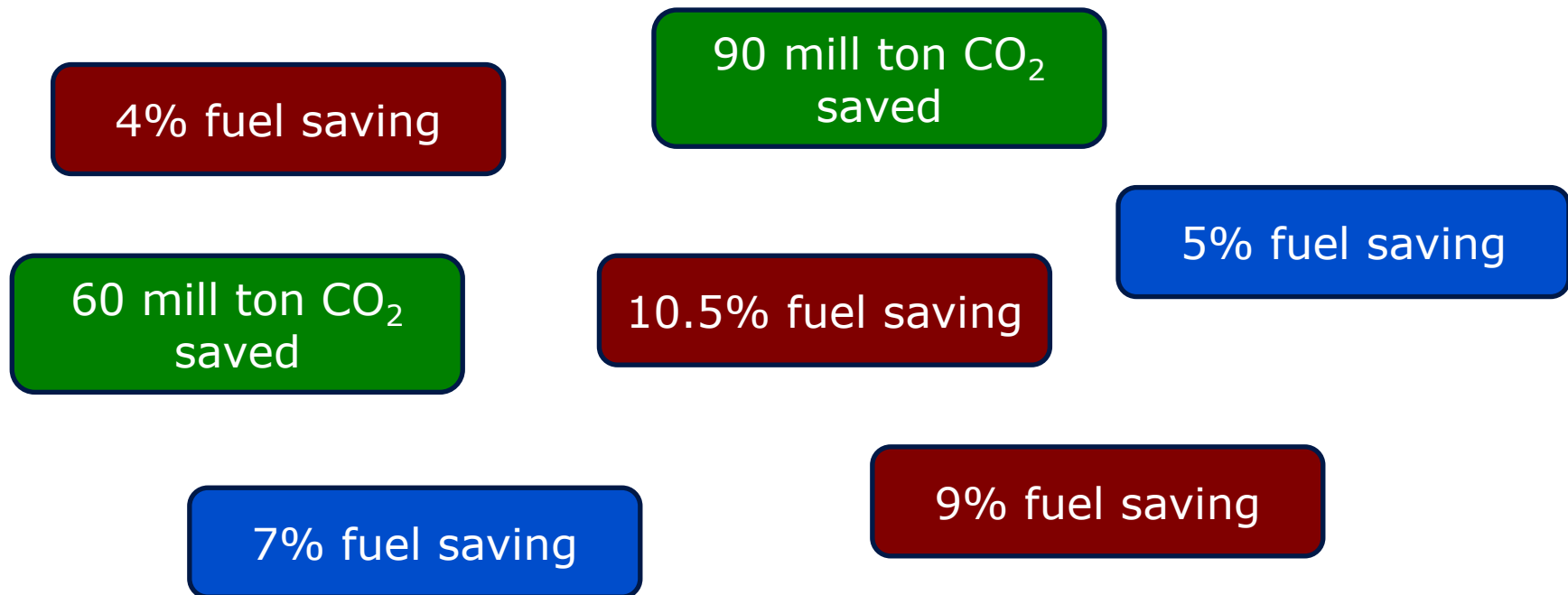


“Perception is everything” – make sure that you can discover the illusion

Fuel savings – Compared to what & how to measure?



Almost all suppliers to the marine industry offers fuel / emission savings – but can everyone be correct?



Current methods fall short...



	HULL ROUGHNESS	FUEL CONSUMPTION	"BLACK BOX"
Description	Measuring Hull Roughness (HR) out of and into DD, translating HR into Friction Coefficient (CF) and CF into Hull performance	Measuring actual Fuel Consumption over time	Depends on provider
Challenges	Accurately measuring Hull Roughness is extremely complex and difficult. Only measuring out of and into DD, i.e. no data on performance in between. The relationship between HR and CF is far from fully understood	Many potential sources of random error, including fuel quality, engine performance, vessel operation, operating conditions, etc.	Difficult for both Jotun and customer to trust The need for "buffers" on both sides makes performance based contracting virtually impossible

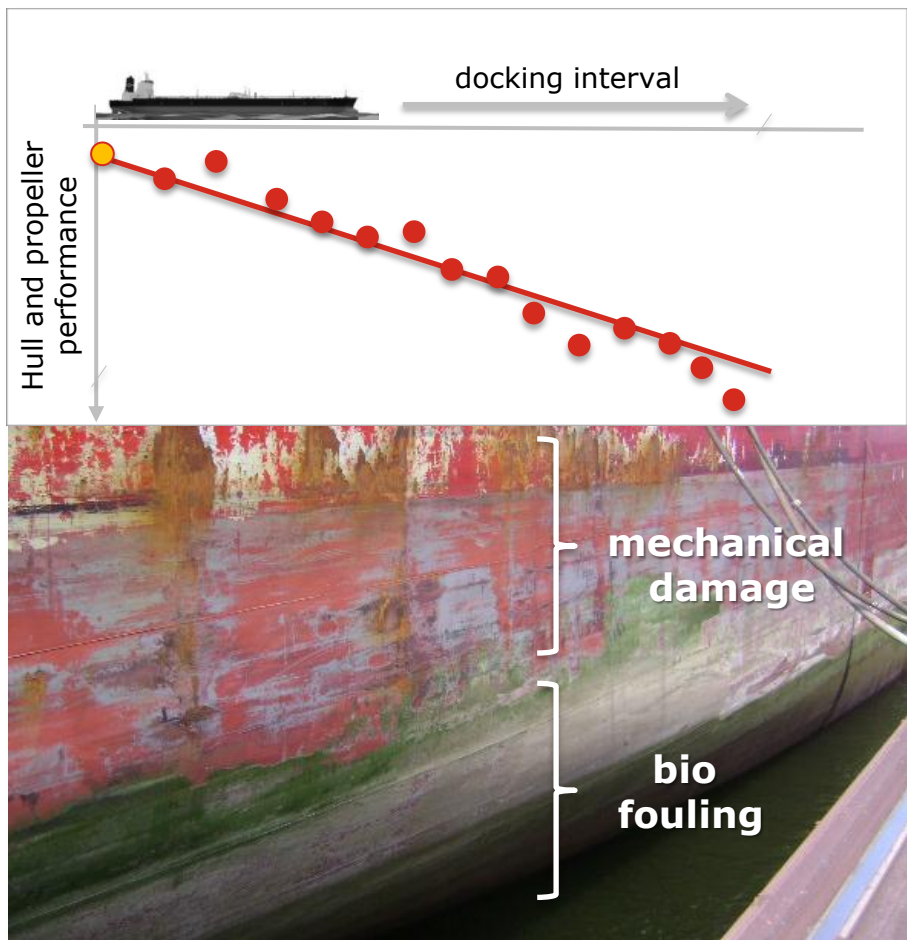
Why monitoring hull performance?



- Important to distinguish two complementary areas of need for hull performance monitoring:
 - **operational** decision support (e.g. cleaning schedules)
 - performance based **contracting** on lifetime quality of underwater hull coatings (of strategic importance)
- Different needs define different requirements
 - required resolution (short term vs. long term)
 - sets of general requirements



The culprits – biofouling and mechanical damage



- Average over period drop in propulsion efficiency caused by bio-fouling and mechanical damage:
 - Marintek¹: ~ **15%**
 - Propulsion Dynamic (tankers)²: ~ **20%**
 - Jotun (avg. over 60 months): ~ **18%**
- CSC in MEPC 63-4-8: 15 to 20% loss in propulsion efficiency -> **9 to 12%** increase in energy cost and GHG emissions

1) In second IMO GHG study 2009, section A2.63

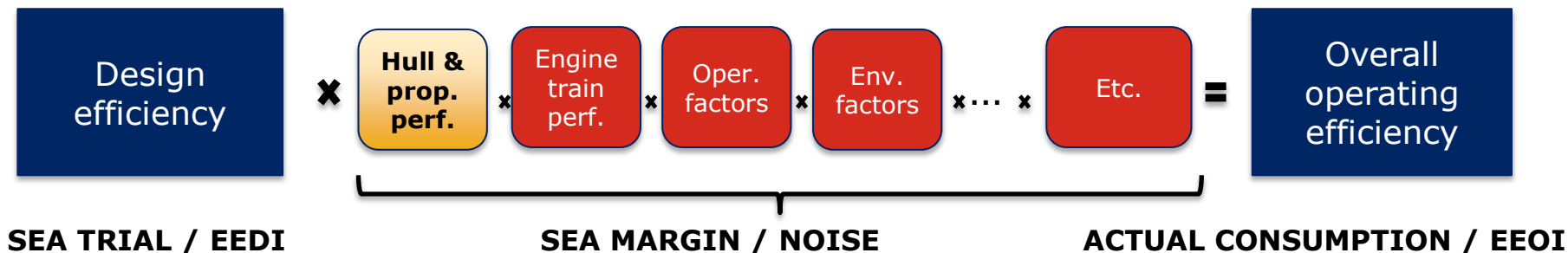
2) In Hellio & Yebara, Advances in marine antifouling coatings and technologies, 2009



Given the vast range of performance enhancing technologies, products and solutions available on the market – why does performance remain poor?



No / limited measurability

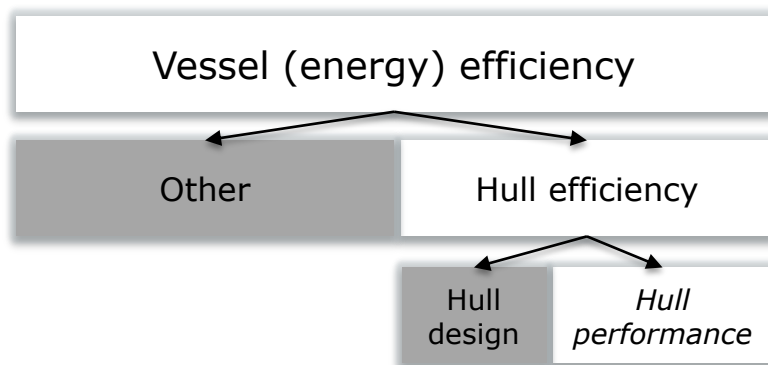


If I can't measure a return, investing in improved performance has no value!



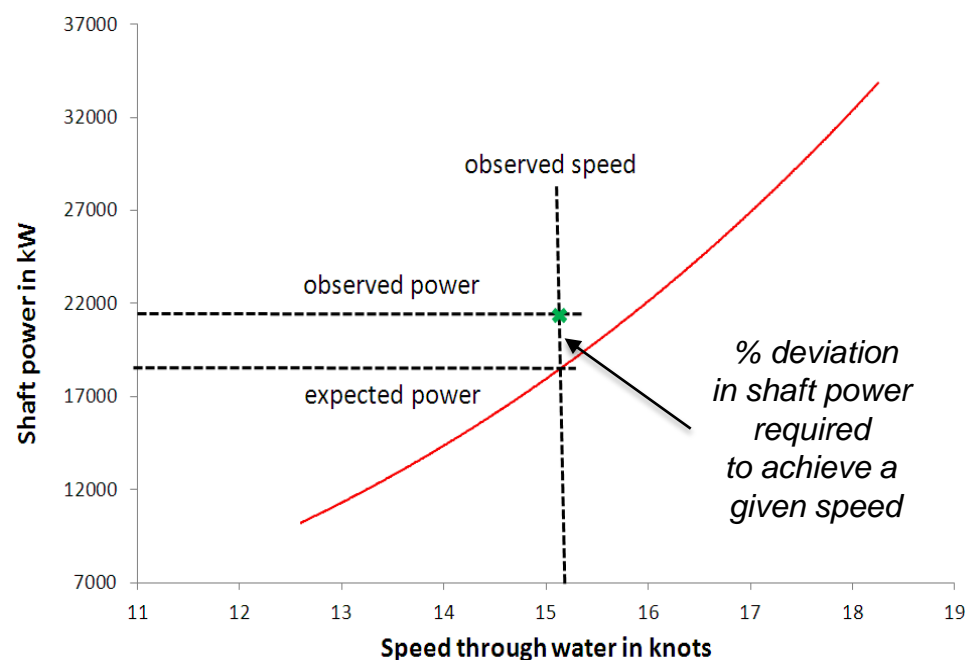


Measuring changes in the efficiency of the underwater hull over time



How much more (or less) power is required to achieve a given speed attributable to changes to the condition of the hull over time?

- given unchanged hull design

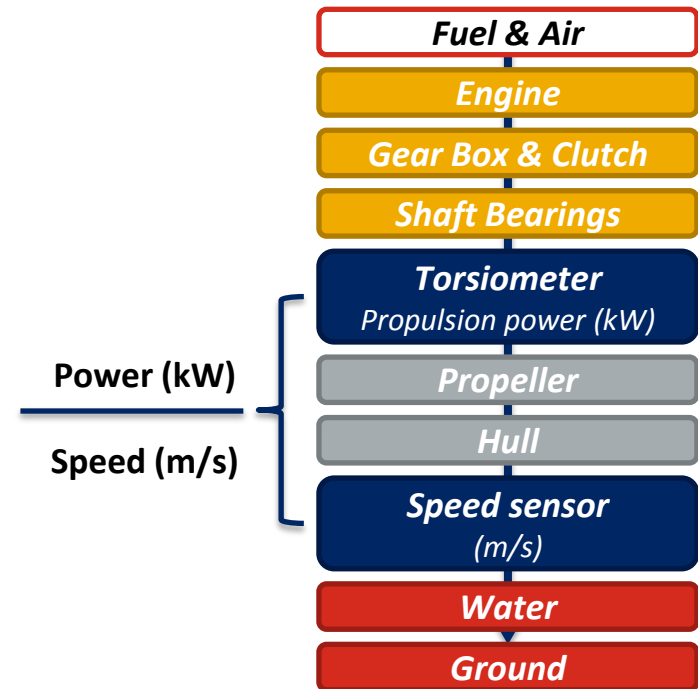


Jotun Hull Performance Measurement Method (JHPMM)



- Isolate Hull & Propeller Performance by tracking changes in the relationship between shaft power and speed through water over time
 - Not yet possible to separate hull from propeller performance so we take responsibility for both.
- Long-trend approach to dealing with measurement noise:
 - track % deviation from vessel specific speed-power curve every 10 to 15 seconds over the full lifetime of the system (~ 2.5 million data-points per year)
 - normalize for draft
 - filter for bad weather and values outside (accurate) speed-power curve range
- Currently in use for performance based contracting and proposed as starting point for ISO standard

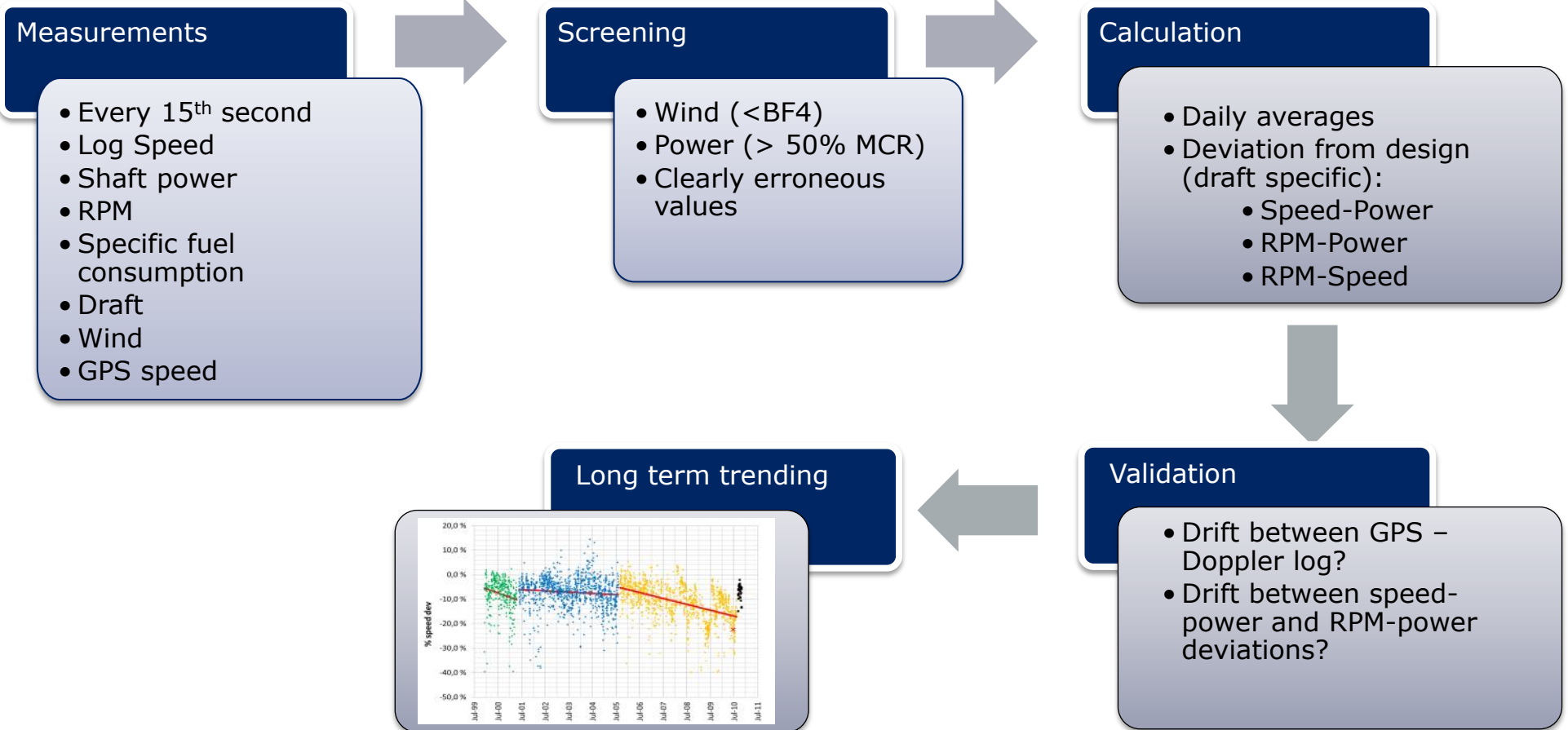
Vessel engine train and measurement points for Hull & Propeller Performance



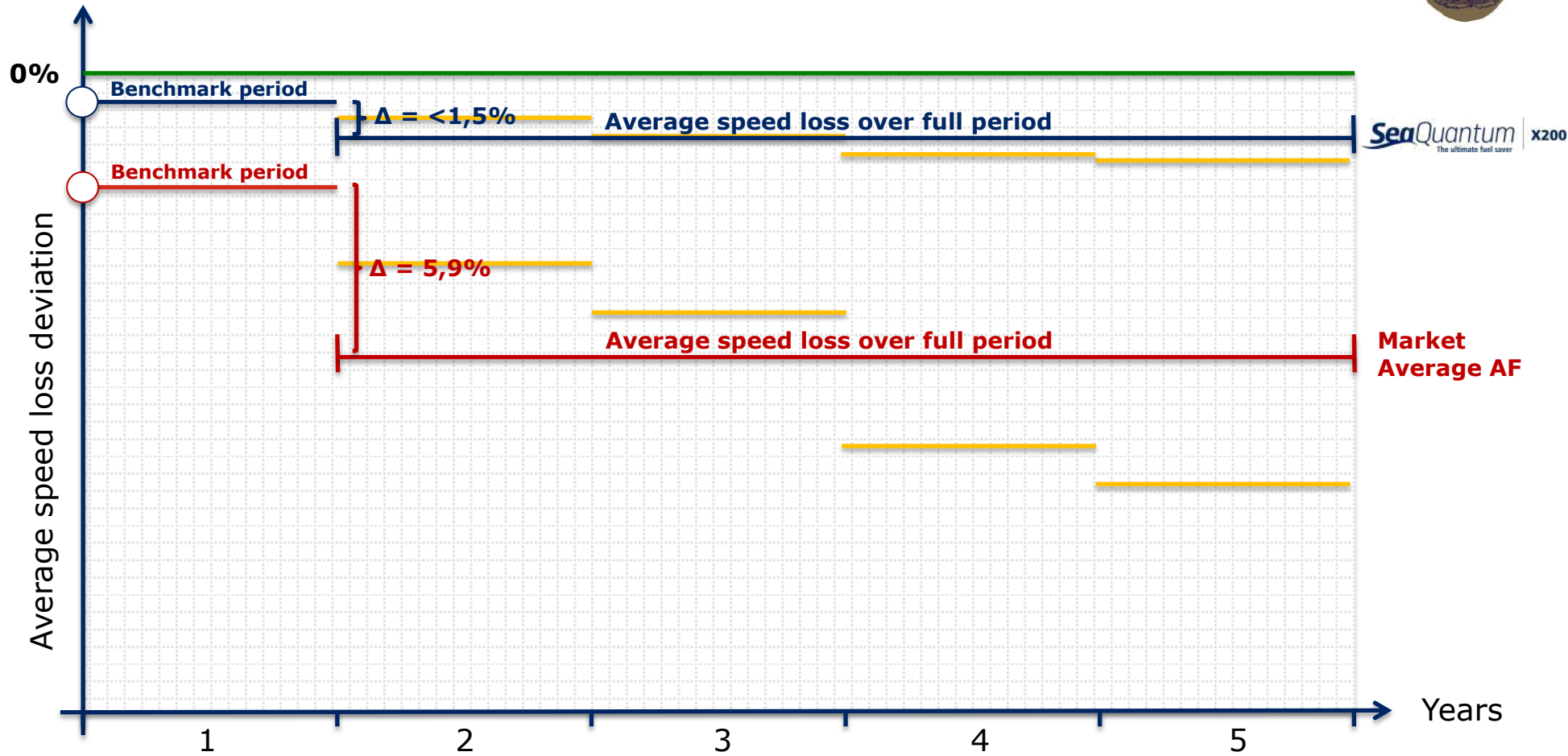
JHPMM - solution components



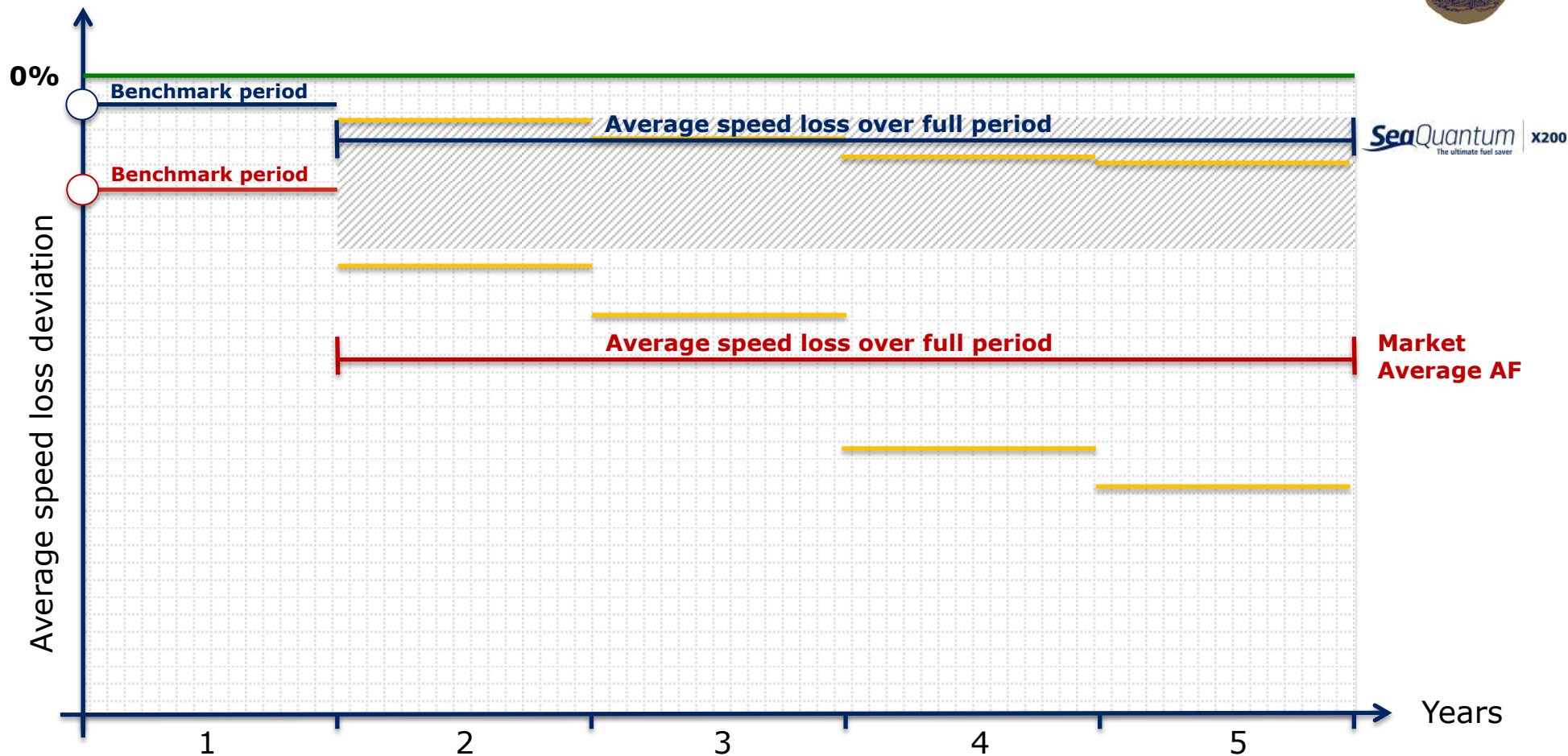
Jotun processing of automatically logged data



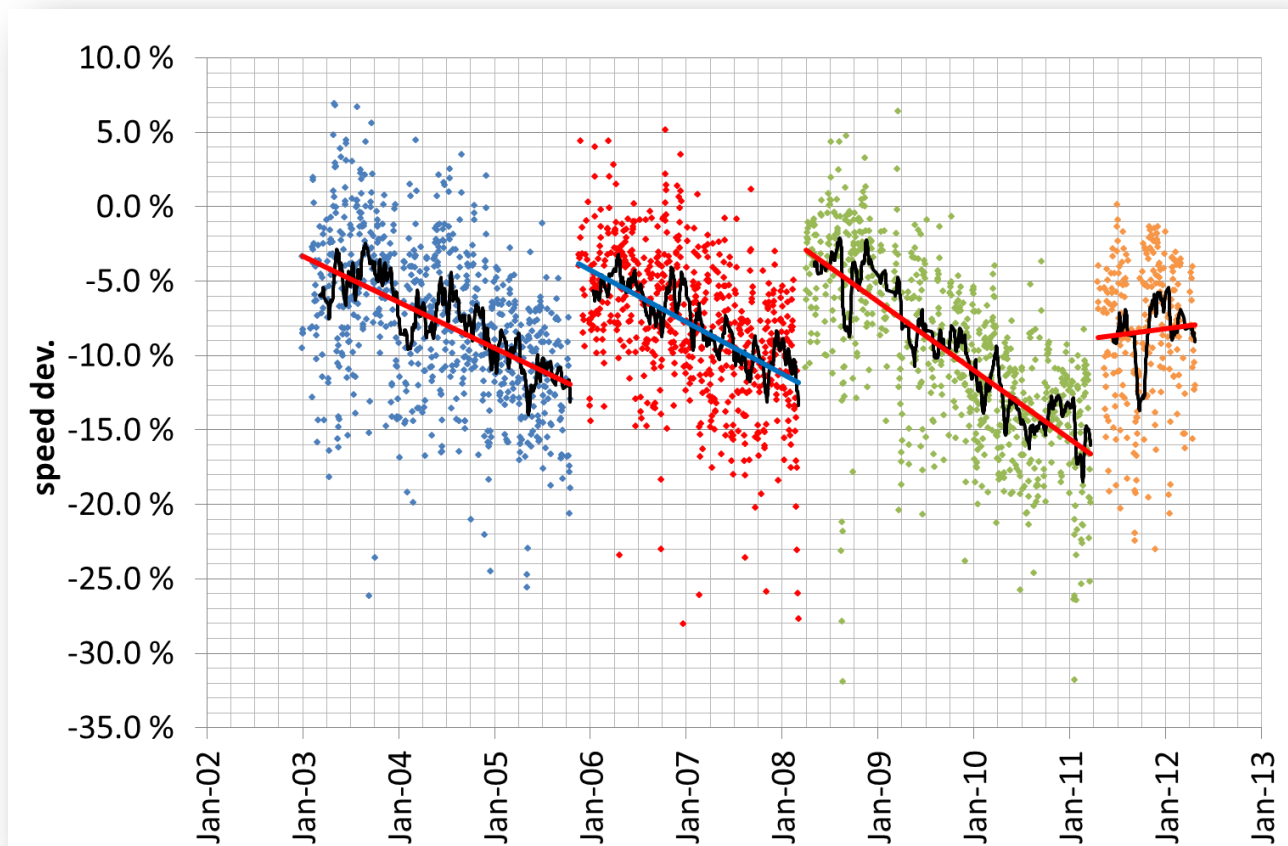
Measuring speed loss deviation



Measuring speed loss deviation



Measuring speed loss deviation



- **Period 1 ~34 months**
 - Speed dev: -3.1%/y
 - Avg. speed loss: 4.4%
 - Efficiency loss: 13.2%
- **Period 2 ~28 months**
 - Speed dev: -3.5%/y
 - Avg. speed loss: 4.1%
 - Efficiency loss: 12.3%
- **Period 3 ~36 months**
 - Speed dev: -4.6%/y
 - Avg. speed loss: 6.9%
 - Efficiency loss: 20.7%
- **Period 4 ~12 months**
 - Speed loss: +0.8/y

Measurability Challenges - establishing a market standard



- ① Accurate measurement of the impact of the hull (and propeller) surface on the energy efficiency of the actual vessel in question
- ② Over the relevant lifetime of the surface(s)
- ③ Fully transparent method open for 3rd party audit / replication
- ④ Sufficiently practical so as to allow for widespread adoption



Establishing a market standard



- The Clean Shipping Coalition (CSC) joined the IMO as observer in June 2010
- Current Board Members in CSC:
 - Bellona Foundation
 - Air Pollution & Climate Secretariat
 - Clean Air Task Force
 - Environmental Defense Fund
 - Transport and Environment
 - Oceana
 - Seas At Risk
 - Stichting De Noordzee
- They presented a “slow steaming initiative” at MEPC 63



Establishing a market standard



- CSC at MEPC 63-4-8: **15 to 20%** increase in energy consumption (fuel) on average over a sailing interval due to deterioration in Hull & Propeller Performance
- By employing available technology to improve Hull & Propeller Performance, the world fleet GHG emissions can be reduced by **7-10%**
 - 35-50% of IMO's CO₂ reduction target can be achieved by improving Hull & Propeller Performance alone



Conclusion:

Hull and antifouling performance stand out as one of the most important initiatives with regards to improving the efficiency of the shipping industry



Establishing a market standard – ISO



- 1st International Workshop on Hull and Propeller Performance Measurement Standard conducted in Norway in January 2013 with CSC as host and Jotun as co-host and a 2nd one was conducted in London in May 2013
 - 30 participants including paint companies, performance monitoring companies, class societies, ship owners, etc.
- ISO ballot held 30.05.13
 - 6 votes in favor (China, Korea, UK, US, Russia, Norway), only 1 vote against (Japan)
- First ISO workshop on Hull and Propeller Performance was held beginning of June 2013 in Oslo (during Nor-Shipping week)

Establishing a market standard – ISO

- The draft standard is now ISO 19030-1 to 3 and the working group is ISO / TC8 / SC2 / WG7
- Jotun has been appointed project leader of the draft standard
- The working group now consists of 12 experts from China, Korea, Japan, US, UK and a BIMCO representative
- It is expected that another 8 to 10 experts will be directly involved



BIMCO issues hull-cleaning clause for charter contracts

Two-year plan to develop hull performance standards

Proposal will help owners to judge hull coating claims

15

15

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<http://www.lloydslist.com/l/sector/regulation/article426178.ece>



Establishing a market standard – ISO



- The proposed standard shall include 3 parts:
 - 1) General principles
 - 2) Method for measuring changes in hull and propeller performance with the purpose of enabling performance based contracting
 - 3) A method for the same with the purpose of enabling company internal reporting
- The working group has agreed to use Jotun's method (JHPMM) as the starting point for Part 2
- We aim to have a rough draft ready for informal circulation to stakeholders around November – December this year
- We estimate that we have 2 to 3 years of hard work ahead of us...

Jotun Hull Performance Solutions



SeaQuantum
X200

Performance
monitoring

High standard
technical service

Performance
guarantee



Jotun High Performance Guarantee (JHPG v2)



JOTUN

Specimen.
High Performance Guarantee.

..... (hereinafter referred to as the Guarantor) offers (hereinafter referred to as the Owner) the following Guarantee (hereinafter referred to as the Guarantee) covering the performance of the antifouling system of (hereinafter referred to as the Property) at (hereinafter referred to as the Yard), subject to the following terms, conditions and limitations.

The system, areas and parameters for calculation of the system covered under this guarantee are identified in Appendix 1, which forms a part of this guarantee.

1. SCOPE OF GUARANTEE

1.1 The Guarantor will guarantee the effect of the antifouling system on hull performance, specified by a Maximum Average Speed Loss of **1.5%** over the Guarantee Period (Clause 3.4).

1.2 If the measured Average Speed Loss over the Guarantee Period (Clause 3.10) is higher than the Maximum Average Speed loss specified in Clause 1.1, the Guarantor will cover the Retained Cost of Additional Fuel (Clause 3.3).

1.3 Guarantor's maximum liability under this guarantee shall not exceed **80%** of the invoiced value of the antifouling materials (excluding V.A.T.).

2. CONDITIONS

2.1 Notwithstanding signature by the parties hereto, the Guarantee shall commence on the date the Property is delivered to Owner or on the date on which the completed application is accepted by the Guarantor, whichever shall first occur (the Commencement Date).

It is a strict condition of this Guarantee that the Property is in a fouling-free condition upon the commencement of this Guarantee and that the coating system has not been damaged prior to commencement, including but not limited to damage caused by cleaning. The Owner shall provide such reasonable evidence as the Guarantor may require to substantiate this.

This Guarantee will terminate (maximum 60) months from the Commencement Date or on the date of the first forthcoming dry docking, whichever comes first. In the event of sale, lease or transfer of the Property, or upon the Property ceasing to be operated by the Owner prior to termination date, this Guarantee shall terminate at the date of such sale, lease, transfer or cessation, and the Guarantor shall be discharged from any liability under the Guarantee, unless prior written consent of the Guarantor to continue the Guarantee. Such consent shall not be unreasonably withheld.

2.2 The work on the Property shall be carried out strictly in accordance with the procedures for surface preparation and paint application as visited by the Guarantor and accepted by the Owner and all other parties involved.

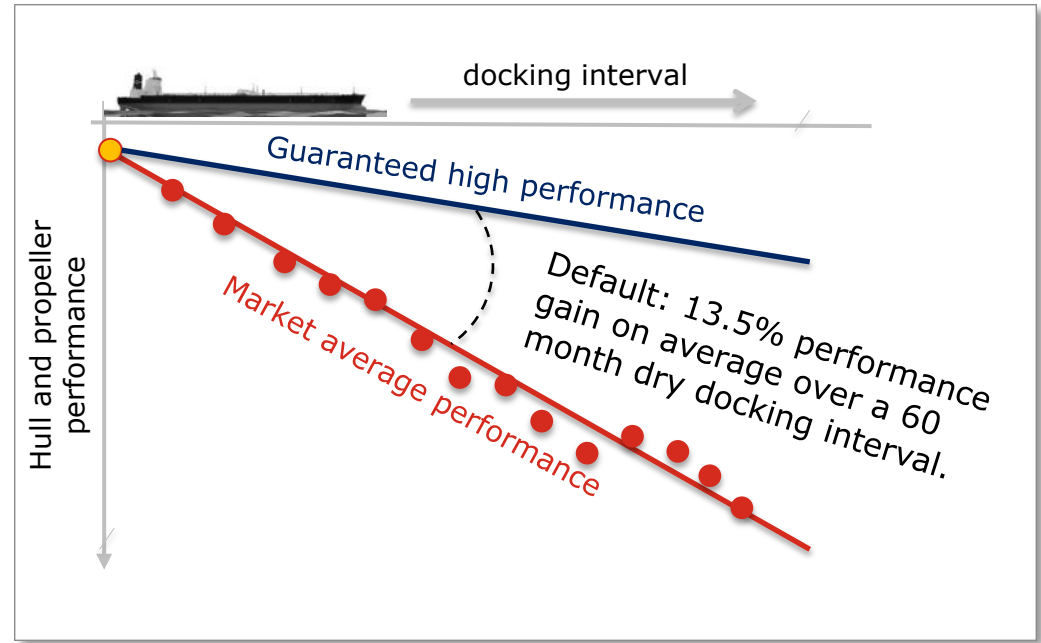
2.3 The Guarantor shall not be liable under this Guarantee unless the Owner has made available to the Guarantor relevant performance and operational data in respect of the Property (Clause 4.1 and 4.2).

2.4 The Owner shall maintain any existing propeller cleaning scheme and continue to cover the cost of this scheme. In any event the propeller shall be cleaned 2 times per year or more at the Owner's expense.

If the Guarantor has reason to believe that performance is impeded by propeller fouling, the Guarantor shall have the right to request an additional cleaning of the propeller.

Page 1 of 11

High Performance Guarantee Guarantee Serial No.:
Version 2, Revision 3



...or a pay-back a sum equal to the difference in cost between a market average solution and high performance solution

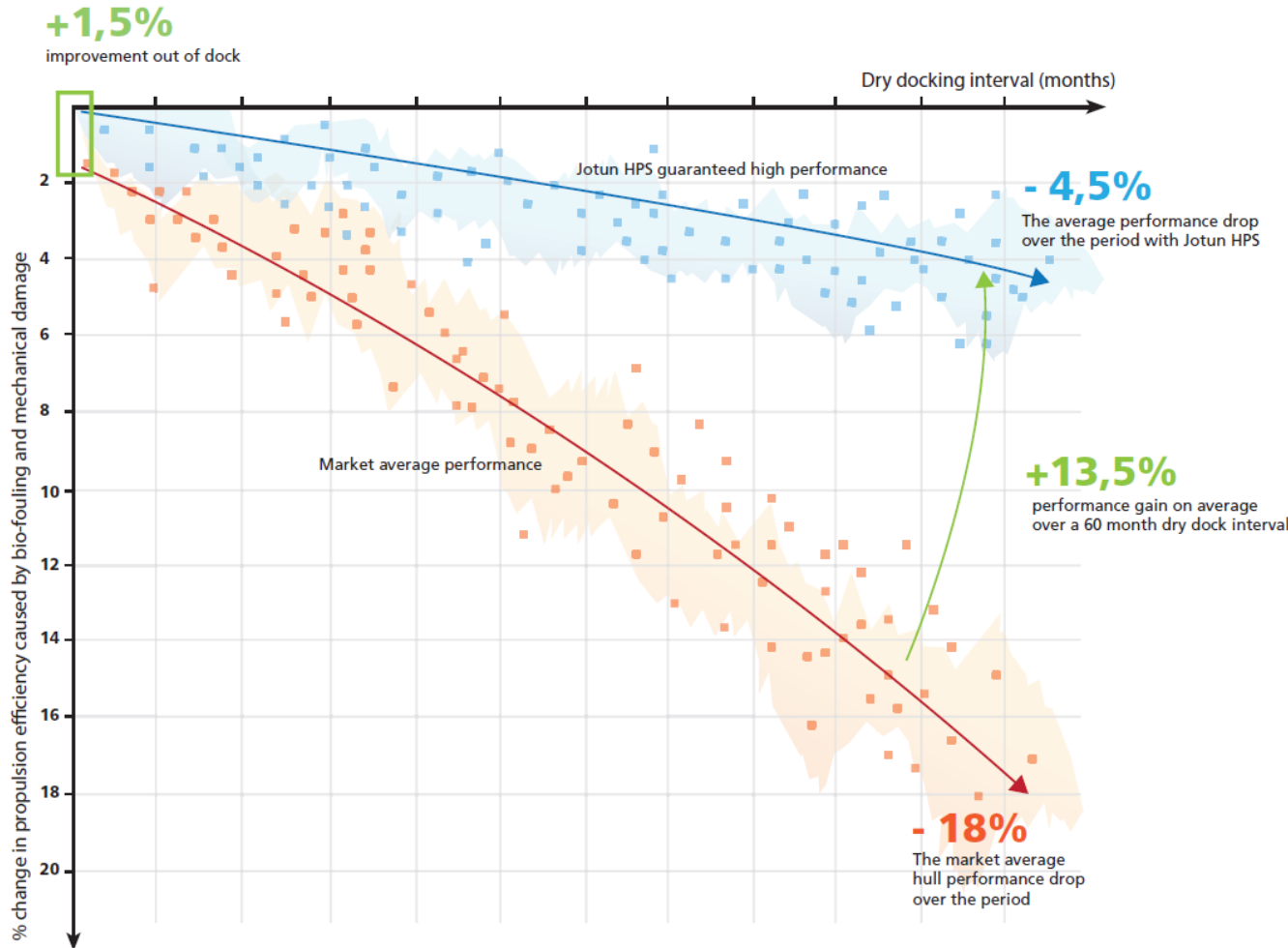
Jotun High Performance Guarantee (JHPG v2)



- Maximum Average Speed Loss of 1.5% (efficiency loss of 4.5%) on 60 month system
 - Note that 1st year is a benchmark year
- Maximum liability is up to 60% of the cost of the antifouling paint
- Standard antifouling guarantee terms up to 20 ppt
- Maximum idle / static period is 30 days
 - If exceeded, underwater hull inspection at owners cost and if fouling identified; hull cleaning and new benchmark period before guarantee is extended
- Slow-steaming is acceptable as long as specified
 - So that the appropriate version of SeaQuantum X200 can be applied (having a higher polishing rate)



One of the most attractive investment opportunities in shipping today



On a typical Aframax tanker, a 13,5% propulsion efficiency gain translates into a \$ 6,7 million fuel cost saving (\$ 3 600 per calendar day) and a 214k carbon emissions saving over a 60 month dry-docking interval ¹⁾.

¹⁾ 56 tons per day, 274 days per year, \$650 per ton, maintaining speed.



Out of dock performance - 10,000 TEU container vessel



- Historically a trade-off between out-of-dock performance and lifetime fouling protection
 - FRCs have performed better out of dock, but poorly over time

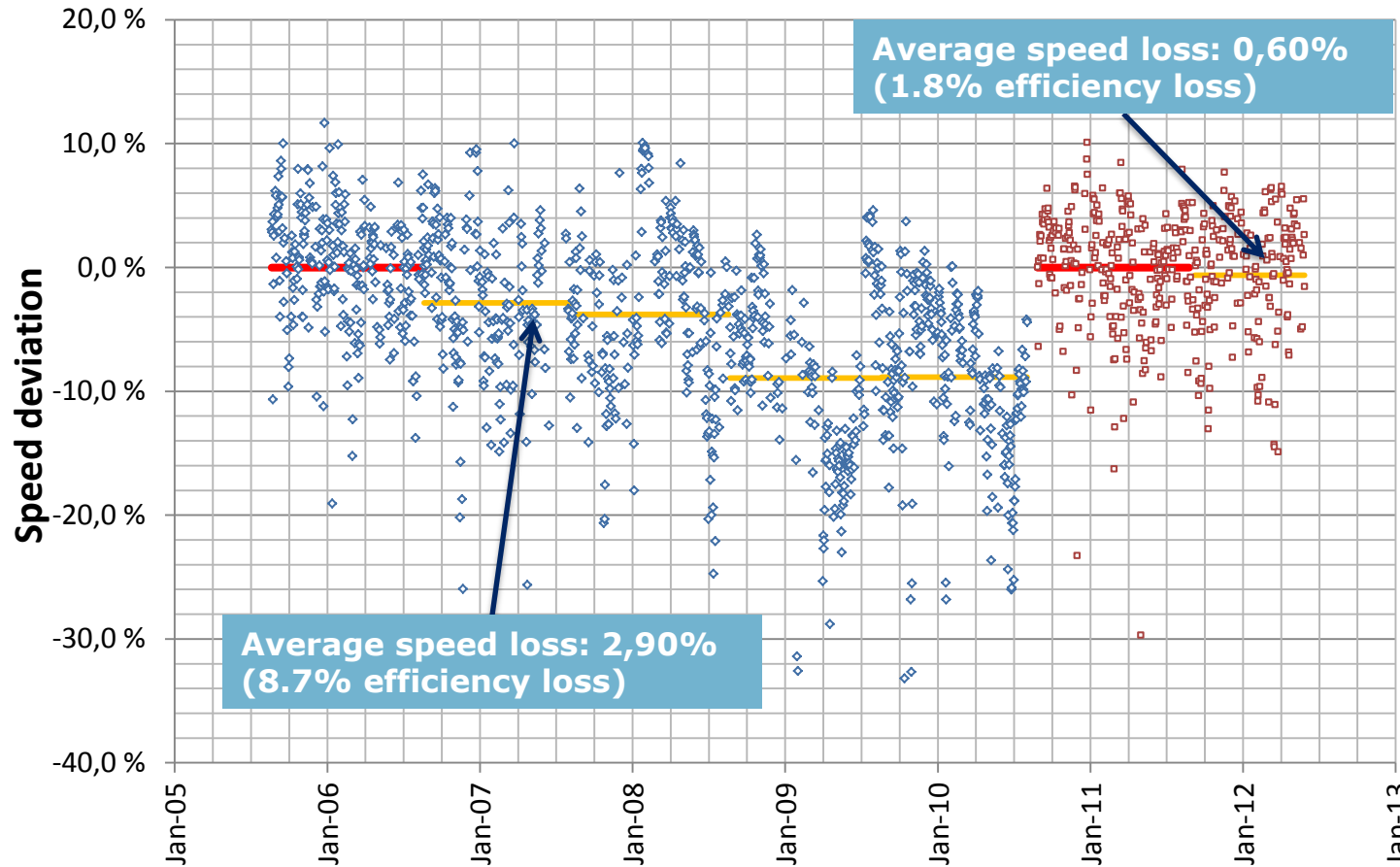
SeaQuantum X200 has been designed to match FRC out-of-dock

The “proof” is in the eating:

76 μm	AHR, full underwater hull
1.5%	Cons. efficiency gain vs. norm (120 μm)
\$ 427,000	Ball park first year fuel cost saving ¹⁾

¹⁾ 150 tons per day, 292 days per year, \$650 per ton

In service performance – 51.000 DWT bulk carrier



A fuel cost saving of more than \$500,000 in the first year after benchmark year alone¹⁾

¹⁾ 47 tons per day, 255 days per year, \$650 per ton



JOTUN DOES NOT ONLY SELL THE VERY BEST PRODUCTS WORLD WIDE

WE **DISCOVER** NEEDS
WE **INNOVATE** WE RESEARCH
WE **DEVELOP** CUTTING EDGE PRODUCTS
NEW POSSIBILITIES
CREATE SOLUTIONS
WE **PROTECT YOUR PROPERTY**

THE BOTTOM LINE IS THAT
WE ENHANCE YOUR COMPETITIVENESS

DO YOU WANT TO WORK WITH US?

