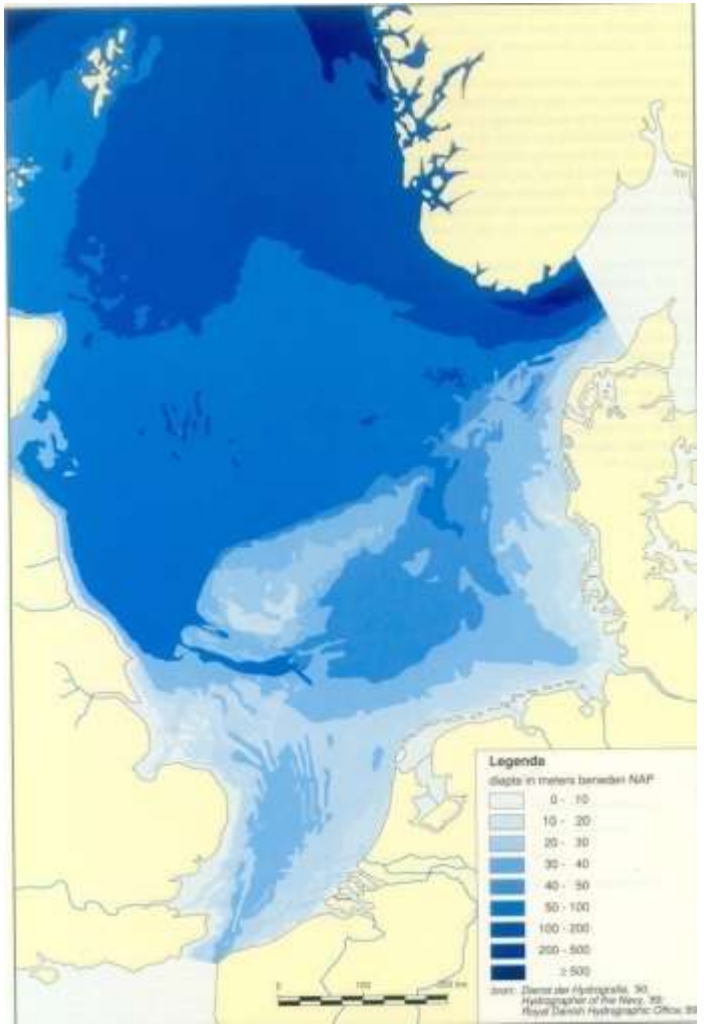
Leefgebied: Doggersbank

Noordzee

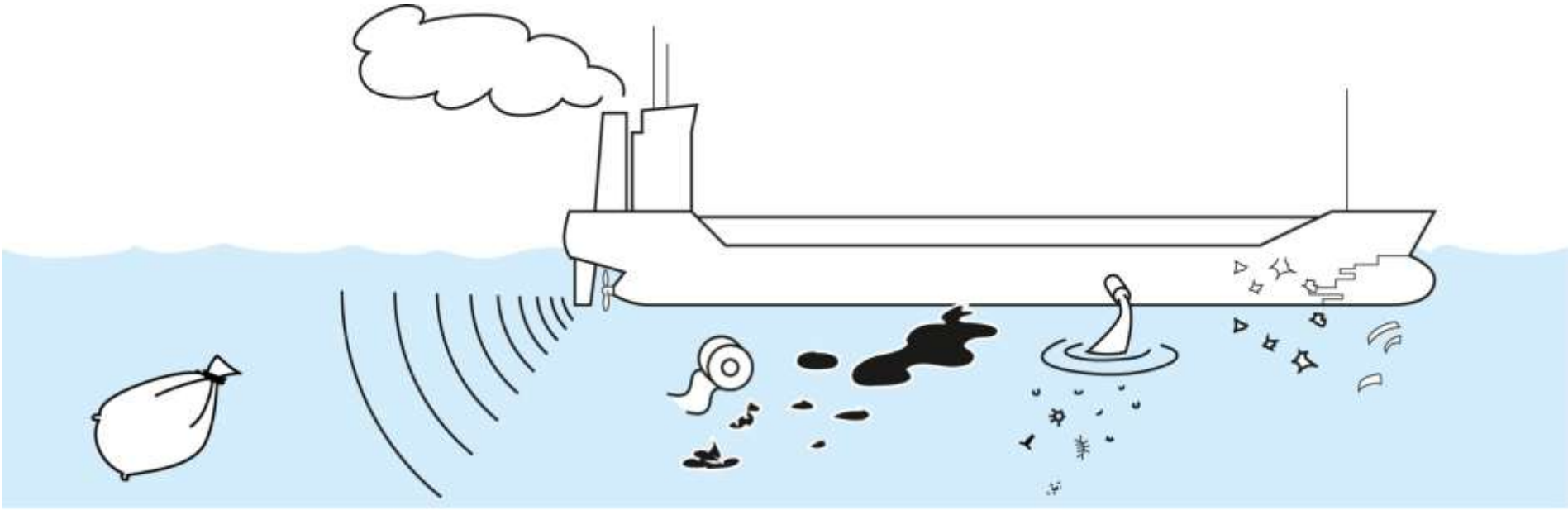
Kreeg zijn huidige vorm zo'n

11.000 tot 7.000 jaar geleden





Scheepsemissies



Marine litter (solid waste) | Underwater noise | Air emissions | Sewage | Oil spillage | Invasive species (ballast water) | Chemicals | Antifouling

Onderwatergeluid van de zeevaart

Vooral een probleem voor zeezoogdieren: gebruiken geluid voor horen en ‘zien’

De laatste 150 jaar heeft de zeevaart een monsterachtige ontwikkeling doorgemaakt

Veel scheepsgeluid overlapt met het *geproduceerde* en *waargenomen* geluid van zeezoogdieren

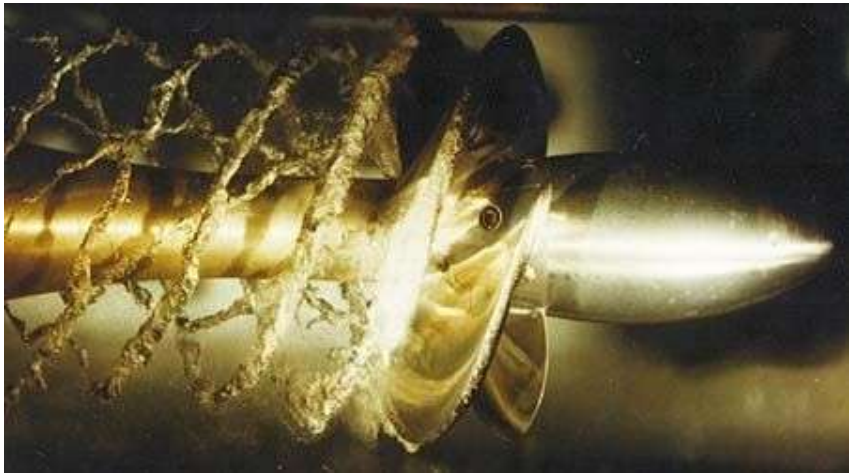
Bronnen van onderwatergeluid

- Natuurlijke bronnen
  - Biologisch
  - Fysiek: vulkaanuitbarstingen, aardbevingen, golfslag, weer

- Menselijke activiteiten

Belangrijkste bronnen aan boord zijn

- cavitatie door propellor
- golfslag door scheepshuid in water
- geluid motoren door scheepshuid



Onderwater is er zeer beperkte zichtbaarheid

Door troebelheid water of beperkte inval van zonlicht

Zeezoogdieren kunnen onderwatergeluid niet ontwijken

Geluid plant zich in water *sneller* en over *grote afstand* voort

honderden kilometers of meer

Zeezoogdieren gebruiken hoororgaan als *primair* zintuig

Geluid bij andere zeedieren

Veel vissoorten en ongewervelde dieren gebruiken geluid om

- Partners te vinden
- Roofdieren af te wenden

Oyster Toadfish

Spiny lobster

Knorrepos

96

Geluid als *communicatie* bij zeezoogdieren

- Sociale orde ‘handhaven’
- Partners zoeken
- Fitheid tonen
- Bevestigen band tussen kalf en moeder
- Waarschuwen bij gevaar

- *Echo-locatie*

plaatsbepalen en fourageren

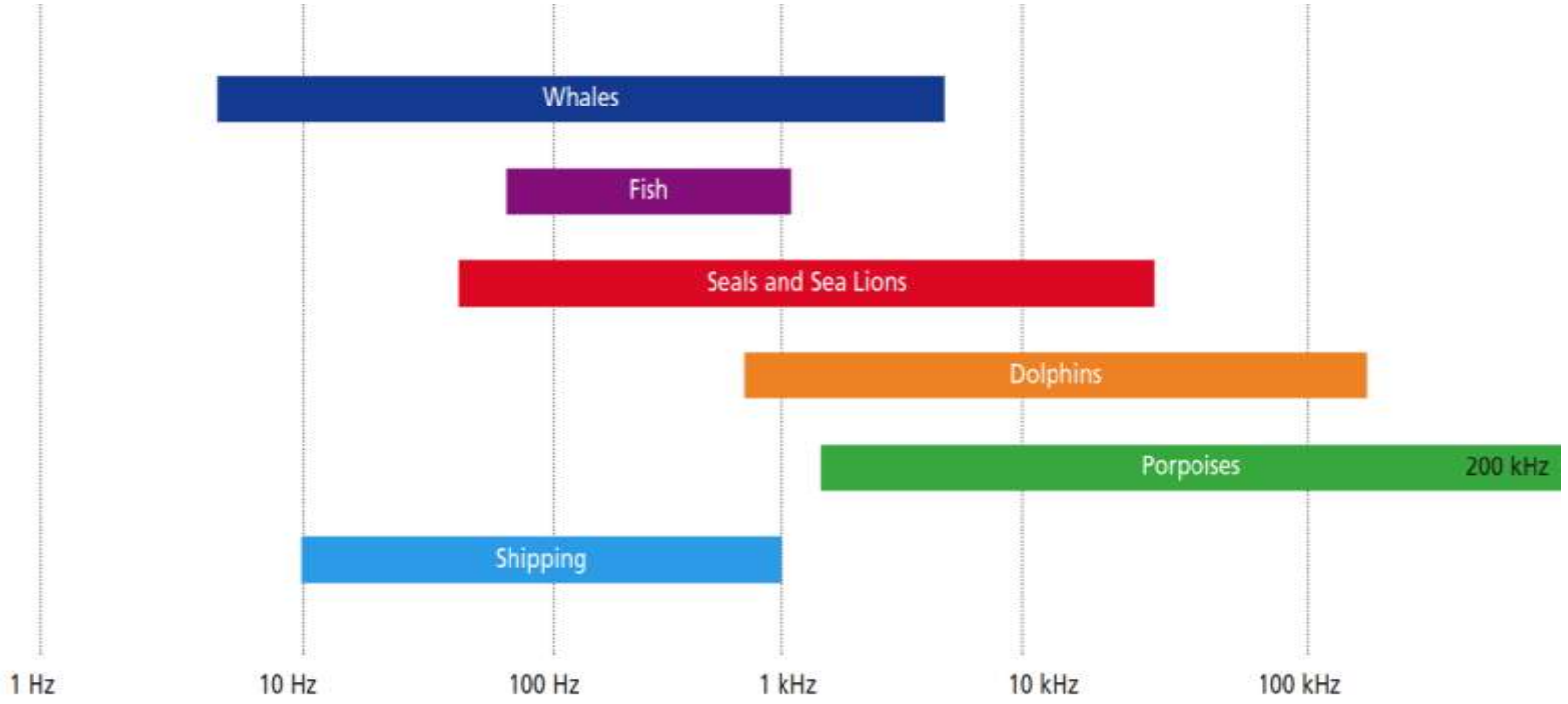
- *Navigatie*

Gevolgen van onderwatergeluid (I)

Het door schepen gemaakte geluid veroorzaakt problemen:

- Geluiden zijn hard en laagfrequent: toename *achtergrondgeluid*

- Het overlapt met *dezelfde frequenties* zeezoogdieren



98

Gevolgen van onderwatergeluid (II)

- Het maskeert belangrijke geluiden
- ‘Treshold Shift’ : tijdelijke of permanente doofheid
- Schade door drukverschillen
- Gedragsbeïnvloeding
- Ship Strikes

Gevolgen van onderwatergeluid (III)
Een probleem?

Atlantic Northern Right Whale

- - *Right Whale* Populatiegrootte
- enkele honderden (Westelijk) en < 100 (Oostelijk)
- - Ship Strikes doods oorzaak bij ongev. *30 tot 50 %* (w.o. geluid)
- - 21 soorten zeezoogdieren gevoelig voor geluid
- fin whales, sperm whales, humpback whales ook gevoelig

- Ja, want:
- - Esthetisch
- - Imago maritieme industrie
- - Schade aan vaak kleine populaties

Oplossingsrichtingen onderwatergeluid

- VS loopt voorop met speciale gebieden met meldplicht en areas to be avoided
- IMO beslist in 2014 mogelijk over eerste *Guidelines*
- *Voorzorgsprincipebenadering* en nadruk op nieuwbouw: vnl. propellor/ hull-ontwerp en maatregelen rondom motoren (uitdaging bij 2 stroke engines)
- EU kaderrichtlijn marien wil effecten van energie in water brengen (zoals geluid) beperken

Marine Environmental Awareness Course

BLOCK 1
Introduction, sustainable shipping and the marine environment

- Introduction – lecture
- Personal opinions – workshop
- Marine environment – lecture
- Regional marine area – background article

BLOCK 2
Environmental challenges I

- Discharges to the sea – lectures
  - Chemicals
  - Oil (+ 1 movie)
  - Sewage
  - Solid waste (+ 3 movies)
- Reputation of shipping – workshop

BLOCK 3
Environmental challenges II

- Emissions to air – lectures
  - Overview
  - Greenhouse gases
  - Ozone depleting substances
  - Other emissions to air (focus on SO_x, NO_x, PM)
- Introduction of invasive species including ballast water – lecture
- Other impacts on the marine environment – lectures
  - Noise
  - Antifouling paint
  - Ship recycling

BLOCK 4
Pollution prevention, personal involvement

- Pollution prevention measures – workshop
- Personal involvement – workshop

UNDERWATER RADIATED NOISE FROM SHIPS

Johan Bosschers

IMO, what's next, Oktober 2013

OUTLINE

- General introduction underwater noise
- International activities
- Underwater radiated noise from ships
- Noise mitigation measures
- On-going EU FP7 Projects
- Concluding remarks

INTRODUCTION TO SOUND

- Definition Sound Pressure Level (dB, re 1 µPa)

$$\bar{p} = \sqrt{\frac{1}{T}\int_{-T/2}^{T/2} p^2(t)dt}$$

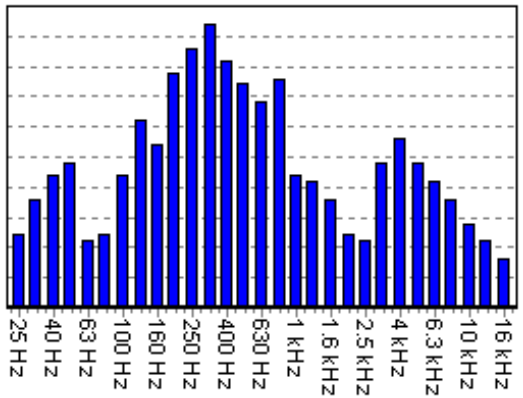
$$L_p = 20\log_{10}\left(\bar{p}/p_{ref}\right)$$

- Source Level (distance normalisation to 1m)

$$L_S = L_p + 20 \times \log_{10}\left[\frac{R}{r_{1m}}\right]$$

- Spectrum level: band width 1 Hz

- Alternative: 1/3 octave bands
  - Integrate spectrum level over specific frequency bands (log scale)

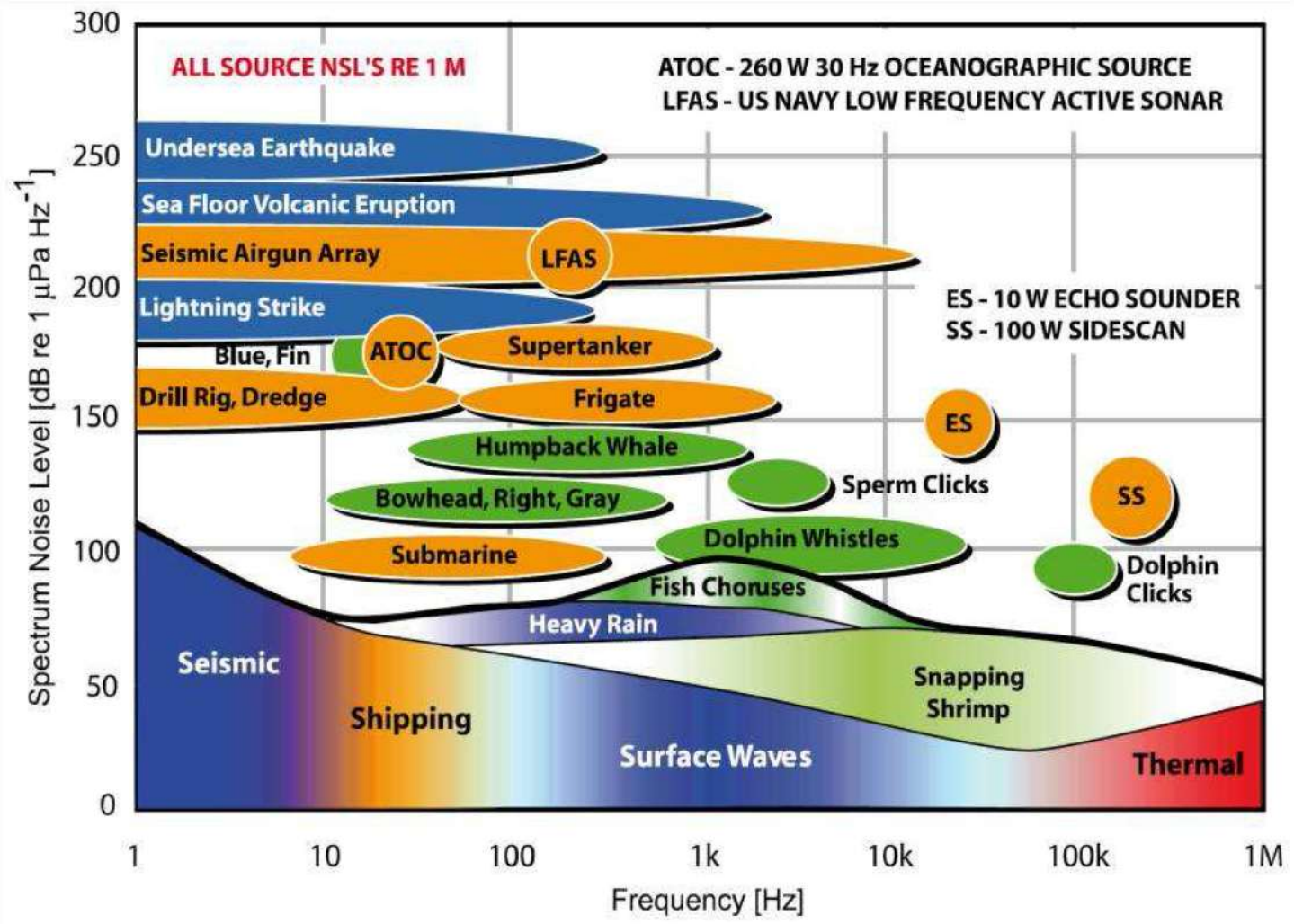


UNDERWATER RADIATED NOISE OF SHIPS

- Relevant for
  - Signature (detection) and self noise of naval vessels
  - self noise acoustic positioning systems/sonar/….
  - self noise for fishery research vessels
  - Noise nuisance in ocean for marine life

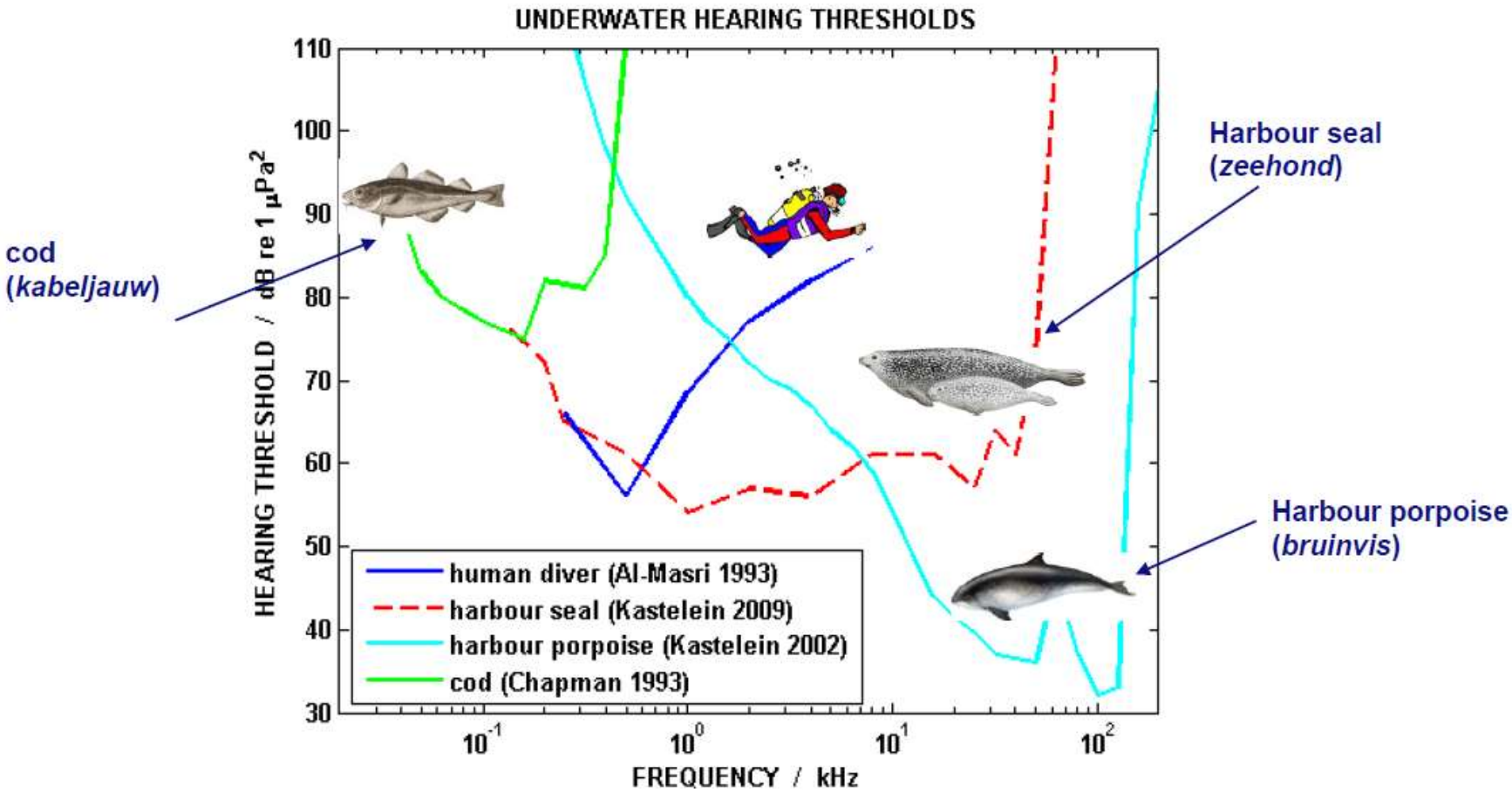
MARIN

TYPICAL UNDERWATER NOISE LEVELS



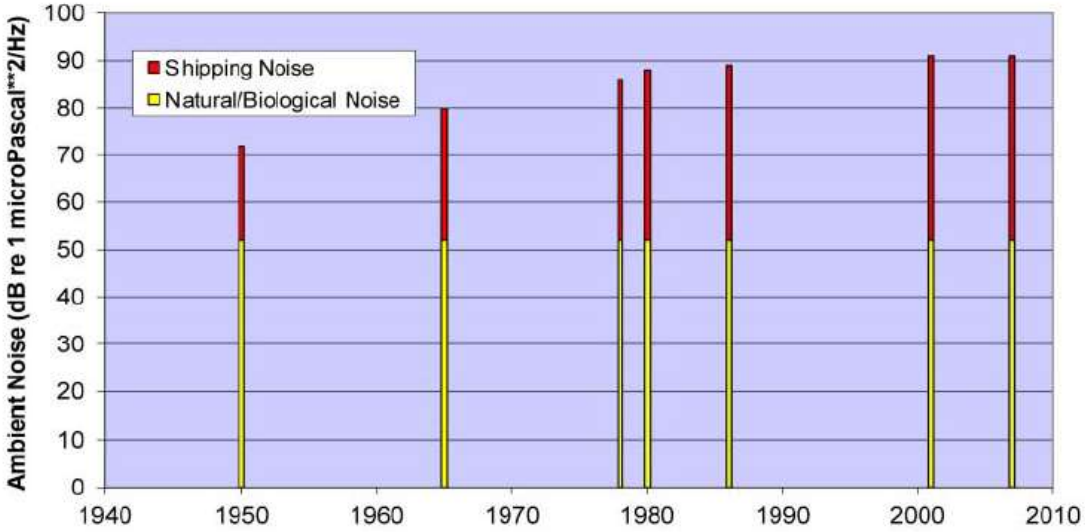
Seiche Ltd.

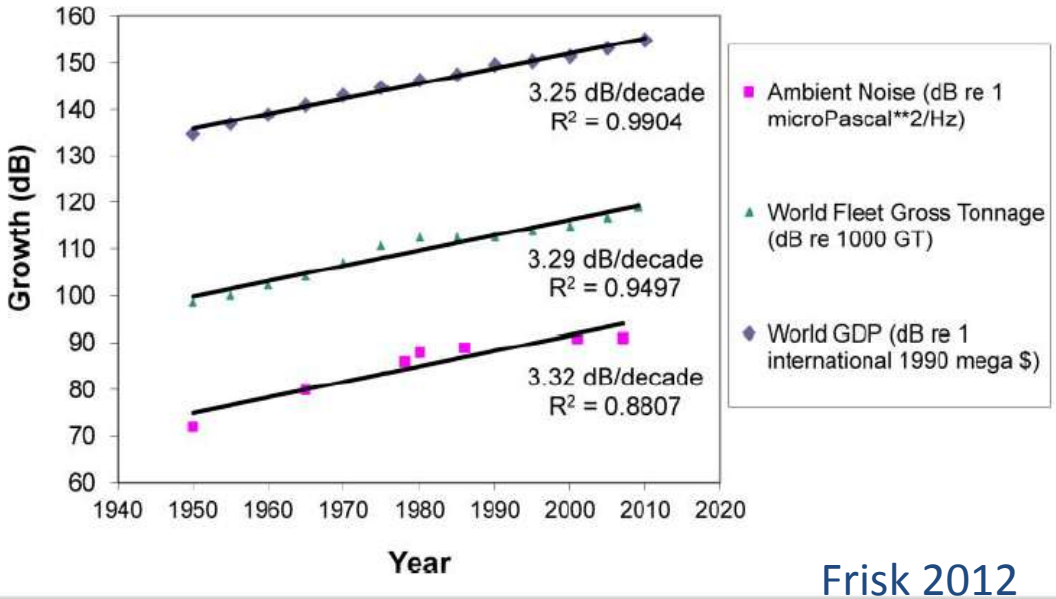
AUDIOGRAMS



Ainslie (2009)

INCREASE BACKGROUND NOISE LEVELS OCEANS





- More detailed analysis by Ainslie (2011)

Frisk 2012

IMO DEVELOPMENTS

- IMO MEPC Correspondence Group
  - Correspondence group established at MEPC58 (2008)
  - Documents MEPC 59/19, MEPC 60/18, MEPC 61/19
  - Address and minimize incidental introduction of noise from commercial shipping operations into the marine environment

- DE 57/WP8 (March 2013)
  - (non-mandatory) guidelines for the reduction of underwater noise from commercial shipping
  - For discussion at MEPC 2014

EU MARINE STRATEGY FRAMEWORK DIRECTIVE (2008)

- Aims to achieve good environmental status of the EU's marine waters by 2020
- Each Member State is required to develop strategies for their marine waters
- 2010: 11 Criteria and Methodological Standards for Good Environmental Status
- Descriptor 11: Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment

EU DEVELOPMENTS

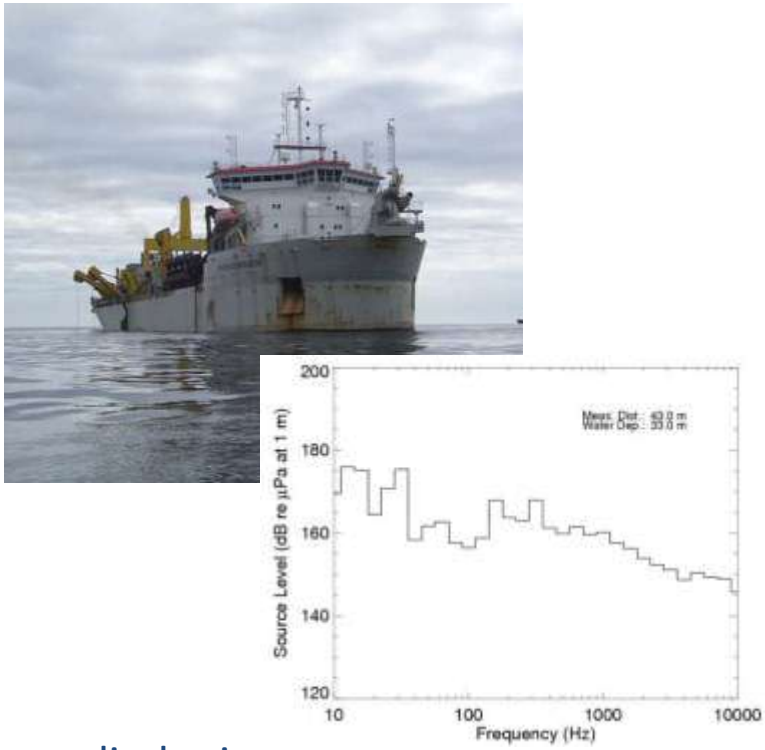
- Definition Good Environmental Status 2020

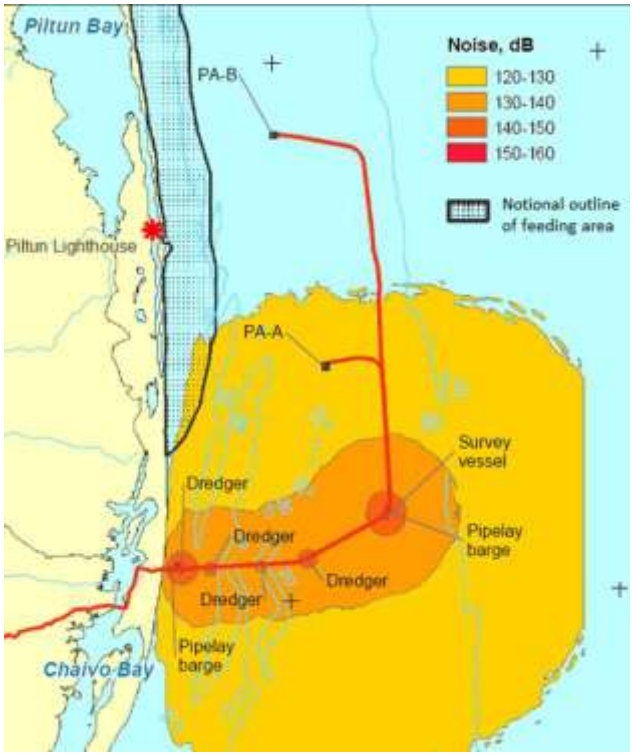
11.2. Continuous low frequency sound

— Trends in the ambient noise level within the 1/3 octave bands 63 and 125 Hz (centre frequency) (re 1µPa RMS; average noise level in these octave bands over a year) measured by observation stations and/or with the use of models if appropriate.

LEGISLATED OBLIGATIONS (EIA)

- Increasing regional legislation to assess and monitor acoustic impact for sensitive areas





Jasco applied sciences

NOISE MEASUREMENT STANDARDS

- Deep water only
- ANSI/ASA
- ISO

- Shallow water in development...

Grade	A	B	C
Grade name	**Precision method**	**Engineering method**	**Survey method**
Measurement uncertainty	1.5 dB	3.0 dB	4.0 dB
Measurement repeatability	± 1.0 dB	± 2.0 dB	± 3.0 dB
Bandwidth		One-third octave band	
Frequency range (one-third octave bands)	10 to 50,000 Hz	20 to 25,000 Hz	50 to 10,000 Hz
Narrowband measurements	Required	Required	As Needed
Number of hydrophones	Three	Three	One
Hydrophone geometry	Figure 1	Figure 1	Figure 2
Nominal hydrophone depth(s)	15°, 30°, 45° angle	15°, 30°, 45° angle	20° ± 5° angle (see 5.4)
Minimum water depth	Greater of 300 m or 3x overall ship length	Greater of 150 m or 1.5x overall ship length	Greater of 75 m or 1x overall ship length

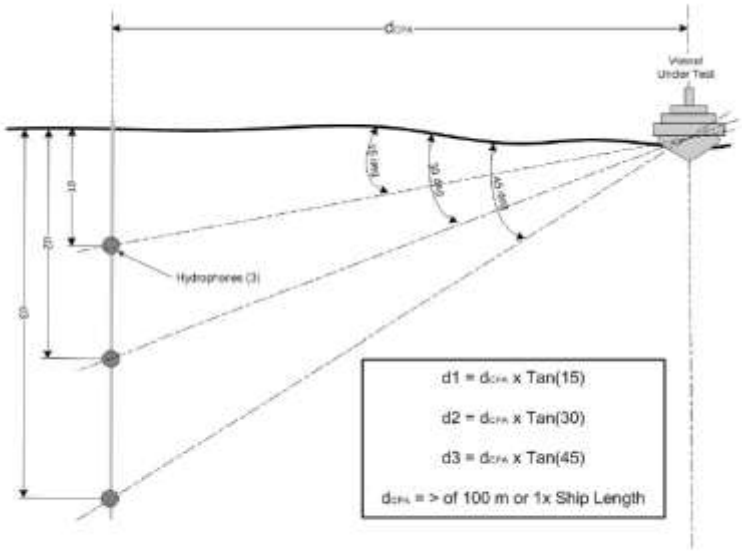
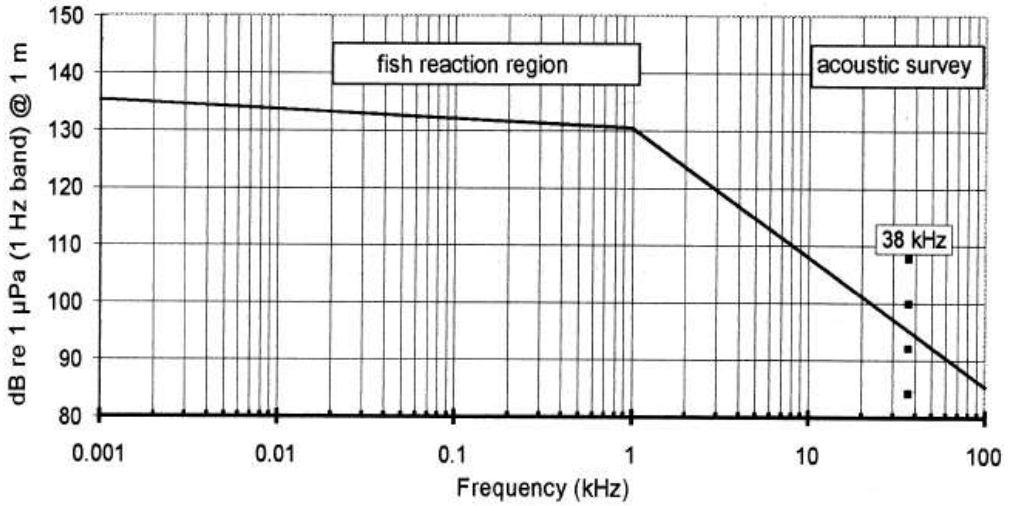


Figure 1 – Grades A and B hydrophone geometry

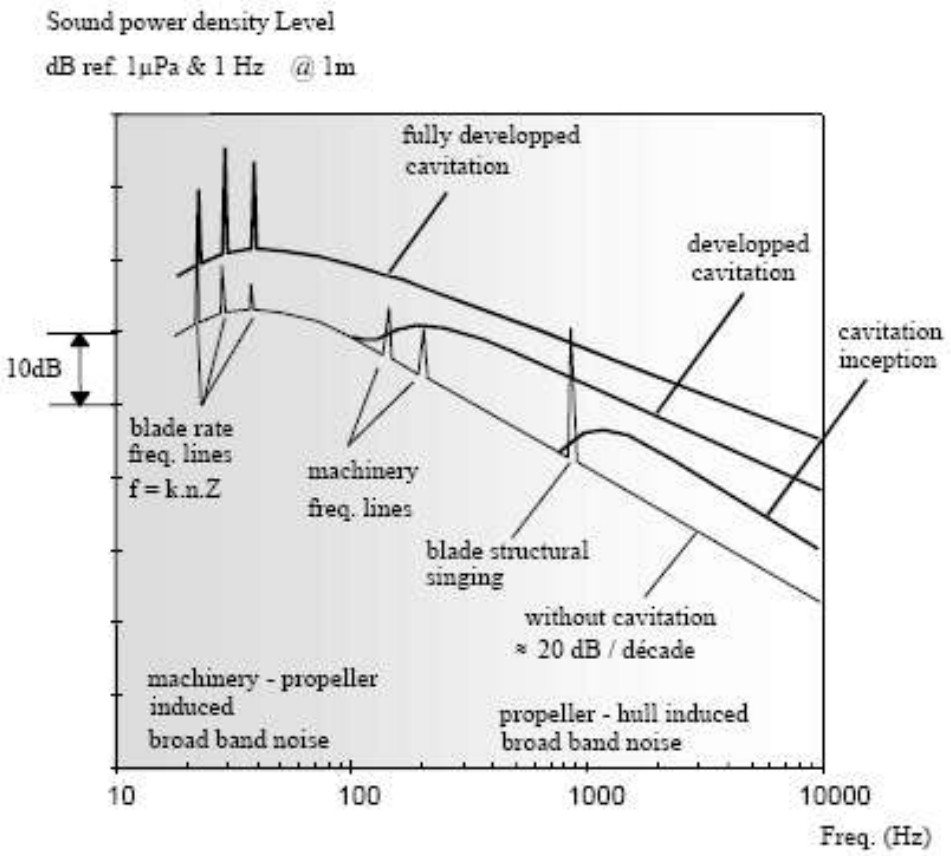
NOISE STANDARDS

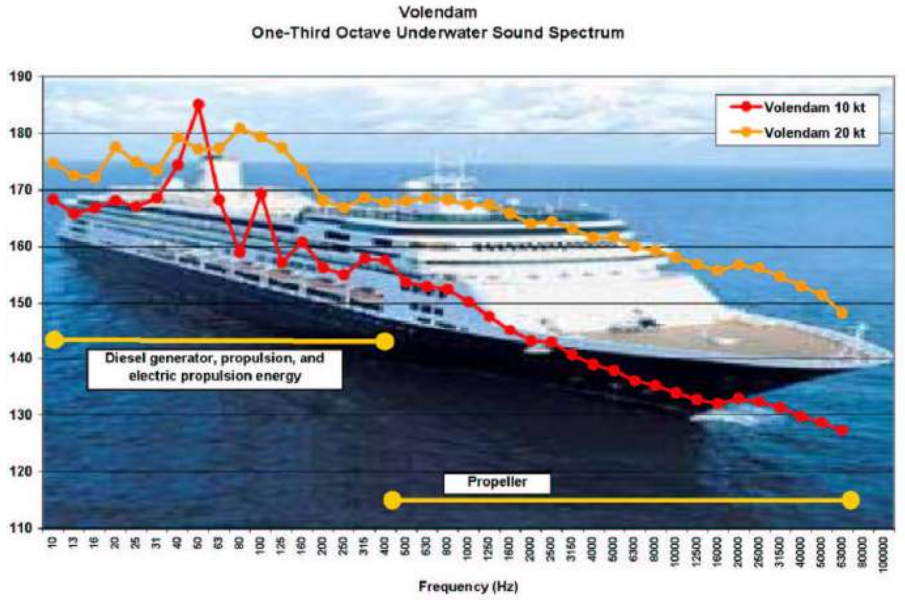
- Fishery research vessels (ICES CR209)



- DNV SILENT class
  - Vessel using hydro-acoustic equipment
  - Seismic research vessel
  - Fishery vessel
  - Fishery research vessel
  - Controlled environmental noise emission

NOISE SOURCES ON SHIPS

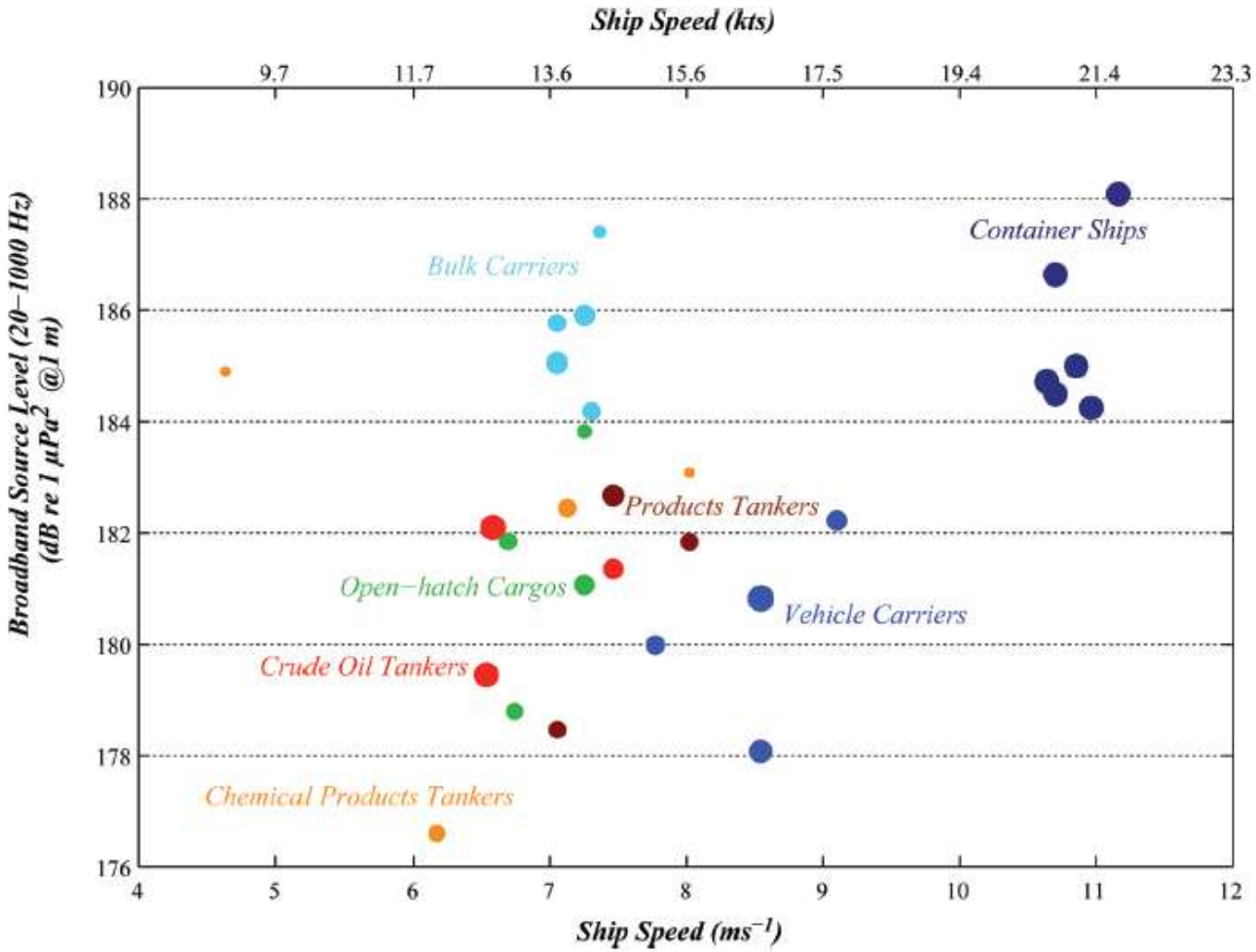




- Flow noise
- Auxiliaries: pumps, generator, …
- Main engine, gearbox

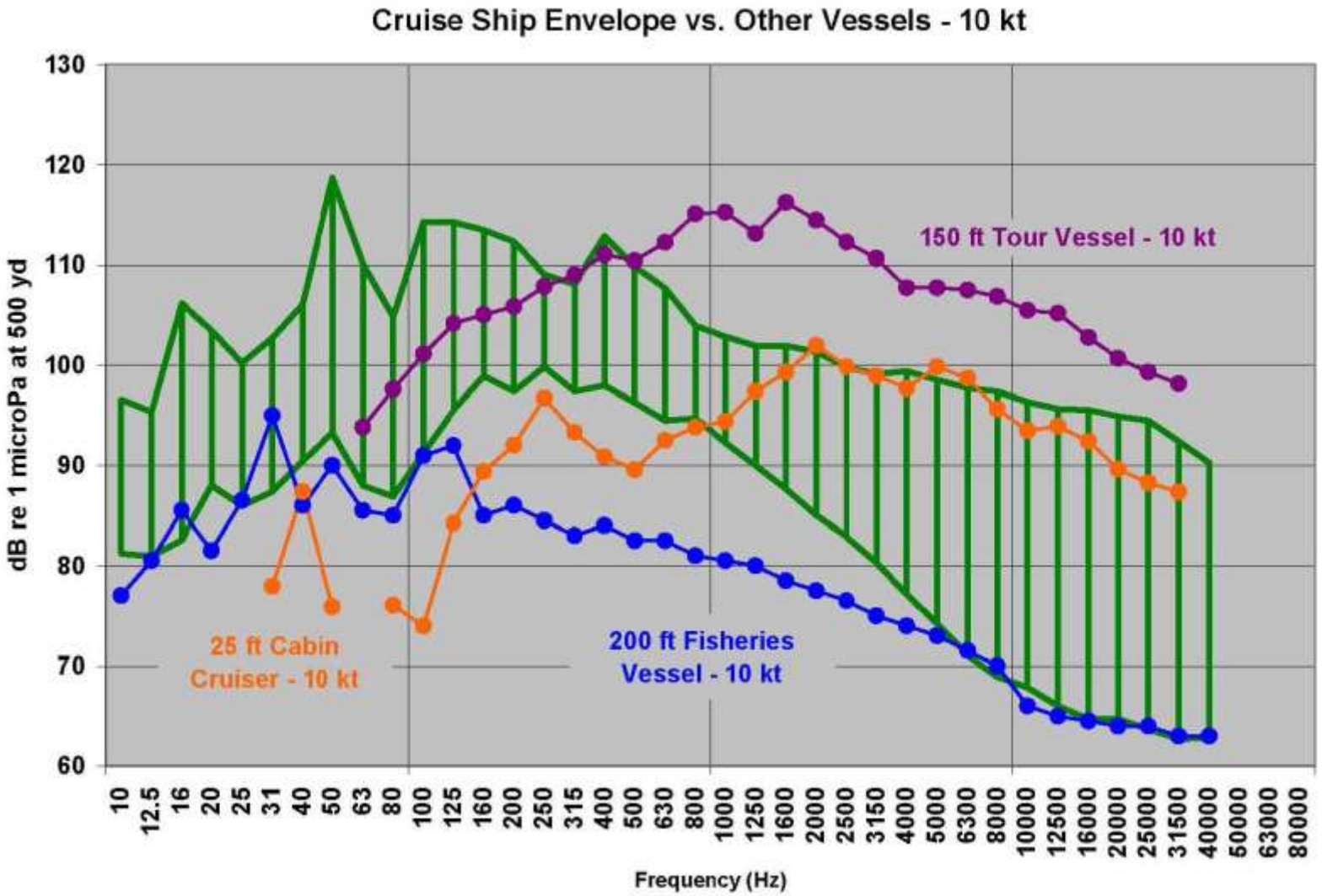
- Propeller
  - Non-cavitating noise
  - Cavitation noise
- Bow & stern thruster

SOME SHIP NOISE LEVELS



- McKenna et al (2011)

INFLUENCE SHIP SIZE



- Kipple (2007)

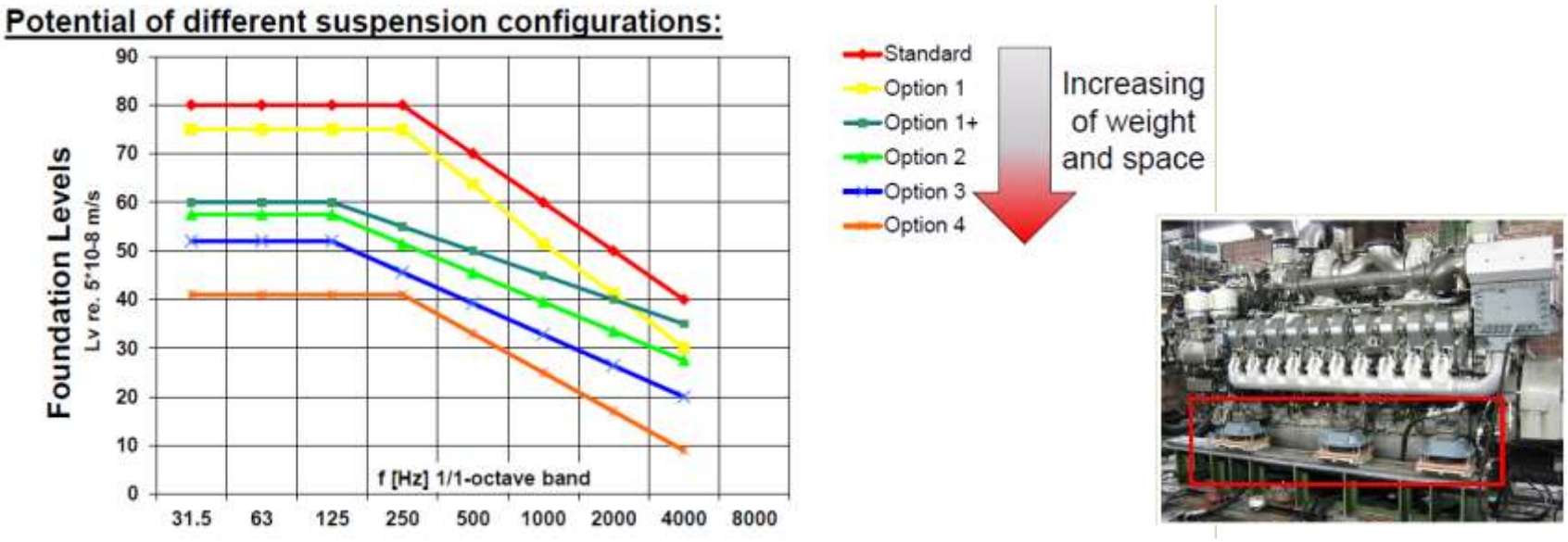
IMO DE57/WP8, GUIDELINES

General guidelines for

- Propeller design
- [Hull design]
- On board machinery
- Additional technologies for existing ships
- Operational and maintenance consideration

NOISE MITIGATION MEASURES – MACHINERY NOISE

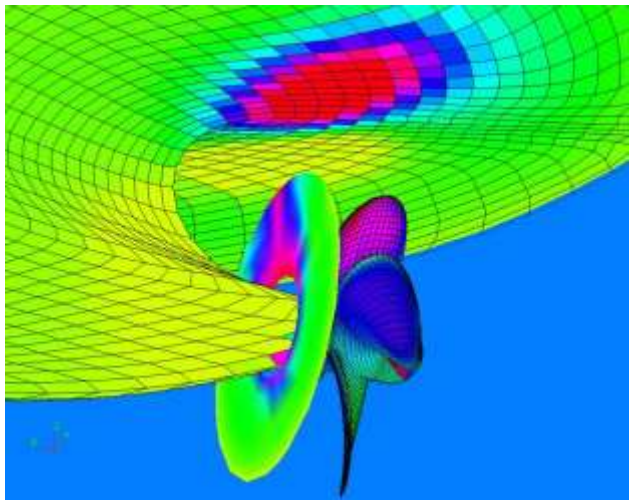
- Machinery noise
  - Diesel-electric most quiet
  - Apply resilient mountings, but not suitable for two-stroke engines
  - Elastic coupling between engine and gear box
  - Vibration isolation mounts for auxiliaries

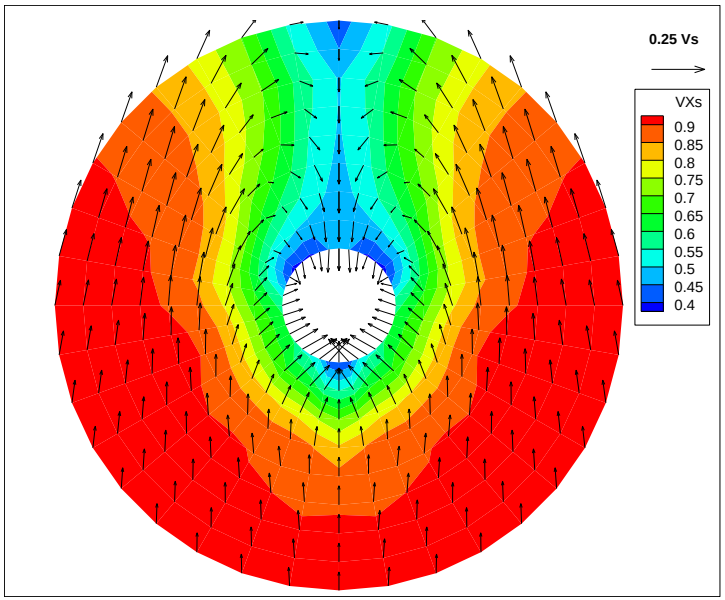


MTU

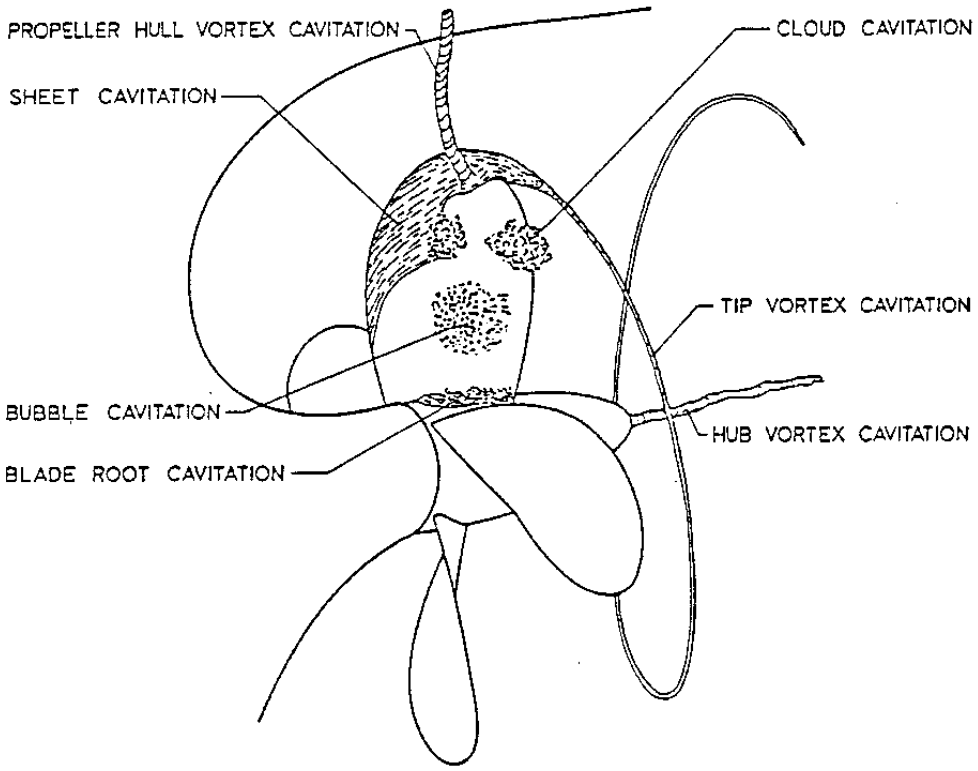
NOISE MITIGATION MEASURES – CAVITATION

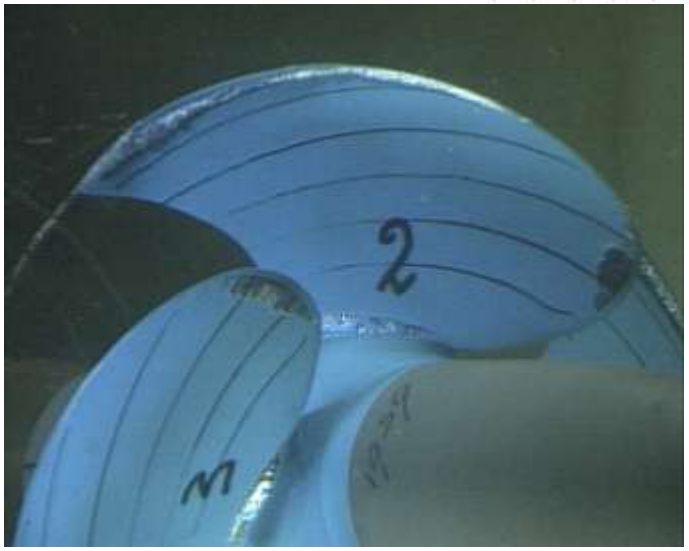
- The propeller operates in the ship wake field
  - varying velocity field -> varying loading -> cavitation dynamics
  - Cavitation dynamics -> noise and vibration hindrance
    - On-board: excitation of hull plating (traditional field)
    - Off-board: direct noise radiation ('new' field)

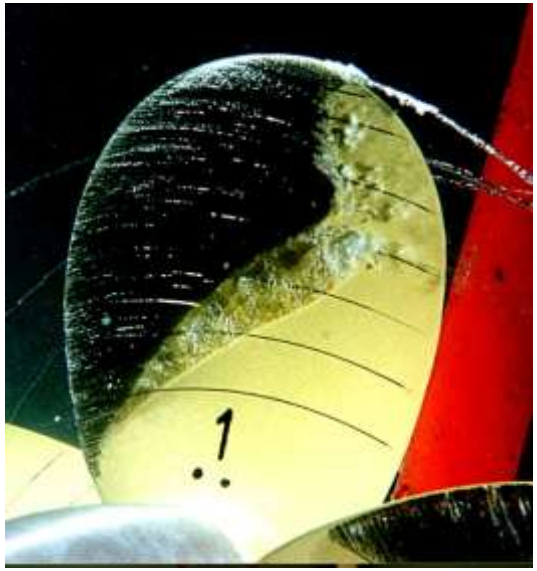




PROPELLER CAVITATION





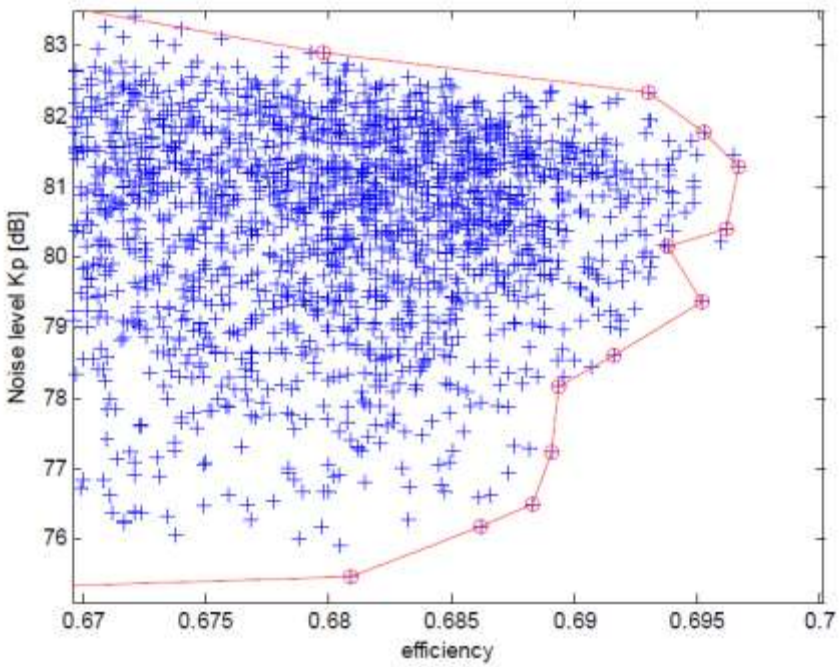


tip vortex cavitation.avi

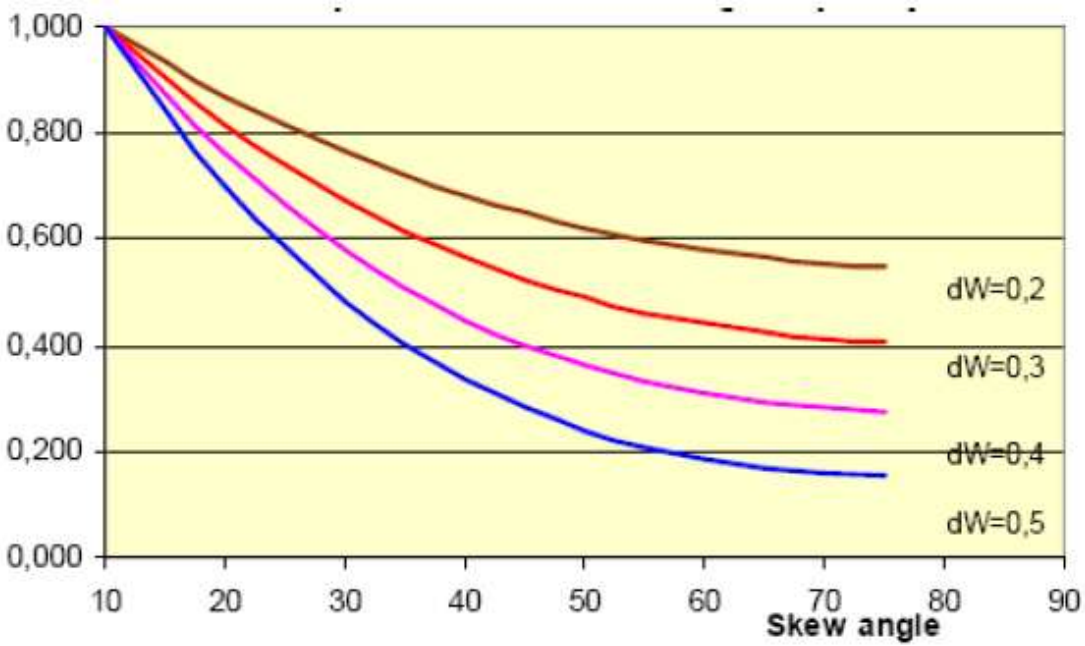
SHIP AND PROPELLER DESIGN PROCESS

- Optimize ship hull and appendages (experience, CFD, model tests)
  - Efficiency
  - Smooth wake field
- Optimize propeller (experience, CFD, model tests)
  - Efficiency
  - Cavitation hindrance

- Use parametric variations in CFD studies
  example: 4600 propellers



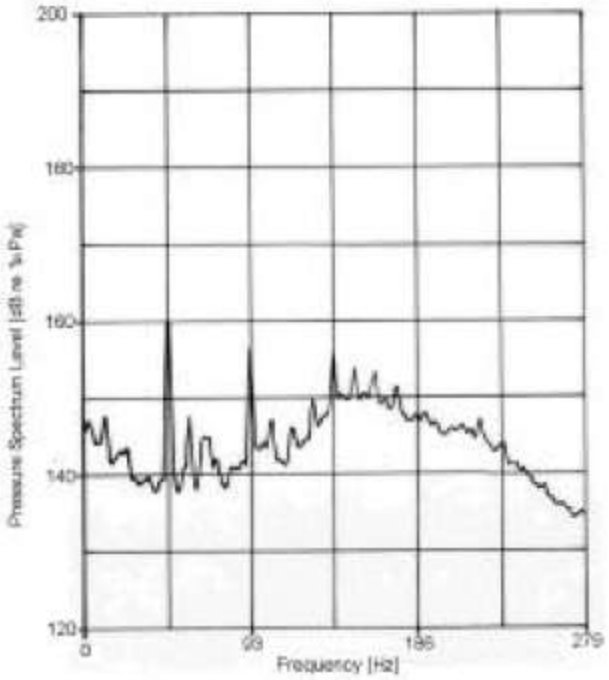
NOISE MITIGATION MEASURES – PROPELLER DESIGN

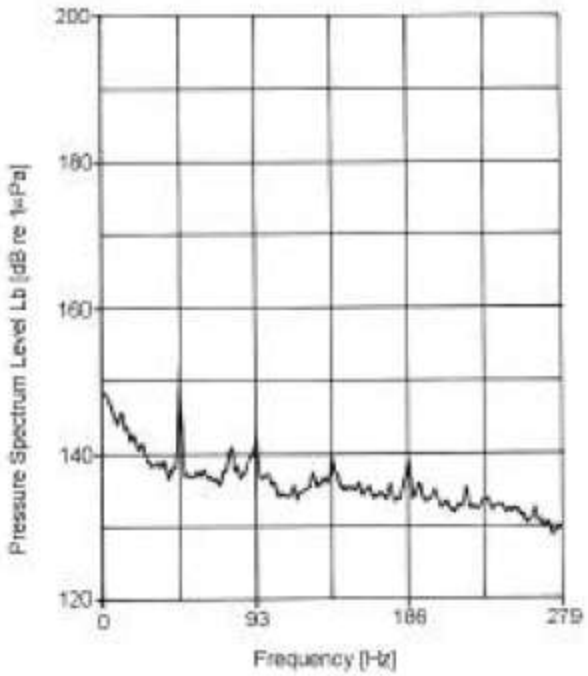


- Influence of propeller skew on hull pressures for various wake peak depths

NOISE MITIGATION MEASURES – PROPELLER DESIGN

- Propeller design
  - Influence tip loading twin screw vessel on hull pressures





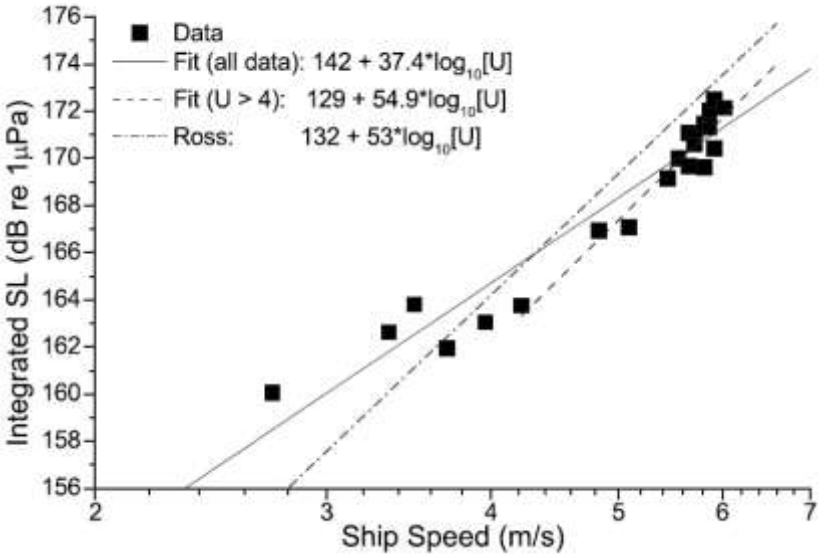
- High tip loading

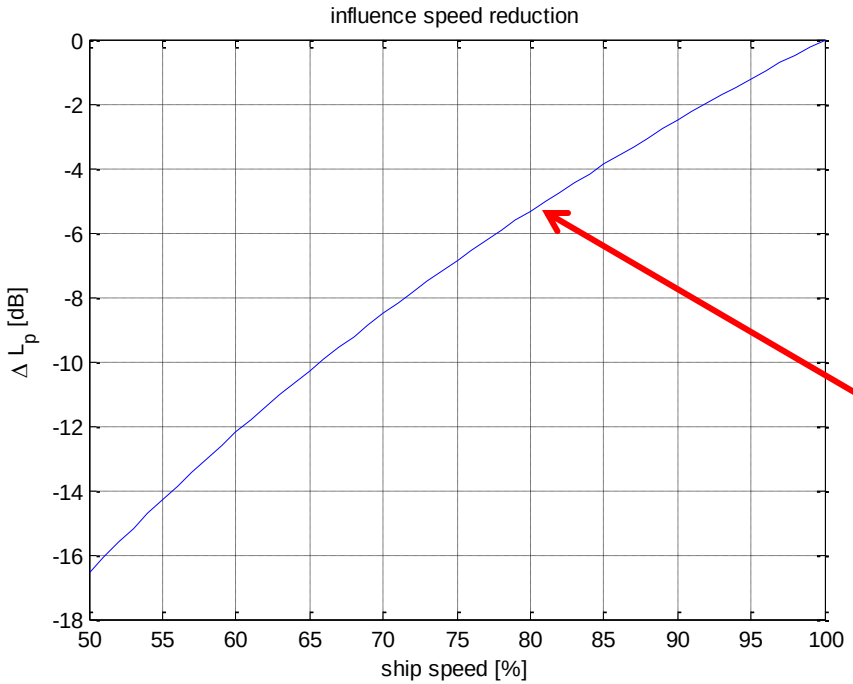
unloaded tip

NOISE MITIGATION MEASURES – SPEED REDUCTION

- Overall Ls scales as 55 log V

  can be higher for cavitation noise
- Does not work for CPP's !

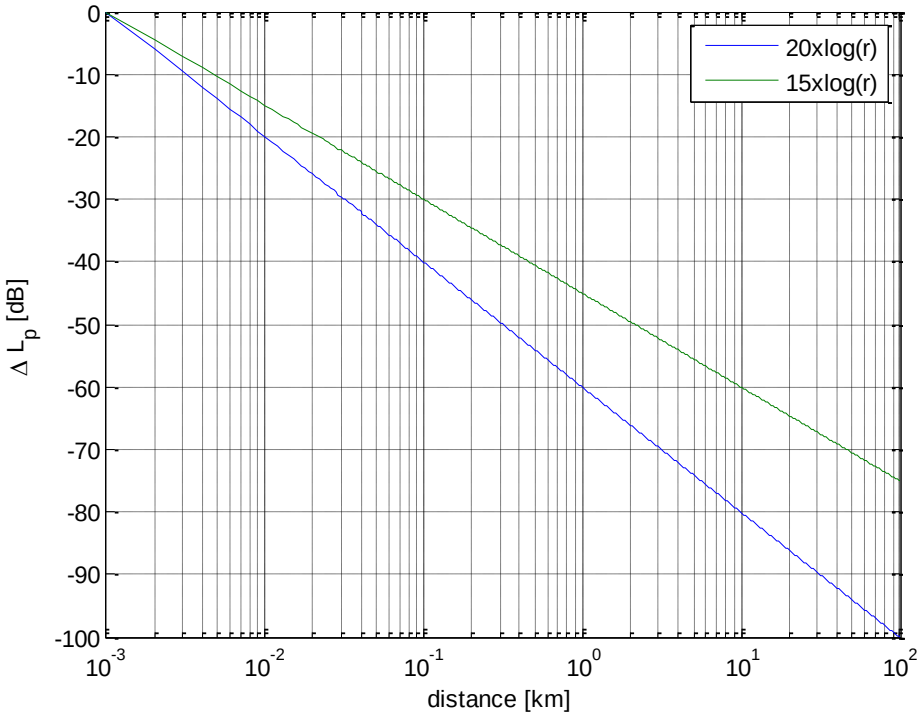




Speed reduction by 20%:
Noise reduction of 5.3 dB

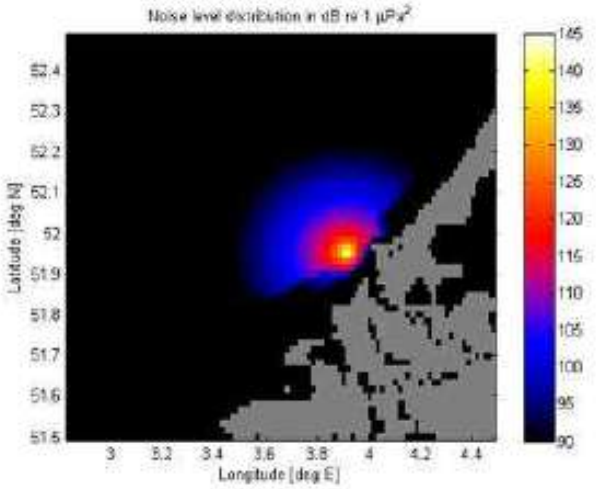
NOISE MITIGATION MEASURES – REROUTING

- Spherical spreading loss: 20*log R
  - Doubling of distance: 6 dB noise reduction
- Spreading loss may be much less in shallow water

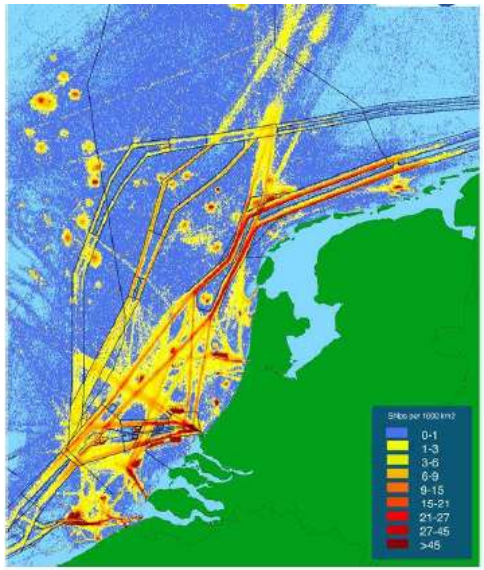


ON-GOING EU FP7 PROJECTS (2012-2015)

- Goals:
  - Develop prediction tools for noise footprint in design stage
  - Investigate shipping noise and mitigation measures
  - Develop noise map based on AIS data
  - …



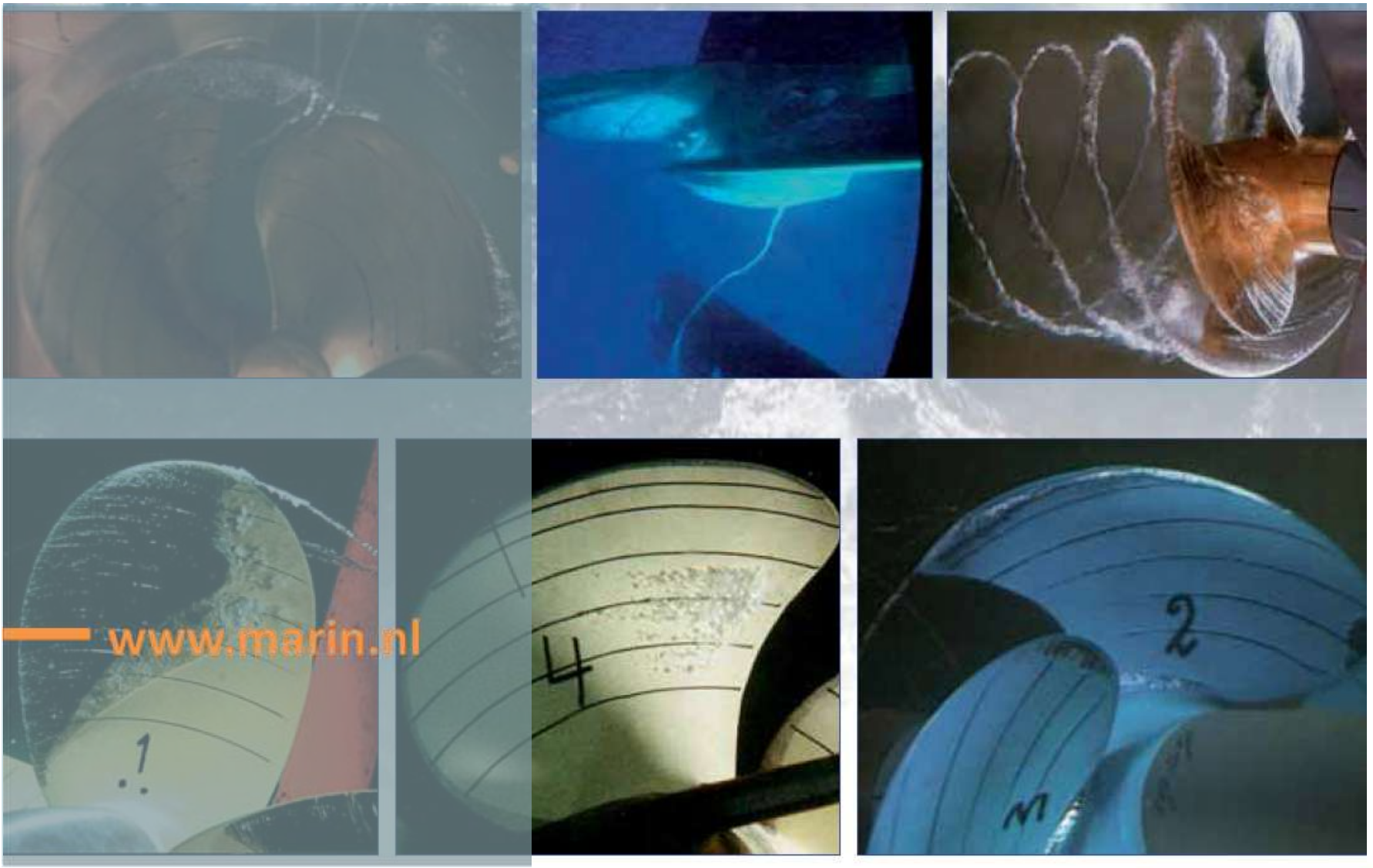
- SONIC (www.sonic-project.eu)
  - Coordinator MARIN
  - participants NL: MARIN, TNO
- AQUO (www.aquo.eu)
  - coordinator DCNS (Fr)
  - participant NL: IMAREST



CONCLUDING REMARKS

- Influence of shipping noise on marine life has interest of regulatory bodies (IMO, EU, EIA)
- Noise measurement standards for deep water available, for shallow water in development…
- Shipping noise is monitored and measured
  - US, EU, Korea,…
- Improved prediction methods for (cavitation) noise are in development
  - develop noise mitigation measures while maintaining efficiency
- Noise mapping tool based on AIS data in development
  - Investigate consequences noise mitigation measures

THANK YOU



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Introductie Black Carbon

-Paul Altena
Stafmedewerker Milieuzaken
Koninklijke Vereniging Nederlandse Reders

Woensdag 2 oktober 2013
IMO, What's Next? Seminar Platform Schone Scheepvaart

Black Carbon – a short history

January 2010 MEPC 60/4/24, Norway, Sweden, USA

1. The Arctic is warming faster than the rest of the planet;
2. Rapid melting of Arctic land and sea ice is accelerating this warming;
3. Black Carbon emissions, especially when deposited on land- and sea-ice are a significant contributor to this warming;
4. Reductions in Black Carbon, first and foremost, will lead to important benefits for human health; and
5. Black Carbon emissions are short-lived in the atmosphere; thus, emission reductions also can help reduce warming and provide climate benefits in the near-term.

->Table

Black Carbon – a short history

feb-12	BLG 16	Correspondence Group to develop a definition for Black carbon emissions
		Consider and identify the most appropriate measurement methods for Black carbon
		Identify and collate possible control measures to reduce the impact of Black carbon emissions

->40 dgr

Black Carbon – a short history

40th parallel north

->Table

Black Carbon – a short history

feb-12	BLG 16	Correspondence Group to develop a definition for Black carbon emissions	
		Consider and identify the most appropriate measurement methods for Black carbon	
		Identify and collate possible control measures to reduce the impact of Black carbon emissions	
5-15% of PM emissions = BC		MEPC 63	Mar-12
		MEPC 64	oct-12

->Table

Black Carbon – a short history

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<tr><td colspan="2">The Committee taking into account that this matter will be considered at BLG 18, agreed to forward document MEPC 65/4/22 to BLG 18 for consideration.</td><td rowspan="2">MEPC 65</td><td rowspan="2">may-13</td></tr>
<tr><td colspan="2">agreed that DE Sub-Committee should await the outcome of the BLG Sub-Committee's work on the impact on the Arctic of emissions of BC from international shipping.</td></tr>
</table>

->Def.

What is Black Carbon? - Definitions

- Soot: “black, mostly carbonaceous material originating from combustion sources” (Wikipedia: definition for Black Carbon)

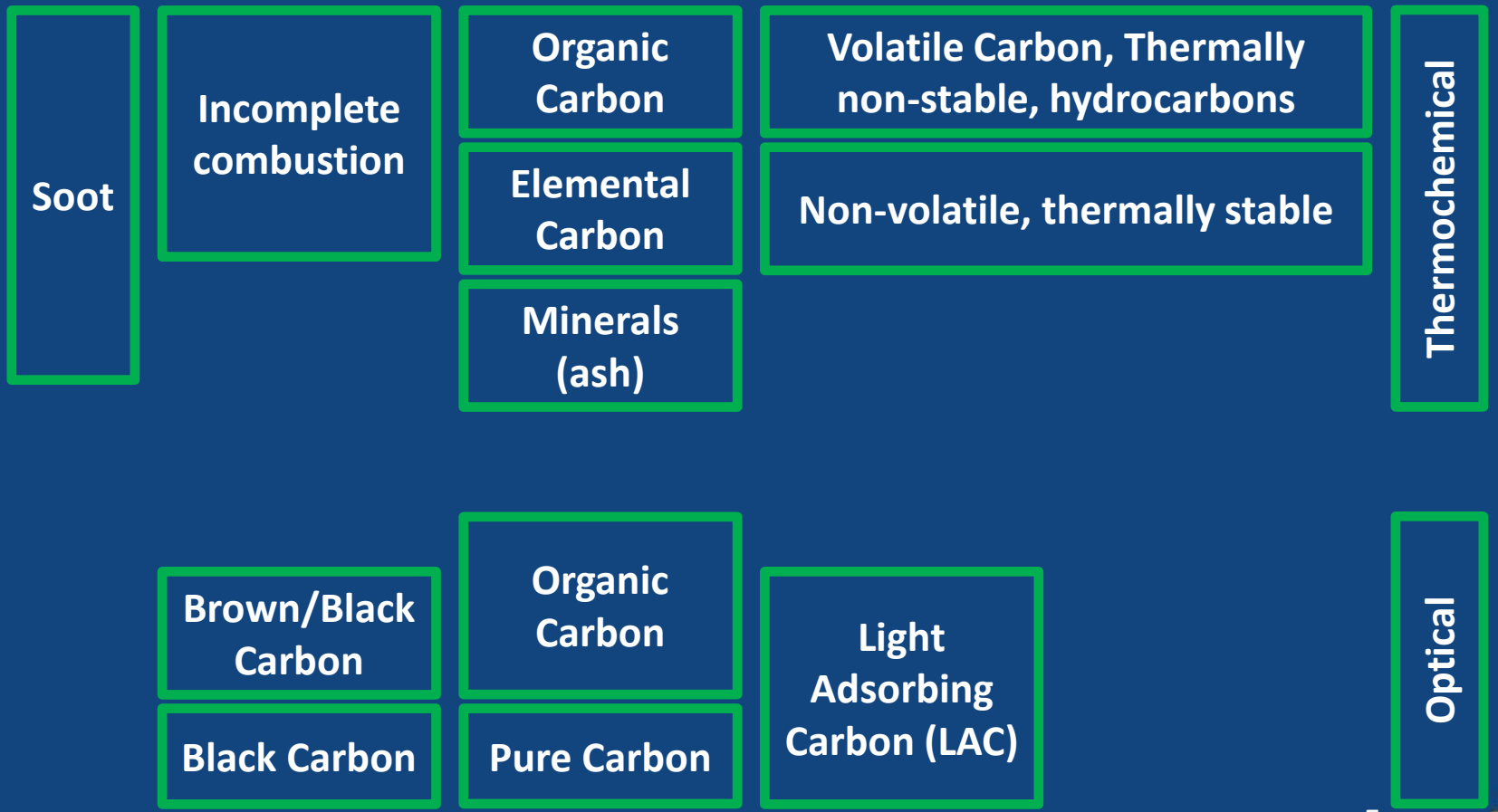
- Black Carbon (BC):
- “used when specific attention is paid to optical properties” (e.g. light adsorption of atmospheric aerosols)

- Classification of carbonaceous material:
  Optical vs. Thermochemical

- IMO definition – not accepted yet (2013)

->Graph

What is Black Carbon? - Schedule



->Exp.

Can we expect IMO legislation any time soon?
-Responsibility of shipping sector

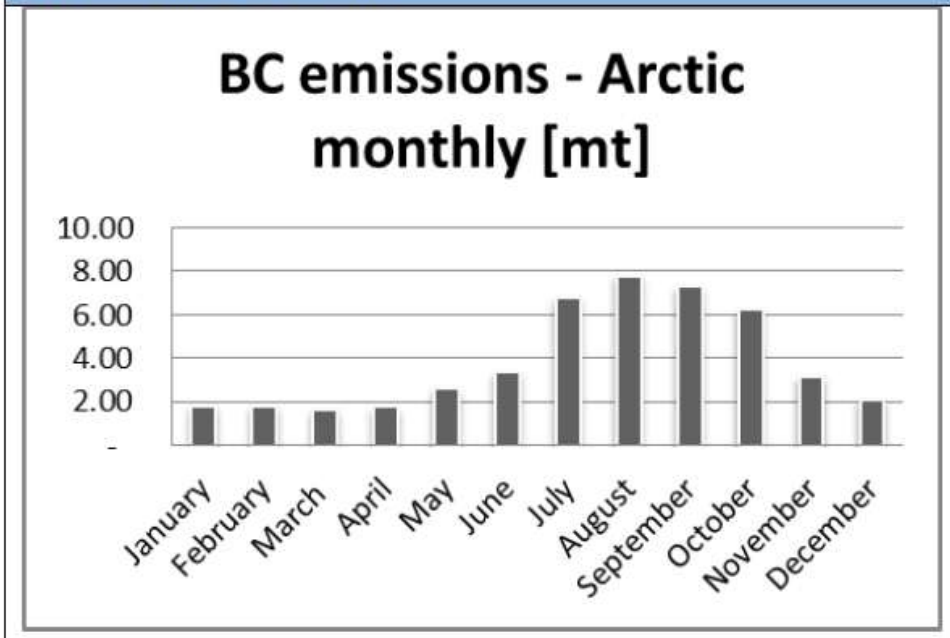
- Worldwide
  - Probably less than 1% (CIMAC (2012))
  - International shipping emits between 71 000 and 160 000 metric tons (mt) of BC annually, representing about 15% of total PM emitted by ships and about 2% of global BC from all sources. (Corbett et al., 2007; Lack et al., 2008, 2009)
- Arctic:
  - 37%: biomass
  - 21%: S-E Asia
  - 18%: Europe
  - 14%: Russia
  - 9%: N-America
  - 7%: Aircraft (Koch and Hansen (2005))

->Effect

Black Carbon effects of shipping

Shipping emissions in the Arctic are projected to increase dramatically over the next several decades, by up to five times by 2030 and almost 20 times by 2050. (source:, MEPC 60/4/24, Norway, Sweden, USA)

Presentation of results



Vessel Category (one year)	BC [mt]
Other Activities	15.81
Other offshore vessels	0.79
Bulk ship	6.13
Fishing vessels	20.31
Gas tankers	0.00
Product tankers	4.04
Reefers	1.48
Container vessels	13.90
Offshore supply vessels	7.02
Oil tankers	10.75
Passenger vessels	7.71
General cargo	4.24
Unknown	-
Total (one year)	92,17

(Source: MEPC 64/4/22 Norway)

->Climat

Climate effects of Black Carbon

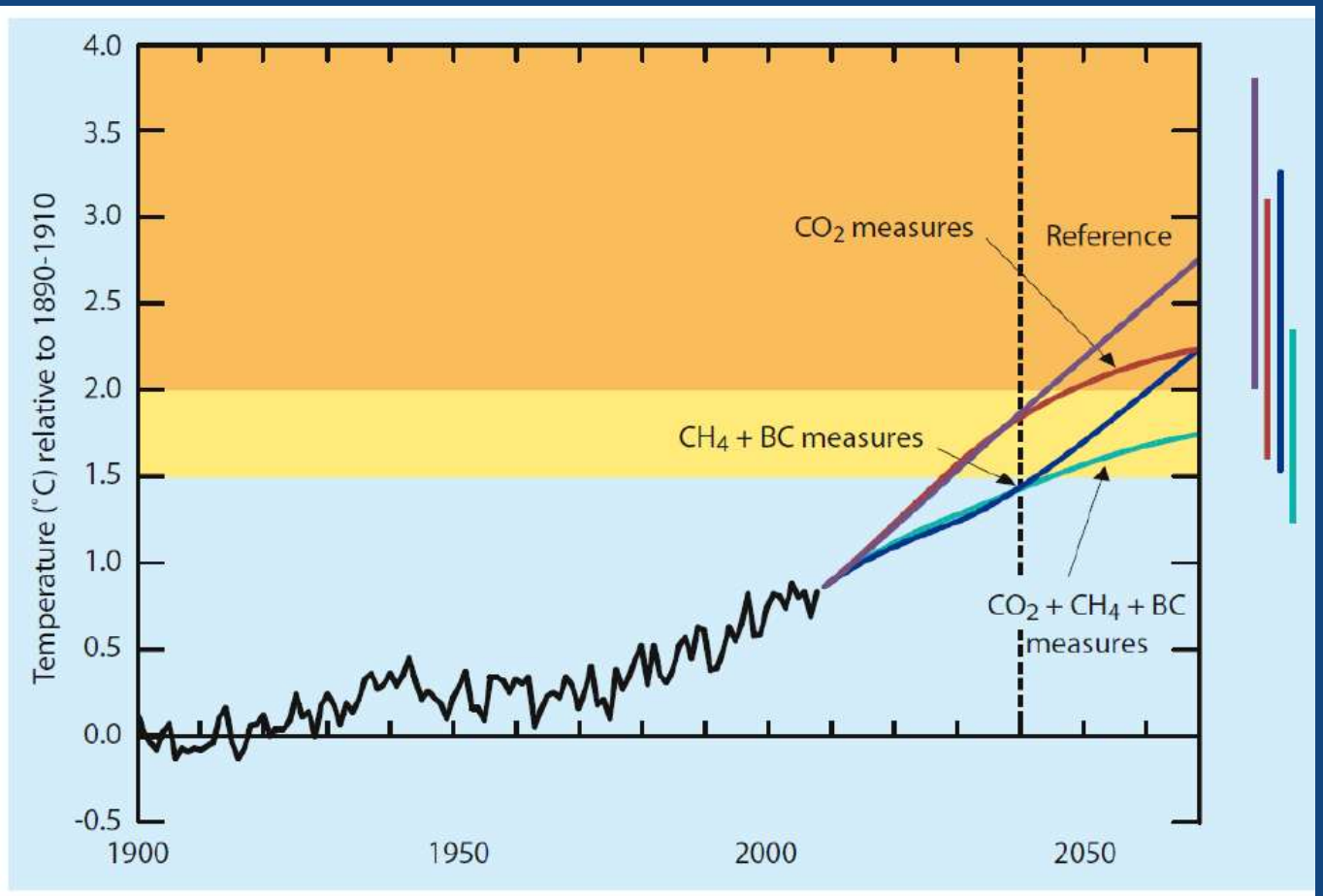


Figure 4: Source: UNEP/WMO using an average of two global composition models (GCMs) that estimates pollutant concentrations, radiative forcing and global climate.

MEPC 64/4/22
Norway

->Meas.

Abatement Measure	⇓CO_2 %	⇓BC %	⇓NO_X	⇓SO_X	Technology Maturity	Uptake Time	Remarks	Ref.
EEDI*	30	30	Yes	Yes	n/a	LT	Required due to regulation; New-builds, >400 tonnes	[36]
Slow Steaming: With De-Rating	18.5	15	Yes	Yes	CM	IN	New engine needed	[10, 62, 72, 76, 78]
Water-in-Fuel Emulsion	0	70	Yes	Yes	CF	IM		[62, 65, 85, 87]
HFO - Distillate	7	52	No	Yes	CM	IM	Fuel cost/ availability	[10]
LNG	22.5	93.5	Yes	Yes	CF	IN	Engine/fuel storage retrofit; Port supply of LNG; Fugitive emissions.	[62, 96-98]
Diesel Particulate Filters	-3.5	85**	No	No	D	IN	Commercial availability for ships; Requires low sulphur fuel.	[65, 97, 112-114]
Scrubbers - High Sulphur	-3	60	Yes	Yes	CM	IM	Unit cost: Fuel S regulation motivation.	[10, 65]

Source: Litehauz 2012

->End

Thank you for your attention

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Black Carbon Emissions - Possible Solutions

2 October 2013

Göran Hellén
Senior Manager
Wärtsilä Finland Oy

WÄRTSILÄ

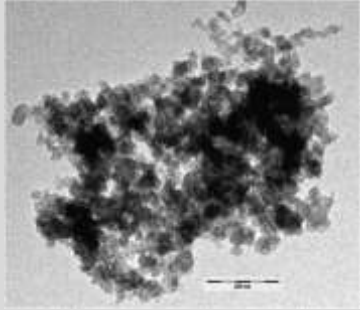
Content

- Background – why are we interested in Black Carbon (BC)
- Definition of BC
- Typical BC Emissions and Emission Factors
- Choice of Measurement Method for BC
- Switch to Distillate Fuel – is that a solution?
- Comments to Proposed and Potential Black Carbon Abatement Measures
- Sum up and Conclusions

Why we are interested in ”black carbon”?

- Global Warming
  - Important greenhouse agent
  - Anthropogenic sources
    - Emission reduction?
- Short Lived Climate Forcer (SLCF)
  - Lifetime in atmosphere up to some weeks
  - Successful abatement is expected to result in measurable temperature change after short time period

Definitions



- Black Carbon (BC)
  - No good definition exists
  - Used as synonym to soot
- Soot
  - No good definition exists

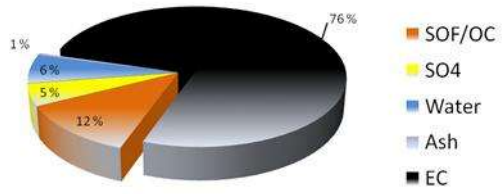
Combustion derived particles/matter

1. Black
2. Carbon

→ **In practise Black Carbon is defined by the measurement method**

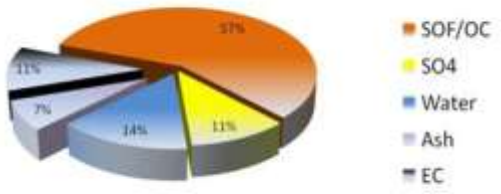
Typical Diesel Particulate (PM) Composition – ISO 8178 Measurement method

Vehicle diesel engine - Automotive Diesel Fuel



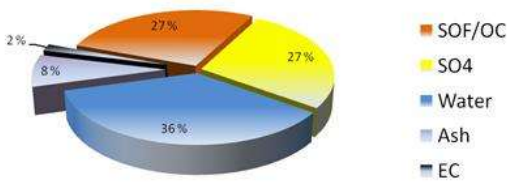
Typically abt. **75%** of the PM consists of Elemental Carbon / ”Black Carbon”

4-stroke marine diesel operating on marine type of Distillate Fuel



Typically abt. **10-15%** of the PM consists of Elemental Carbon / ”Black Carbon”

4-stroke marine diesel operating on Heavy Fuel Oil



Typically abt. **2-5%** of the PM consists of Elemental Carbon / ”Black Carbon”

- Components causing cooling: Sulphates, Organic Carbon, Mineral dust
- Components causing warming: Black Carbon

→ ”HFO-particlulates” tend to have less radiative force than those generated during operation on distillate fuel and the overall contribution of shipping to global warming is supposed to change from cooling to warming due to reduction in fuel sulphur content

References:

Fuglestved J., Berntsen T., Eyring V., Isaksen I., Lee D., Ausen R. (2009) “Shipping emissions: From cooling to warming of climate – and reducing impacts on health” Environmental Science & Technology Viewpoint 43 24 9057-9062

Eyring V., Isaksen I., Berntsen T., Collins W., Corbett J., Endresen O., Grainger R., Moldanova J., Schlager H., Stevenson D. (2010) “ Transport impacts on atmosphere and climate: Shipping” Atmospheric environment 44 4735-4771

Reported Black Carbon Emission Factors

Literature data for Black/Elemental Carbon emissions of ship engines:

	g (Black Carbon) / kg fuel burned	Method of determination
Lack et al.	0.36 -1	Optical / photoacustic
Agraval et al.	0.1	Thermal
Corbett et al.	0.37	-
Petzold et al.	0.06 (85% load) – 0.36 (10% load)	Optical
Petzold et al.	0.179+/- 0.018	Optical

Comments:

- Variation with a factor of about 10
- Some variation can be explained by differences in the measurement method
- Engine laboratory measurements are indicating a typical BC emission level of 0.05 – 0.20 g/kg fuel used.
- Lack et. al estimate the contribution of shipping to the global LAC emissions to be abt. 1.7%. This value is probably overestimated – the contribution of shipping is probable less than 1%

Reference: Cimac Publication – January 2012: ”Background Information on Black Carbon Emissions From Large Marine and Stationary Diesel Engines – Definition, Measurement Methods, Emission Factors and Abatement Technologies”

Choice of BC Measurement Method - Relevance

- What is relevant:
  - Global warming:
    - **<u>Light absorption</u>**

    → Light absorbing carbon (LAC)

    → IPCC: Light absorbing components (BC)

Recommended BC Measurement Method

Several methods exist – All of them measuring various properties - Results from different instruments cannot be compared directly => Black Carbon reference method is needed.

Major criteria for selection of recommended measurement method:

- Proposed measurement method should be optical, as this is most relevant for the global warming aspect.
- Proposed measurement method should mirror the light absorption of Black Carbon deposits, e.g. opacity meters can be misleading.
- Measurement method should be standardized and have robust instruments available also for onboard use.
  - Laboratory methods requiring very skilled personnel must be avoided
- Long experience of the method/instruments is required

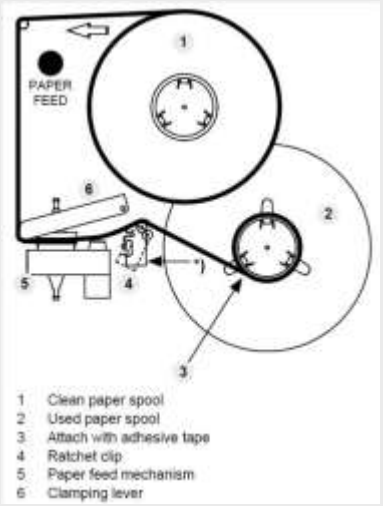
Based on the criteria above **CIMAC, Euromot and Wärtsilä** recommend the **Filter Smoke Number (FSN)** method (ISO 8178 and ISO10054) to be used for measuring Black Carbon emissions from ships.

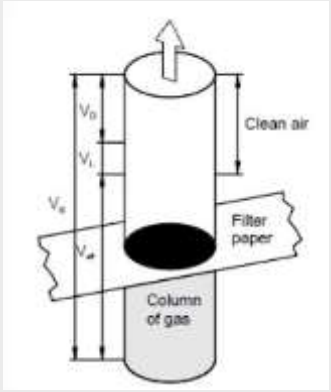
- All other proposed methods are not standardized for stack measurements and/or they require very skilled personnel

Recommended BC Measurement Method - Filter Smoke Number (FSN)

Example of instruments: AVL-415 series of Smokemeters

- Meets the ISO 8178 and ISO 10054 standards
- Widely used and easy to operate

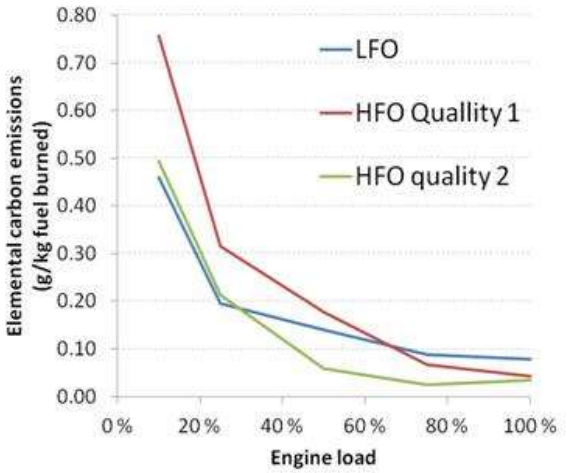




- The measurement method is based on measurement of paper blackening by a reflectometer head
- White filter paper is 0 and completely black is 10 FSN
- Calibration once a year

Switch to Distillate Fuel - Solution ?

Measured ”Black Carbon” emissions from a 4-stroke medium speed engine



LFO:	Sulphur: < 0.05%;	Ash: <0.01%
HFO Quality 1:	Sulphur: 0.89%;	Ash: 0.02%
HFO Quality 2:	Sulphur: 2.42%;	Ash: 0.07%

Conclusion: No measured significant difference in Black Carbon emissions between Marine Distillate Fuel (LFO) and Heavy Fuel Oil (HFO)

Reference: Cimac Publication – January 2012: ”Background Information on Black Carbon Emissions From Large Marine and Stationary Diesel Engines – Definition, Measurement Methods, Emission Factors and Abatement Technologies”

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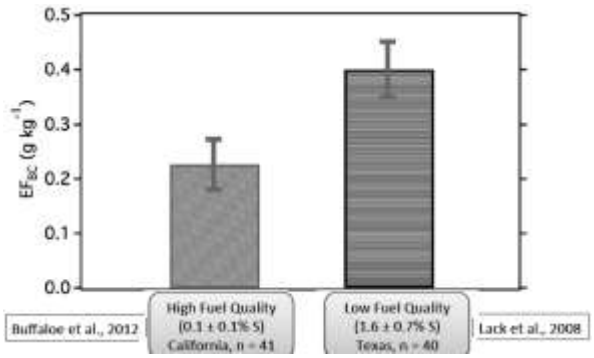
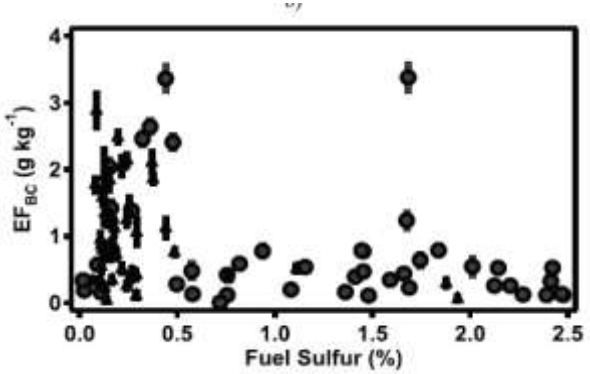
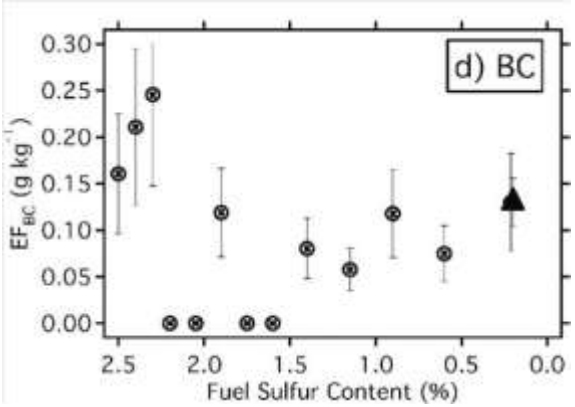
Distillate Fuel versus Heavy Fuel Oil; Emission factors



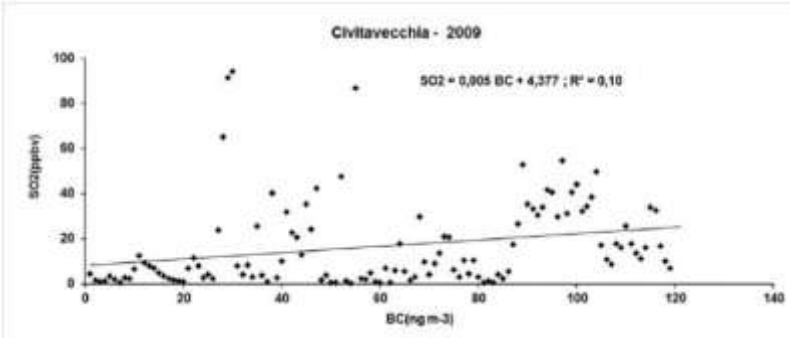
Lack et al 2011 Presentation at IMO/ IMO BLG 16; Jan 2012 [1]



Lack et al 2009 ; Journal of geophysical research [2]



Lack et al ES&T 2011 9052-9060 [3]



Schembari et al. (2012) [5]

Conclusions:

1. **Mixed results regarding Distillate Fuel versus Heavy Fuel Oil - No clear trend**
2. **Mixed results regarding Emission factor levels**

References:

1) Presentation by Dan Lack on "Fuel Quality and Black Carbon from Ships" given on 31st January 2012 during the IMO BLG 16 meeting in London

2) Lack D., Corbett J.J. et al 2009 "Particulate emissions from commercial shipping: Chemical, physical and optical properties" published in Journal of geophysical research (doi: 10.1029/2008JD011300)

3) Lack et al. 2011: "Impact of Fuel Quality Regulation and Speed Reductions on Shipping Emissions: Implications for Climate and Air Quality; dx.doi.org/10.1021/es2013424; Environ. Sci. Technology 2011, 45, 9052-9060

4) Schembari, C., Cavalli, F., Cuccia, E., Hjorth, J., Calzolai, G., Noemi, P., Pey, J., Prati, P., Raes, F.: "Impact of a European directive on ship emissions on air quality in Mediterranean harbours", Atmospheric Environment, Volume 61, December 2012, Pages 661-669, ISSN 1352-2310, 10.1016/j.atmosenv.2012.06.047

Comments to Proposed and Potential Black Carbon Abatement Measures (1/3)

In engine measures:

- Improvements in combustion
  - Large diesel engines have already high thermal efficiency
    - Major improvement steps unlikely
    - Improvement of combustion has always been an ”everyday” task
- Injection valve design – smaller injector sack volume
  - Possible applicable to some 2-stroke engines
  - 4-stroke engines have already small sack volumes
- Common rail fuel injection system
  - Higher injection pressures help to decrease black carbon emissions
    - Typically NOx emissions increase simultaneously
    - Largest improvements obtainable at low loads
- Exhaust gas recirculation (EGR)
  - EGR is used for NOx reduction
  - Black carbon emissions typically increase when NOx is reduced

Comments to Proposed and Potential Black Carbon Abatement Measures (2/3)

In engine measures:

- Fuel Change
  - Water in fuel emulsions
  - Reductions at high loads / with new designs unlikely
- Switch from Heavy Fuel Oil (HFO) to Distillate Fuel (LFO)
  - Mixed results
  - Some results imply reductions in BC while others report no change or even an increase

After treatment:

- Bag filters and electrostatic precipitators
  - Relatively high filtration efficiencies
  - Huge size – not feasible for a ship
- SCR catalyst
  - For NOx reduction
  - No reduction in BC

Comments to Proposed and Potential Black Carbon Abatement Measures (3/3)

After treatment:

- Diesel Particulate Filter (DPF)
  - BC reduction efficiency ?
  - Challenges:
    - The DPF system would need to be very large not to exceed the maximum backpressure requirements
    - Mechanical strength due to vibrations caused by pressure pulses in the exhaust gas typical for this size of engine
    - The ash components of the particulates cannot be burnt away during the regeneration phase causing increasing backpressure and finally clogging of the filter
  - Diesel particulate Filter (DPF) is not a feasible solution today for large marine engines. There is no existing demonstration installation in this scale

- DeSOx systems / Scrubbers
  - Has some ability to reduce particulate emissions
  - Whether scrubbers reduce the BC part of the particulate to significant degree is unclear at present – a consolidated view of the magnitude of the benefit has yet to be formed

Black Carbon at IMO

Important open item at IMO:

- Key question in the discussion at IMO – should we regulate:
  - BC from "only shipping inside the Arctic" or
  - BC from "international shipping" => would mean that the Baltic Sea and North Sea including many other northern hemisphere areas would be affected

Sum up and Conclusions

- Black Carbon is an greenhouse agent
- No good definition on Black Carbon exists
  - Often used as synonym to “soot”
- IMO:
  - CIMAC, Euromot and Wärtsilä recommend the Filter Smoke Number (FSN) method (ISO 8178 and ISO10054) to be used for measuring Black Carbon emissions from ships.
  - All other proposed method s are not standardized for stack measurements and/or they require very skilled personnel
  - Should we regulate BC from shipping inside the Arctic (only) or from “international shipping”
- Typical Particulate Matter (PM) composition:
  - Vehicle on automotive diesel fuel: 75% is BC
  - Marine diesel on marine distillate fuel: 10-15% is BC
  - Marine diesel on Heavy Fuel Oil: 2-5% is BC
- Contribution of shipping to the global LAC emissions has been estimated to abt. 1.7%. This value is probably overestimated – the contribution of shipping is probable less than 1%
- Mixed results regarding BC emission factors with HFO versus Distillate fuel – no significant clear trend observed
  - Switch to Distillate Fuel does not seem to be a solution
- Potential for a big step reduction of BC from big marine engines:
  - Obvious candidate method for a <u>big step</u> is non-existing

Where to learn more about Black Carbon from Shipping

1) Cimac Publication – January 2012: ”Background Information on Black Carbon Emissions From Large Marine and Stationary Diesel Engines – Definition, Measurement Methods, Emission Factors and Abatement Technologies”

2) Cimac Document – July 2013: Influence of Fuel Quality on Black Carbon Emissions in the Arctic Region caused by International Shipping – Comments to discussions at IMO. Issued in 2013 by CIMAC Working Group Exhaust Emissions Control (WG 5)

Both documents can be downloaded from

http://www.cimac.com/workinggroups/Index1-working-groups-exhaustemission.htm

”Every third ship you see is powered by us”

”Every second ship you see is serviced by us”

Thank You for Your attention !

WÄRTSILÄ