

**Design of High Speed Craft
= design for seakeeping**

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The Damen Sea Axe

*HighSpeedBoat
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SORRY, THIS IS NOT ABOUT REALLY HIGH SPEED...



DESIGN OF HIGH SPEED CRAFT
Promise: speed X at loading condition Y**043.1 Speed trials**

The vessel's speed ahead will be measured using maximum engine power at a measured mile or kilometre course.

The vessel is designed to meet the trial speed as given in the Propulsion Selection Diagram (item 210.1).

These speeds are attainable when the vessel is equipped according to this specification, excluding optional equipment, and when the weather- and loading conditions mentioned below are followed.

Loading condition:

<u>Item</u>	<u>Condition</u>	<u>Weight</u>
Fuel	## %	##.# t
Fresh water	## %	##.# t
Waste water	## %	##.# t
Fresh water cargo	# %	##.# t
Crew and effects	#	##.# t
Passengers and effects	##	##.# t
Total		##.# t

Weather condition:

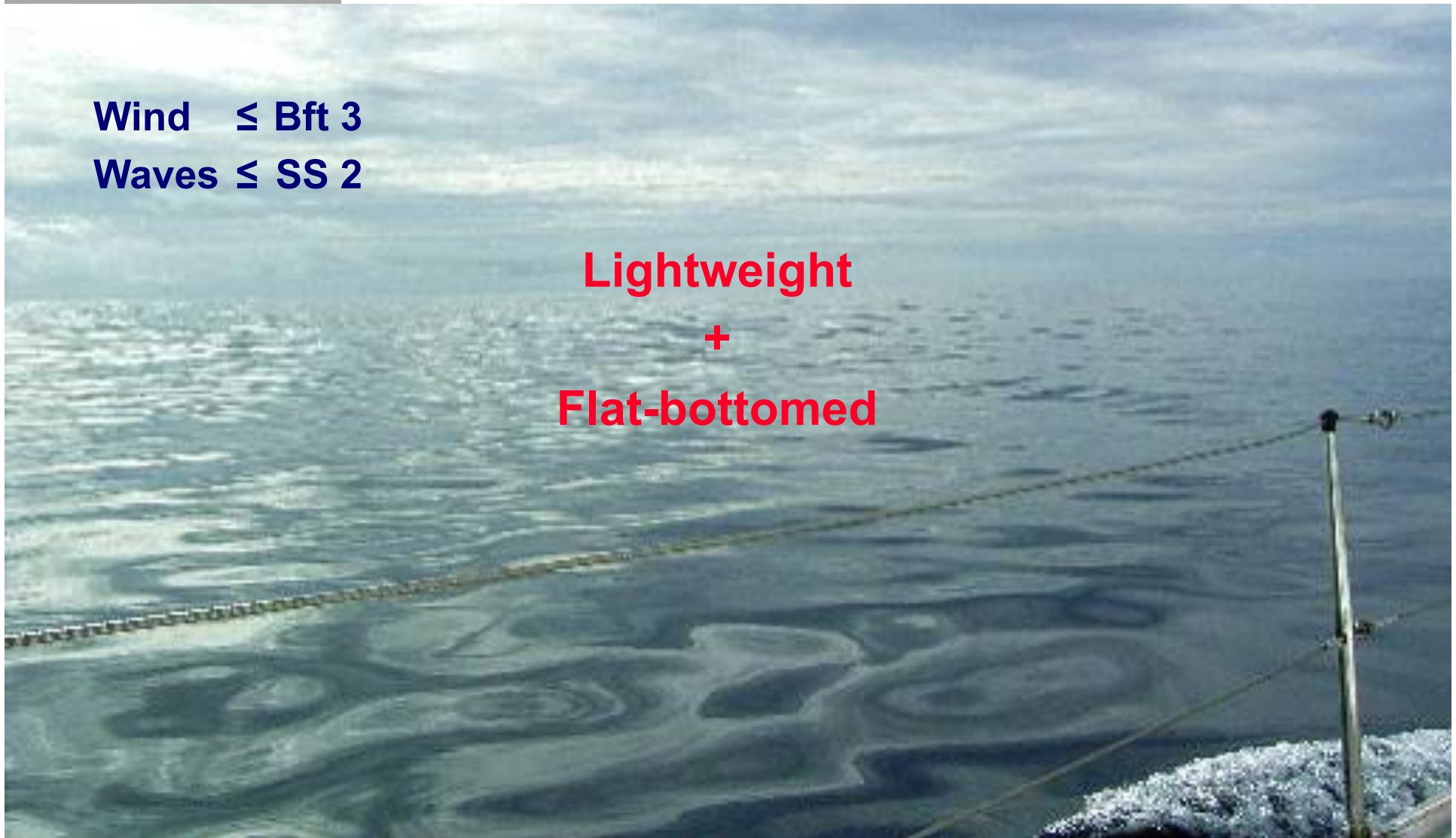
- Sea State 2
- Bf 3

DESIGNING FOR TRIAL CONDITIONS

Wind \leq Bft 3

Waves \leq SS 2

**Lightweight
+
Flat-bottomed**



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DESIGNED FOR TRIAL CONDITIONS



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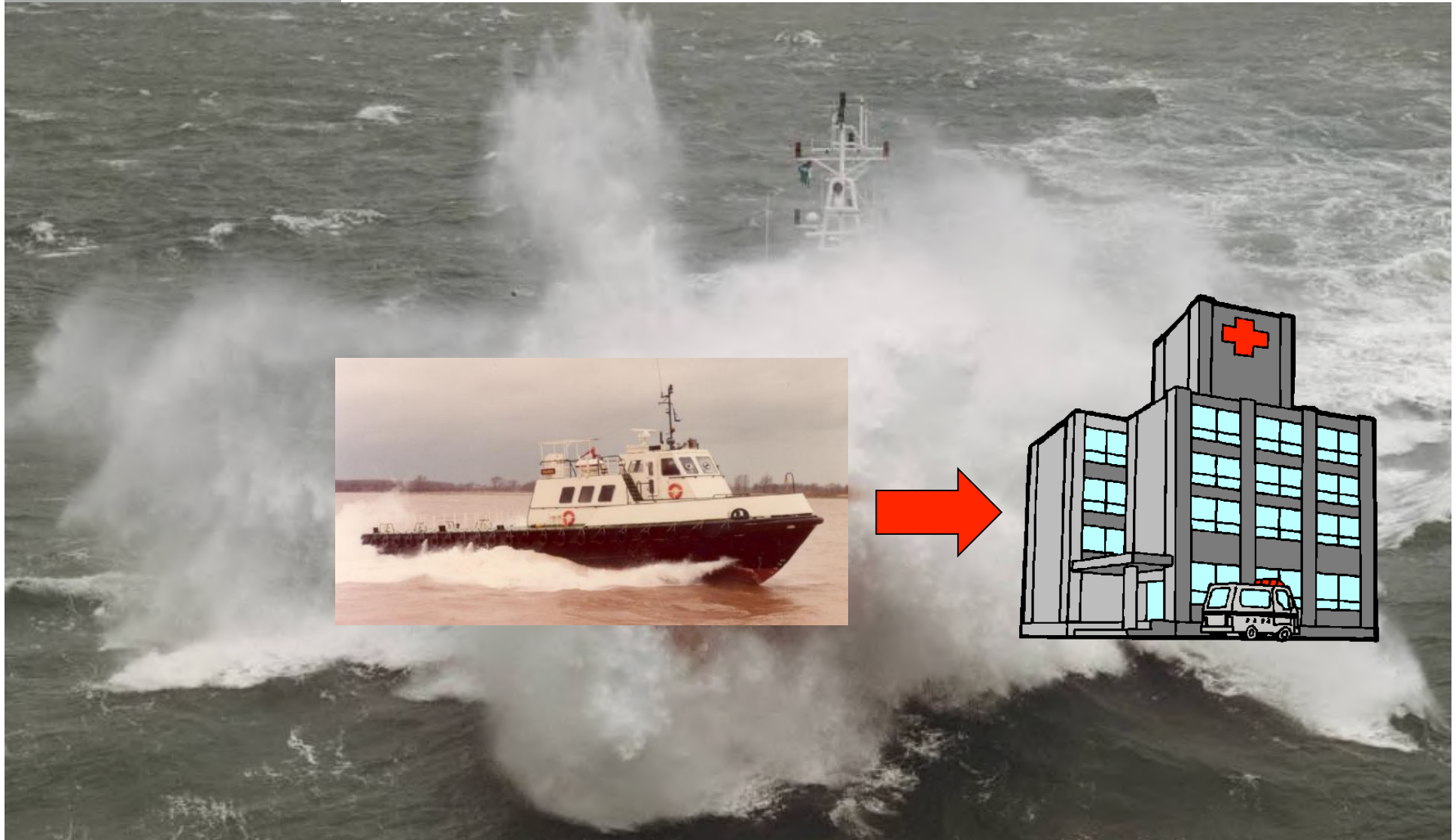
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ACCIDENTS HAPPEN
(Thank you Ed for saving me time!)



IT TOOK AN ACCIDENT TO WAKE UP AT DAMEN (1980)



RESEARCH WITH DELFT UNIVERSITY

1985



111 delivered
80+ to US Coast Guard

1995



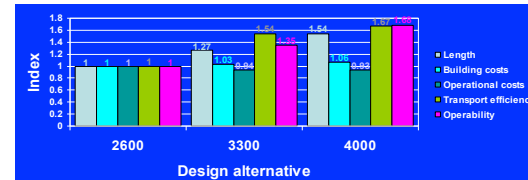
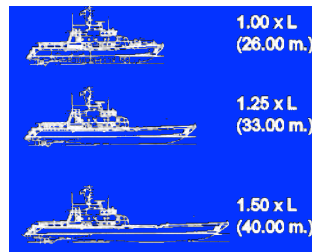
40+ delivered,
80+ under constr.

2005



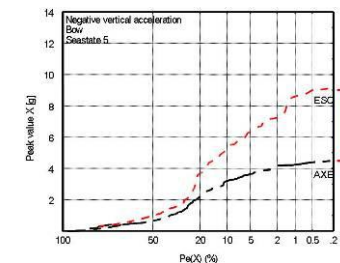
70+ delivered,
50+ under constr.

1995-1998: Enlarged Ship Concept



2000-2005: Sea Axe Development

$$\frac{dY}{d\xi} = -\frac{D(m_{YY} v_{\xi})}{dt} = -\left(m_{YY} \frac{\partial v_{\xi}}{\partial t} + v_{\xi} \frac{\partial m_{YY}}{\partial t} + u m_{YY} \frac{\partial v_{\xi}}{\partial \xi} + u v_{\xi} \frac{\partial m_{YY}}{\partial \xi} \right)$$



1995-1998 – ENLARGED SHIP CONCEPT



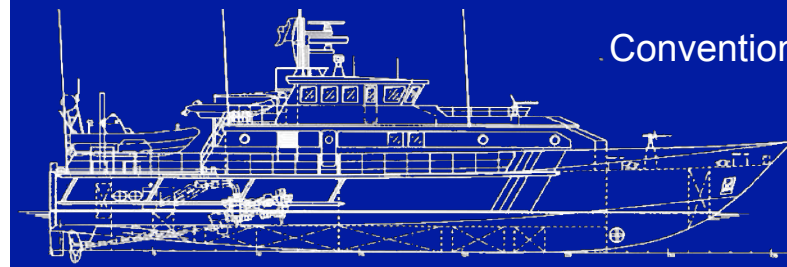
1.00 x L
(26.00 m.)



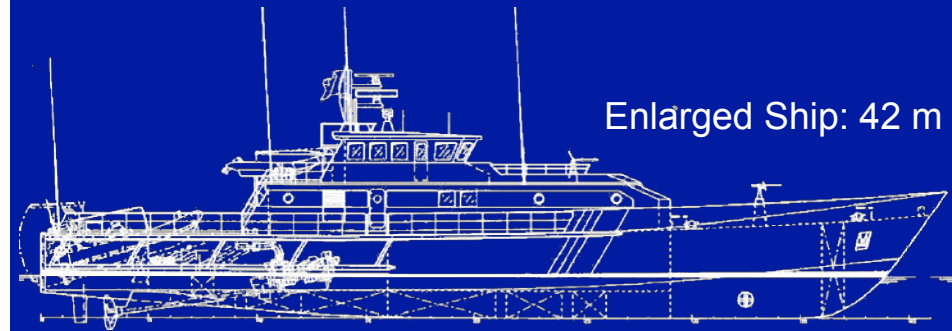
1.25 x L
(33.00 m.)



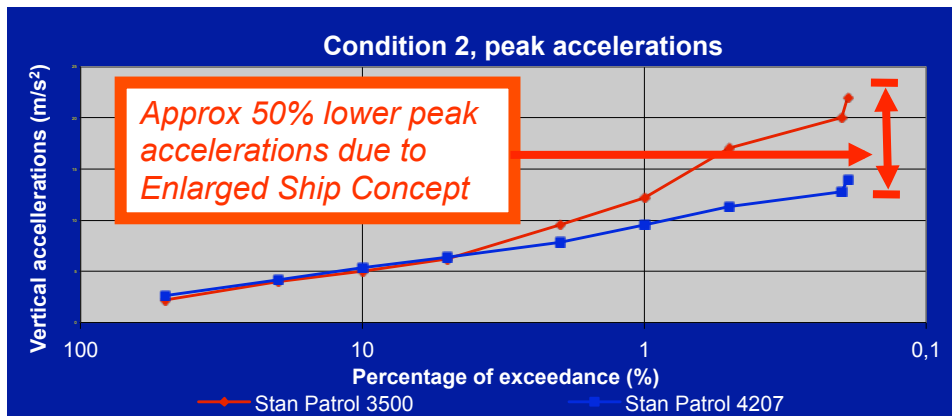
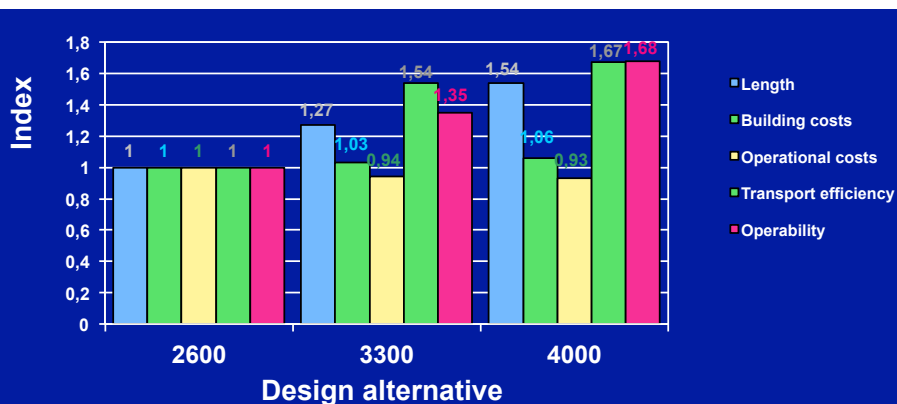
1.50 x L
(40.00 m.)



Conventional: 35 m



Enlarged Ship: 42 m

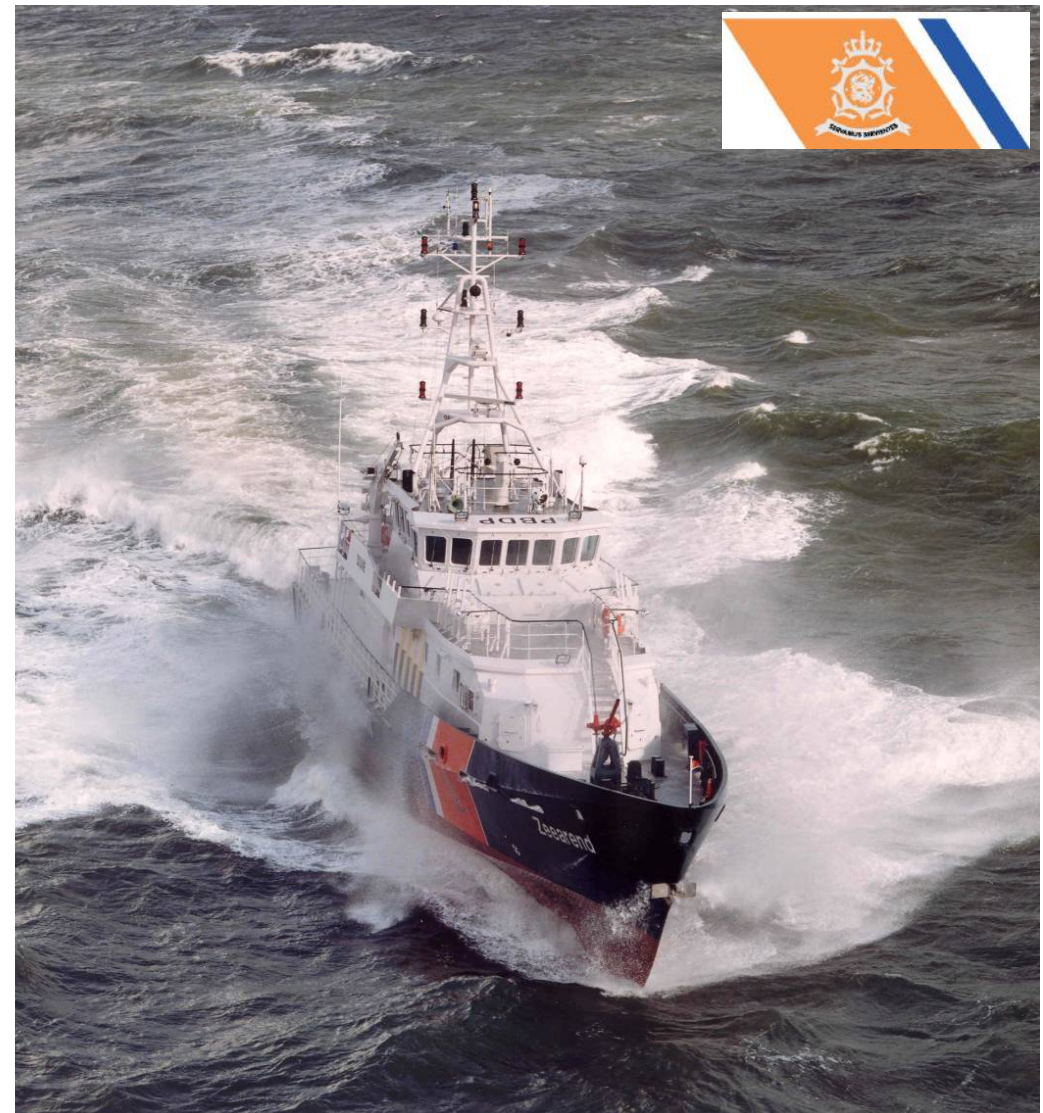


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ENLARGED SHIPS
50+ in service, 70+ under construction



How to assess sea keeping performance?

- Average accelerations?
- Root mean squared?
- Significant wave Hs?

Strong nonlinear behavior in accelerations

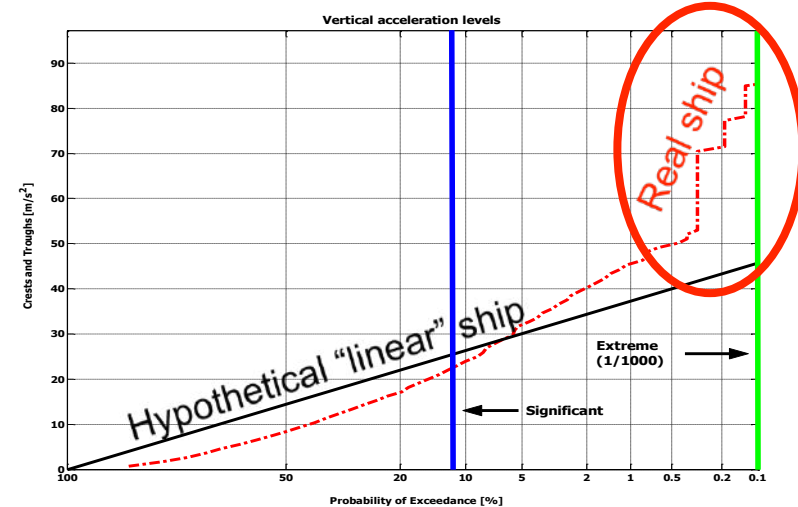
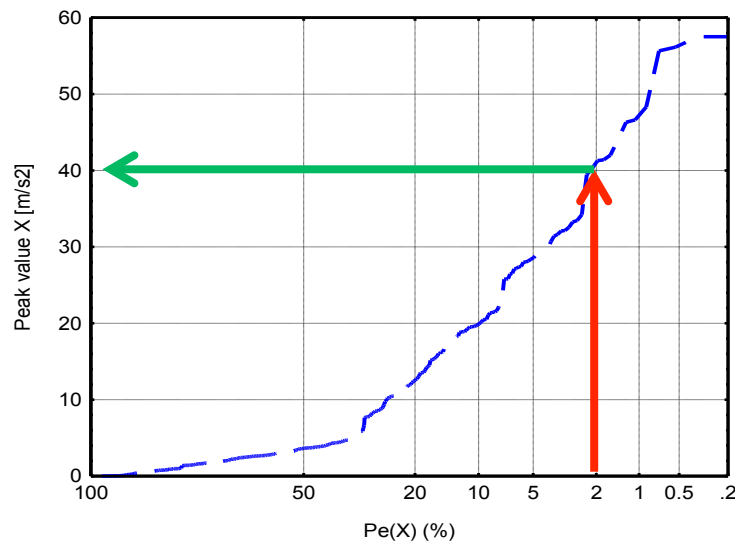
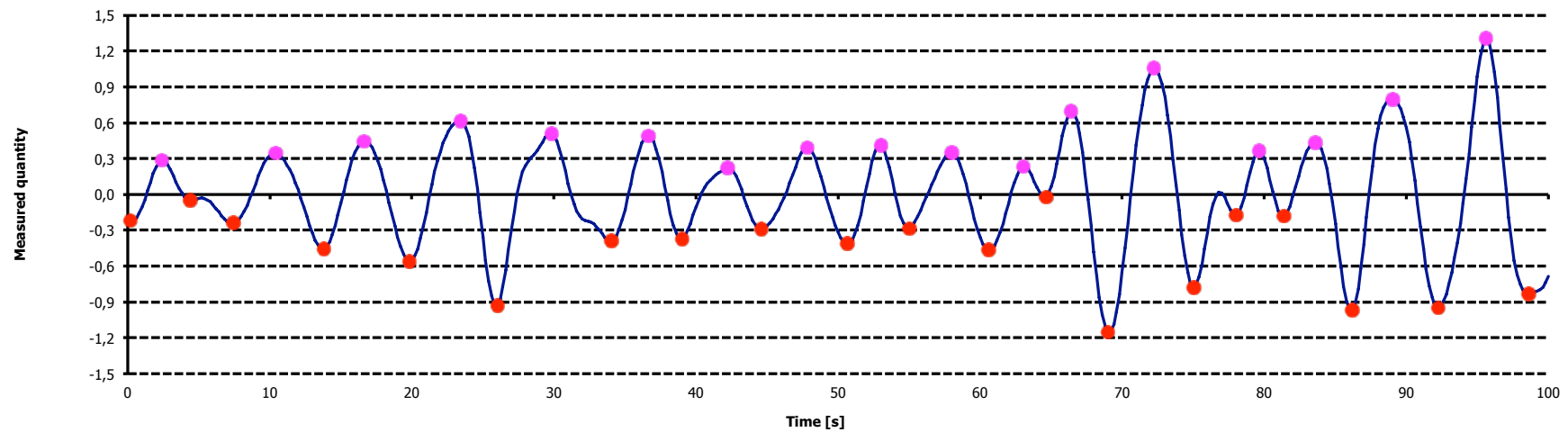
- 85% of speed reductions voluntary
- Peaks are avoided irrespective of significant level at the time

I.e.:

**Human beings do not react on “averages”,
they react on extremes!**



ONGOING RESEARCH Criteria for sea keeping performance



A NEW QUEST

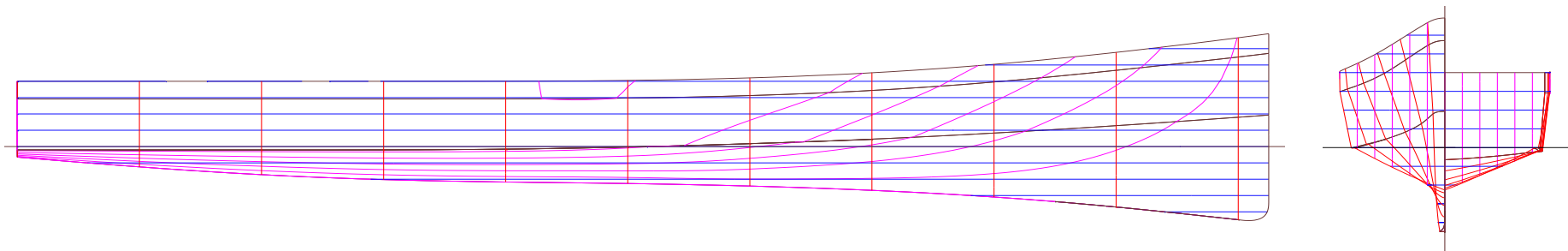
How to design a linear behaving high speed vessel?

$$\frac{dY}{d\xi} = - \frac{D(m_{YY} v_{\xi})}{dt} =$$

$$- \left(m_{YY} \frac{\partial v_{\xi}}{\partial t} + v_{\xi} \frac{\partial m_{YY}}{\partial t} + u m_{YY} \frac{\partial v_{\xi}}{\partial \xi} + u v_{\xi} \frac{\partial m_{YY}}{\partial \xi} \right)$$

Form follows function:

- Less flare
- Deeper keelline at bow
- Less change of waterline beam (V-shape)
- Higher bow



Five years of research

**Sea Axe, compared to
Conventional high speed hullforms**

Highest accelerations

80% lower peak accelerations:
Less fatigue passengers/crew
No slamming – no damage

Resistance

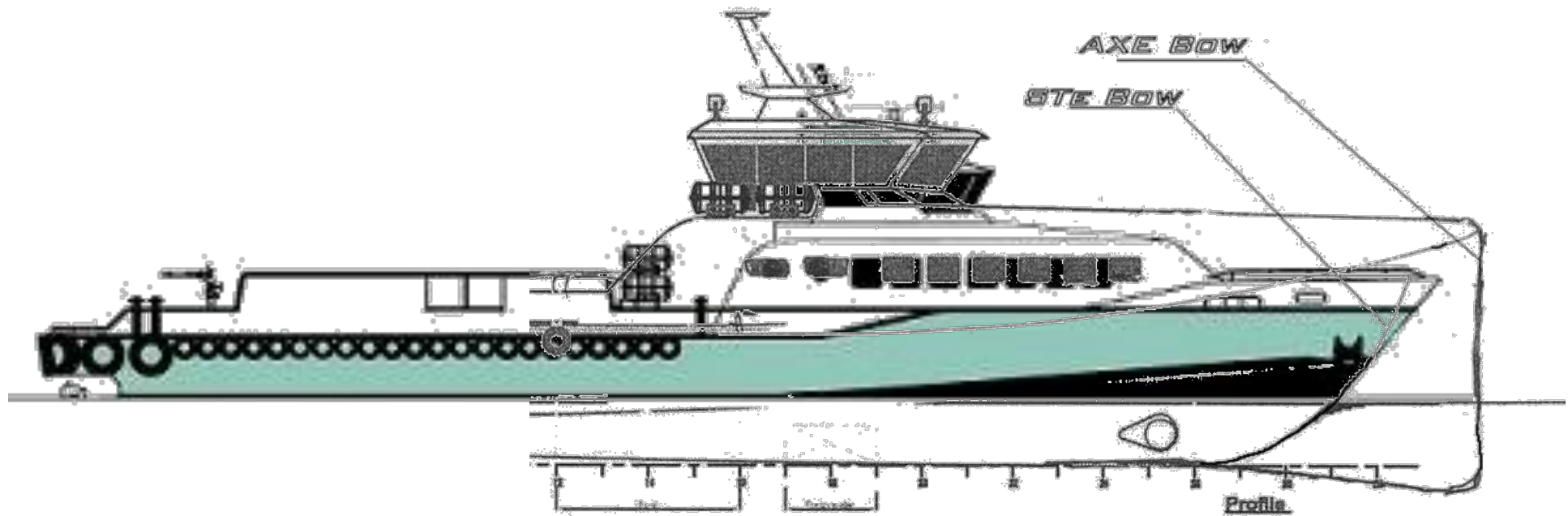
- flat water
- sea state 4

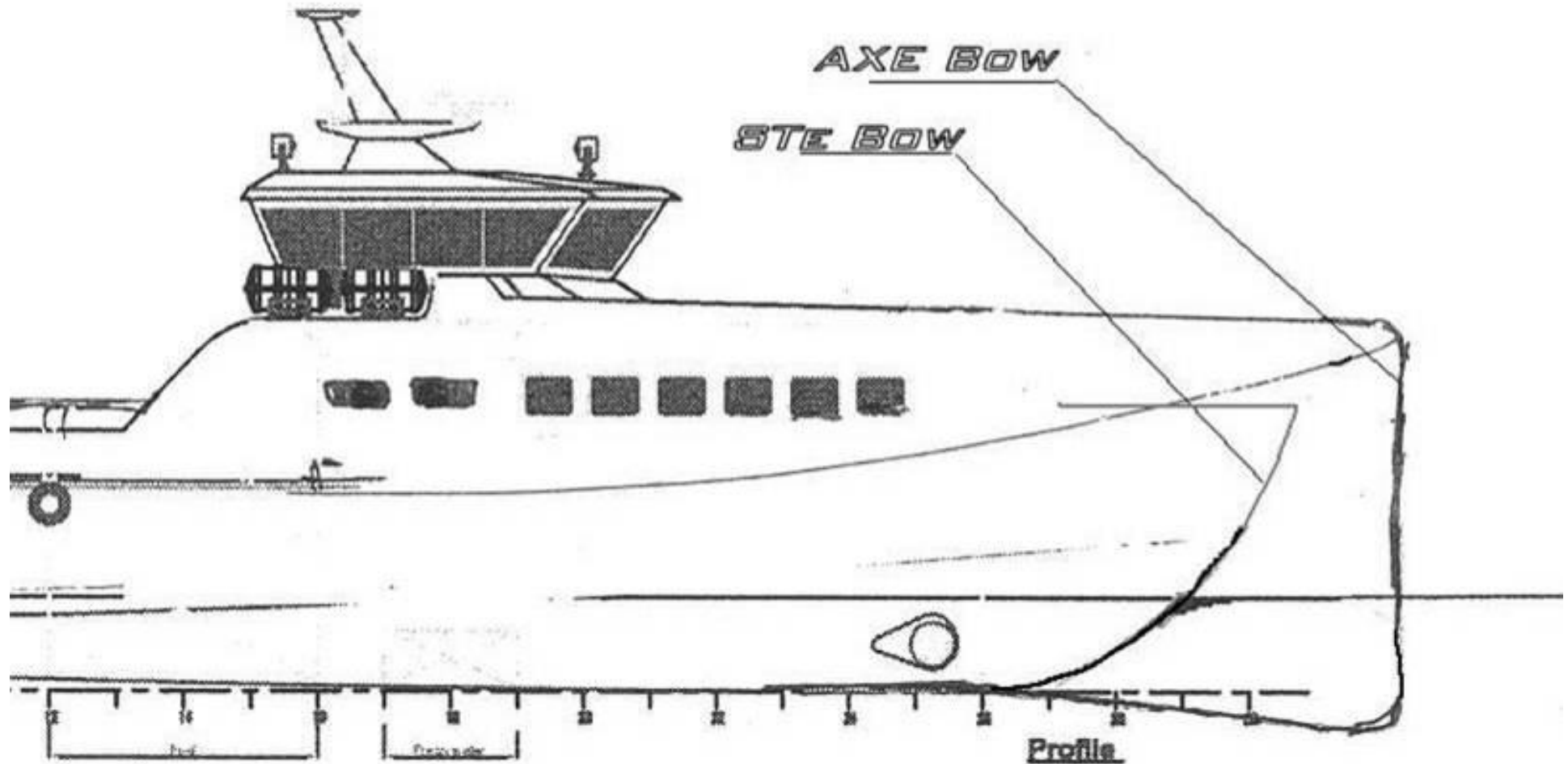
10 % less

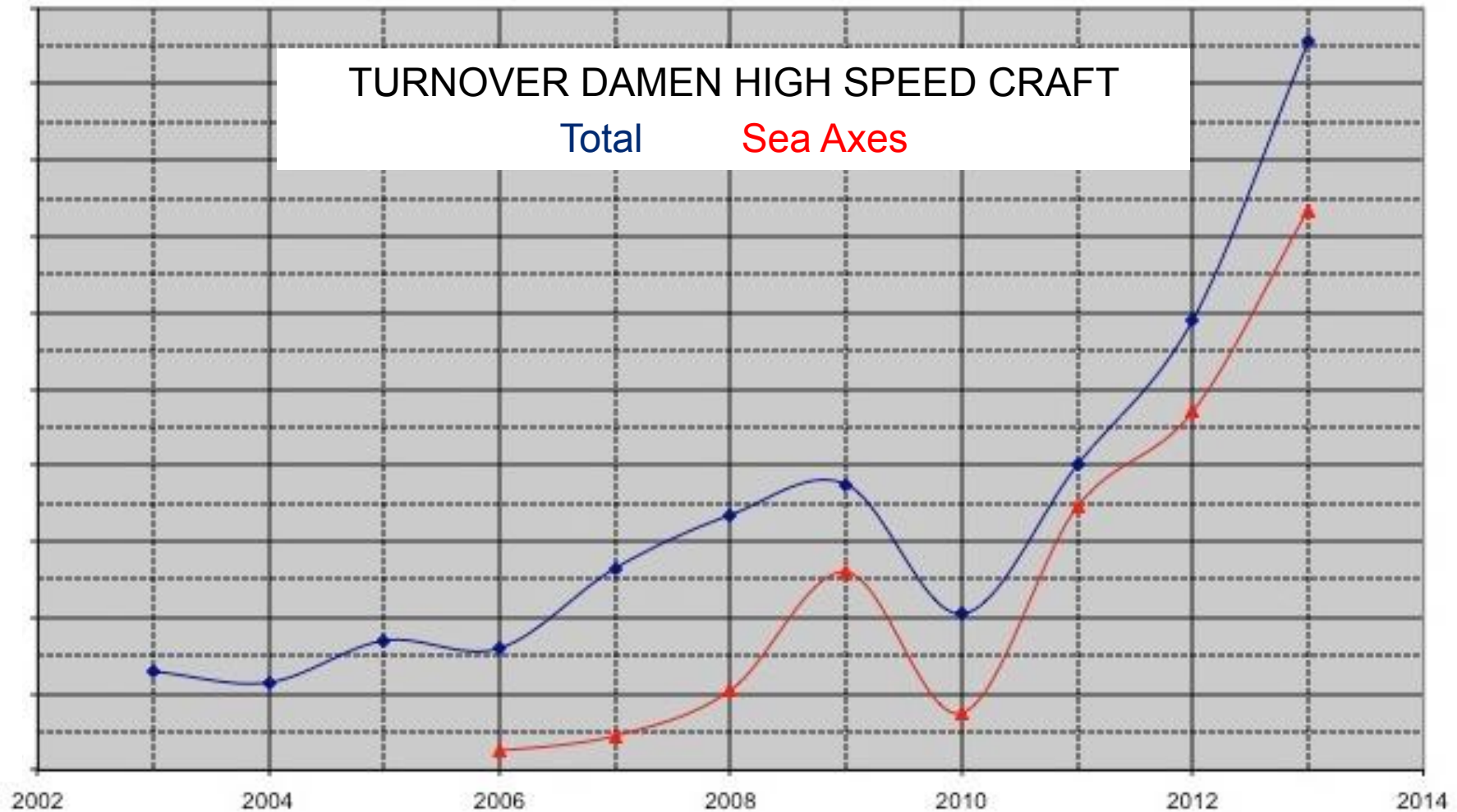
22% less

Voluntary speed reduction

Not necessary:
Speed can always be maintained
No slamming







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SEA AXES
120+ sold since 2006

FCS 1905



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SEA AXES
120+ sold since 2006

Spi/SPa 2205



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SEA AXES
120+ sold since 2006

FCS 2610 Twin Axe



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SEA AXES
120+ sold since 2006

FCS 3307



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SEA AXES
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FCS 3307



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SEA AXES
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FCS 5009



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SEA AXES
120+ sold since 2006

SPa 5009



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SEA AXES
120+ sold since 2006

FCS 6511: outfitted as “Yacht Support Vessel”



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SEA AXES
Semi - Sea Axe SAR 1906 (“Nh 1816 Class”)



ANY PROOF OF:

- **Exceptional seakeeping**
- **Low resistance**

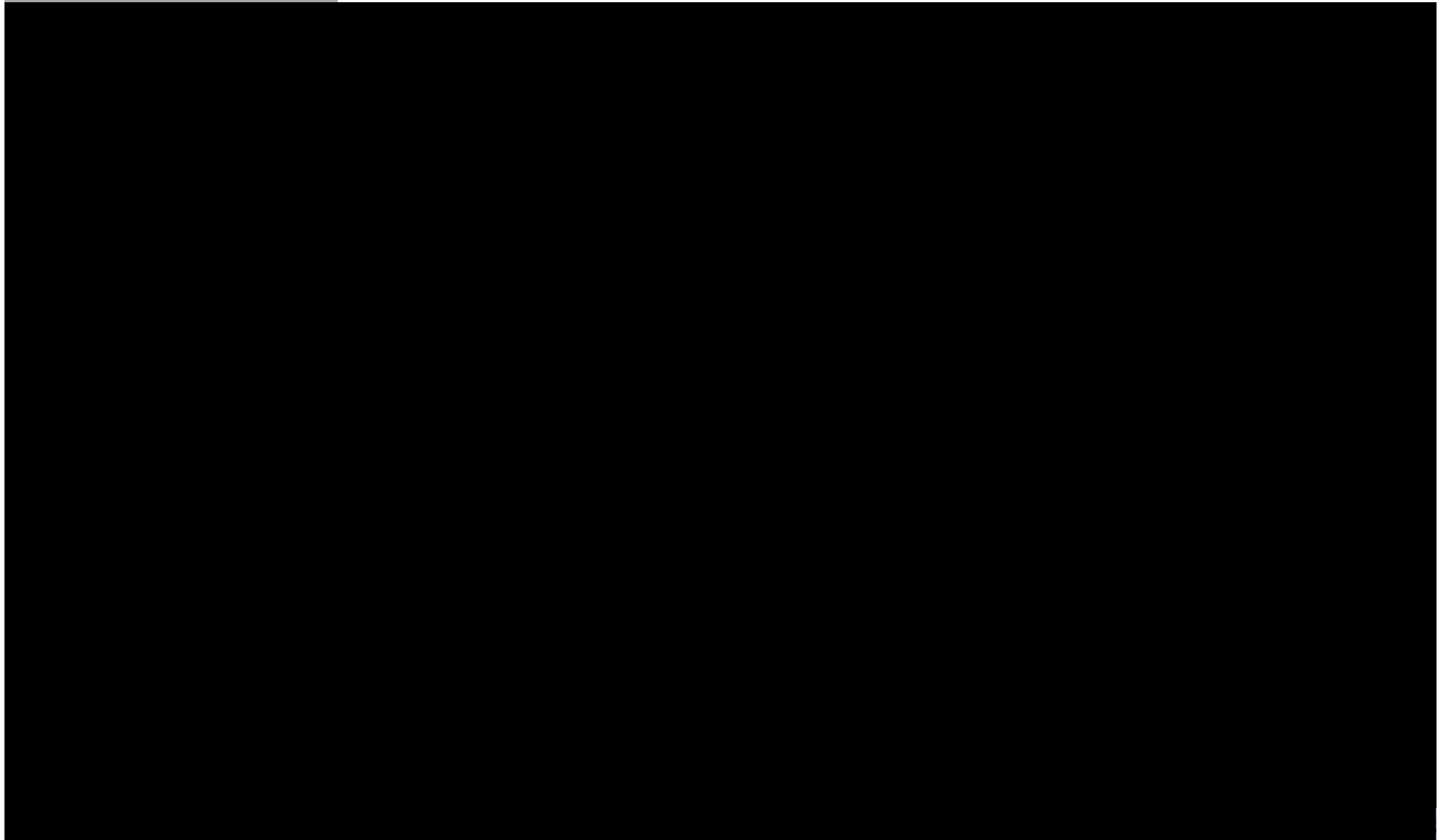




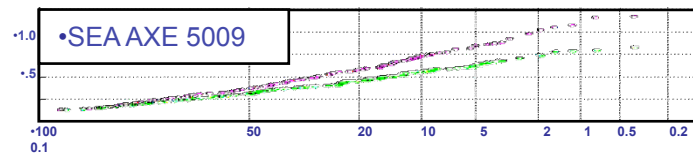
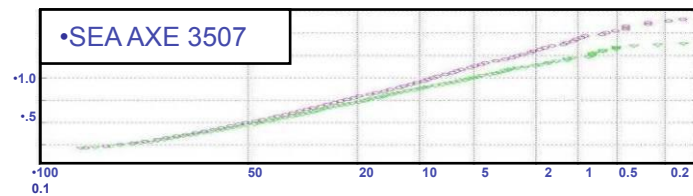
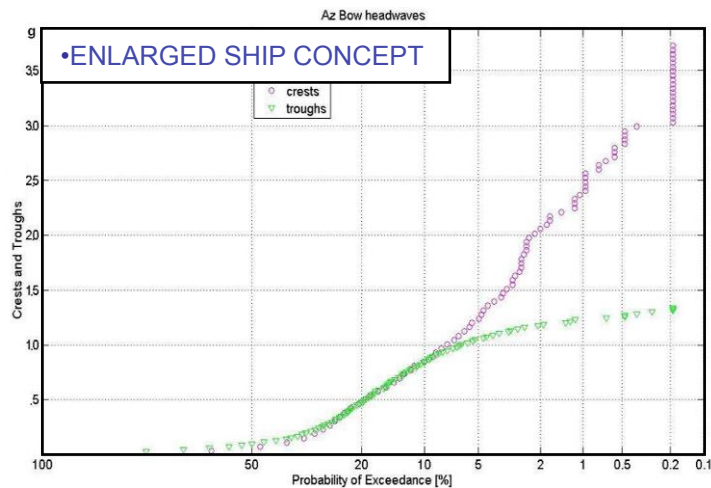
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SEA AXE
Full scale measurements



SEA AXE Sea keeping characteristics



Maximum vertical acceleration at bow

- Conventional Fast Craft : 10 g
- Sea Axe, based on model tests : 2 - 2.5 g

FCS 3507



: 1.3 g

FCS 5009



: 1.1 g

WHAT DO THE CUSTOMERS THINK OF THE SEA AXE?

Endurance trials FCS 3507:

Trials captain, after 4 hrs endurance:
(29 kts, Bf 7, Hs = 2.5 m, very confused seas)

“I do not believe that any other ship of this limited size and weight can come close to this sustained speed for such a long time in these conditions”

Owner, on board during trials:

“Although we planned to use this ship as a fast supplier, I consider to use it for personnel transport instead – the ship has unbelievable seakeeping characteristics”



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WHAT DO THE CUSTOMERS THINK OF THE SEA AXE?

F***ing awesome boat!





The Damen Sea Axe

*HighSpeedBoat
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IF LIFE ONLY STARTS AT 50 (kts)
add two 57 kts DI 1102's!

