MINIMUM POWER REQUIREMENTS FOR SAFE NAVIGATION

Presentation at 2nd International Workshop on Environmentally Friendly Ships Minimum propulsion power of ships in adverse sea conditions- Athens, April 28th, 2015.

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“The Road to **Hell** is Paved with Good Intentions”

Saint Bernard of Clairvaux (c.1150)

The authors of the **EEDI** formula **wanted to create the most efficient ships** targeting a **75% MCR** which coincides approximately with the best **SFOC**.

This is the root cause of the ship powering problem.

Efficiency of road transport is estimated on a **driving cycle** and **has proved successful in increasing vehicle efficiency**.

Why change the concept?

Legislating on flawed shipping assumptions

Second IMO GHG Study 2009, paragraph 5.25, page 47 says:

"…and it is particularly important that they do not have incentives to contribute to inefficient behavior. As an example of the latter, ship upgrades and major maintenance activities depend on the high-level strategies of the operating companies. In cases where ships are operated by a different company than the commercial operator, **the technical operator may tend to minimize time in dry dock (to minimize off-hire cost) and other maintenance costs (e.g., painting costs) while at the same time handing the fuel bill to the commercial operator**."

This statement in the Study is incorrect and misleading.

Each ship is evaluated by the time charterer based on the speed and consumption warranties given by the shipowner and is **offered a daily rate for a specific trip or period on this basis.**

The higher the consumption the lower the T/C rate *ceteris paribus.*

No commercial operator will accept practices leading to inflated fuel bills above the ship's speed/consumption warranties.

Charterers will successfully recoup ship overconsumption or under performance through legal means.

“An expert is a man who has made all the mistakes which can be made, in a narrow field”

(Niels Bohr (1885 - 1962), Danish Physicist)

A simple idea underpins science: “Trust, but verify”

(The Economist Oct 19-25, 2013)

I hope by now we know better!!

THE TECHNOLOGIES HAVE BEEN KNOWN FOR A LONG TIME

Hull form is the most important

- A racing skiff does ~10 kn with 1 M-P
- A light rowboat does ~2.5 kn with 1 M-P

Slow speed engines and propellers

"Propeller efficiency usually increases withincreasing diameter" … "A reduction of the RPM tends to be beneficial" "Muntjewerft in 1983 mentions a possible increase of propulsive efficiency of 10 to15 pct" (PNA-1988)

In 1981 B&W produced their MKIII 65.000 tdw Panamax bulk carrier with a greatly Improved hull, 12.600 BHP engine and a slow turning 6.9 m diameter propeller doing 82 RPM @75% MCR, thus creating a very energy efficient ship.

The ship at scantling draft traded at 13.5 kn consuming 26 t/day of H.F.O.

Its consumption was about 25% less than other ships built at the time.

The B&W MKIII eco Panamax was designed because of high fuel prices

No "EEDI" was necessary

Energy efficiency

"BACK TO THE FUTURE?"

The **EEDI** is the Energy Efficiency Design Index. Its purpose is to promote the **design** of energy efficient ships. **That means improved Hulls (the platform) and of course Machinery and Propellers.** The simplified formula is as follows:

The formula → $$\frac{P \cdot SFC \cdot C_f}{dw \cdot v} = EEDI \leq a \cdot dw^{-c}$$ ← the reference line

As formulated (at a V equivalent to P at 75% MCR) it has a bias to reduce power rather than improve the design.

In MEPC 62/5/6 of 11-15 July 2011, Greece proposed that the EEDI should instead of be linked to a specific speed for different types of vessels. This would directly link engine power to ship hull design and safe navigation.

The databases that produced the regressions which formulate the reference line are plagued with inconsistencies "GiGo"

Table from IMO MEPC 62/5/6 of May 5, 2011 submitted by Greece

MO/YEAR	YARD	DWT (Ton)	Engine (HP)	Speed (kn)	EST EEDI
Feb-95	YARD 1	68519	9799	15.00	3.388 (3.730)
Jun-94	YARD 1	68621	9800	13.90	3.652 (4.019)
Jul-81	YARD 2	65337	15200	15.50	5.334 (5.871)
Jul-81	YARD 2	65020	15202	16.80	4.946 (5.444)
Aug-99	YARD 3	73725	10261	14.00	3.533 (3.889)
Sep-99	YARD 3	73659	10261	15.50	3.194 (3.516)

The above 3 pairs of 2 sister ships built by the same yard within a few months of each other have 8%-10% differences in EEDI.

You also see power reduction over time. The first pair with inadequate power hardly made headway in heavy weather.

Underpowered ships will have to travel greater distances in order to avoid weather. They will also burn more because they will also operate their engines at a higher SFOC.

Distances as per OCEAN PASSAGES OF THE WORLD, Hydrographic Department, Admiralty, (London 1950)

San Francisco to Yokohama

MODERATE POWERED STEAMERS

June to September	4535 miles
October to May	4840 miles

LOW POWERED STEAMERS

All seasons	4840 miles

Increase in voyage length 6.70%

Rio De Janeiro to Cape Town

MODERATE POWERED STEAMERS

All seasons	3310 miles

LOW POWERED STEAMERS

All seasons	3510 miles

Increase in voyage length 6.04%

Sunda Strait to Aden

MODERATE POWERED STEAMERS

May to September	3820 miles

LOW POWERED STEAMERS

April to June	4145 miles
September to October	4145 miles
July to August	4000 miles

Increase in voyage length 8.51%

New York to Gibraltar

MODERATE POWERED STEAMERS

July 1st to April 10th	3.180 miles
April 11th to June 30th	3.185 miles

LOW POWERED STEAMERS

October to April	3.645 miles
May to September	3.360 miles

Increase in voyage length 14.60%

Rio de La Plata to Cape Town

MODERATE POWERED STEAMERS

All season	3590 miles

LOW POWERED STEAMERS

All seasons	3650 miles

Increase in voyage length 1.67%

Over the last 60 years weather patterns have deteriorated. The necessary deviations for the Low Powered Steamers, in all probability, have increased causing higher CO_2 emissions.

Survivability and maneuvering requirements

With the EEDI as formulated, minimum powering requirements should be established for each ship.

Criteria:
The IMO minimum speed requirement for maneuvering in heavy weather, works out from about 7 kn for Handysize ships to about 10 knots for Capesize ships. **From studies carried out at NTUA for 5 ships, present powering is marginal particularly so for the smaller ships. Any reduction will create underpowered ships which will need to follow longer, fair weather routes thus causing more emissions.**

The IMO Stability Code Severe Wind criterion requires testing in winds of 26m/sec plus gusts (10+B and 8 m waves).

- **October 2014 Japan typhoon Vongfong 71.4m/sec (257 km/hr)**
- **October 2013 UK wind speeds of 31.1 m/sec (70 mph) and gusts 44.0 m/sec (99 mph)**
  Denmark 52.8 m/sec (190 km/hr)
- **October 1987 UK wind speeds of 51.1 m/sec (115 mph)**
- **Top wind speeds Hurricanes: Katrina 2005 sustained 77.8 m/sec, gusts 95.6 m/sec**
  Sandy 2012 sustained 41.7 m/sec, gusts 62.1 m/sec

Ships often meet such weather conditions and must survive.

Any powering requirements to meet lesser weather conditions would result in the ship grounding in an upright position in bad weather!

MEPC 64 and MSF Dec 2012 decided on: 19m/sec (8 Beaufort and 6 m waves
MEPC 65 May 2013 reduced the above to: 15.7m/sec and 4 m waves for ships <200m and
19.0m/sec and 5.5 waves for ships >250m !!

In view of the above does this represent safe thinking? NO

Underpowered ships are dangerous

Greece has submitted to IMO MSC 93/inf.13 of 11th March 2014 the paper "Minimum Power Requirements for Ship's Safe Operation in Adverse Weather Conditions", a study prepared by the National Technical University of Athens (NTUA) suggesting that the proposed powering criteria were inappropriate for the weather likely to be encountered. The study proposes that the minimum power should be increased by 15%-20%.

Greece's views at IMO were supported by:

1. **The Royal Institution of Naval Architects (RINA)**
2. **The International Federation of Shipmasters' Associations (IFSMA)**

Press comments:

"….**mariners and marine engineers alike ought to welcome the important intervention of Greece at this month's International Maritime Organization's maritime safety committee**, raising the subject of the safety evaluation of the interim guidelines for determining minimum propulsion power to maintain the maneuverability of ships in bad weather."

Michael Grey "The need for speed" – Lloyd's List May 2nd, 2014:

Underpowered ships continued:

At the MEPC 67, Greece made an interim compromise proposal to ensure adequate power until the SHOPERA study was completed.

Whereas it was supported by about 15 Nations and Associations it was not passed.

More significantly, it was supported by:

- **The Nautical Institute and**
- **The ITF**

Both are Associations whose members sail ships, not desks.

Power is an Incorrect Metric for Operational Performance

The Correct one is Speed

Speed encapsulates safety and forces ship designers to compete on hull lines, displacement to consumption trade-offs, energy saving devices etc.

The EEDI Legislators did not Account for the Human Element.

The EEDI, as formulated, considers lower powered ships with the same hull as "eco". Shipyards immediately complied, by installing smaller engines, as it was cheaper than redesigning a new hull.

Result: A Lost Generation of Underpowered Ships

To avoid more such ships being built, IMO should adopt an Interim Minimum Speed Requirement for ocean going ships of, say, 14-15 knots at full draft, irrespective of their installed power. Such ships would probably have sufficient power for "adverse weather" conditions. They would also generally operate at a lower SFOC.

M.R.V.-An exercise in futility

Trade expands in line with the world economy therefore ship emissions will always increase *ceteris paribus.*

Ships operate in an environment producing many variables most of which are not controlled by the shipowner. All affect speed, resistance and consumption. These are:

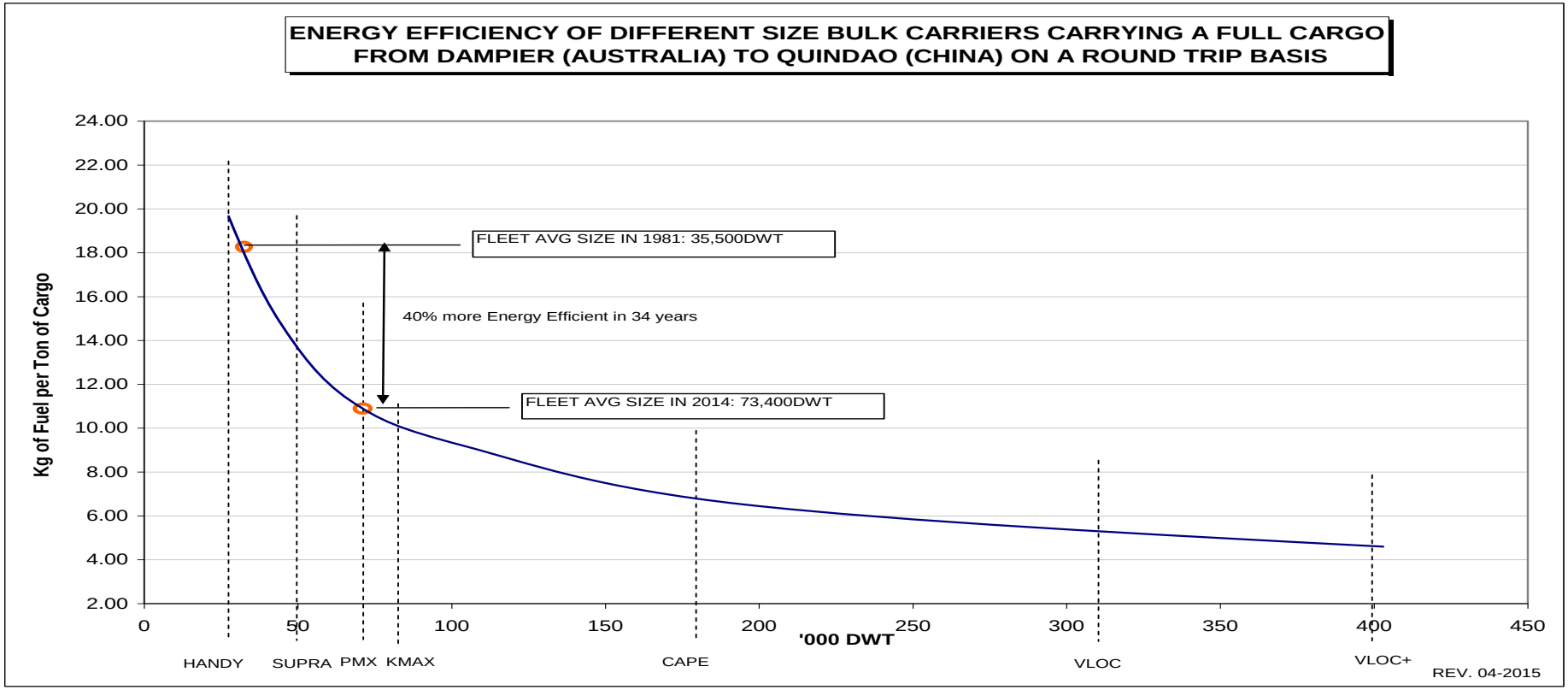
-**Condition of load**: **full load**, **part load**, **light ballast**, **heavy ballast** , **trim** etc., which create greater or lesser resistance and powering requirements.
-**Consumption and emissions vary with speed**. **The speed at which profit is maximized varies with the ratio of freight rate to bunker price if there are no other constrains**. It also varies with weather conditions.

-**Water surface currents:** Over the year they may vary from **1kn to 3 kn on the prevalent axis.**
-**Wind speed and direction**
-**Hull and propeller fouling**
-**Hull deformation/damages/groundings**

No amount of data analysis can be meaningful when trying to assess the recorded speed and consumption of about 50.000 ships, operating with the above variables, particularly if one tries to take averages over extended periods. Even identical sister ships in different trades and trading areas have recorded different consumptions.

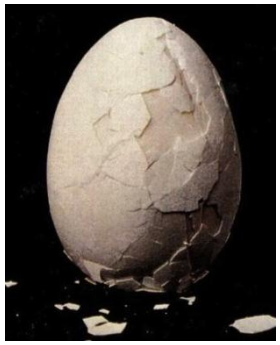
Larger ships are more energy efficient. Over the last 34 years energy efficiency of the average ship in the dry bulk fleet improved 40% *ceteris paribus* or 1.18% PA from the increase in average ship size alone from 35.500 tdw to 73.400 tdw.

Technological improvements increase efficiency further.



Such improvements cannot occur in road or rail transport which have length, axle load and other limitations.

A practical suggestion for rating ship efficiency



"Columbus's egg"

All owners create **warranted time charter speed and consumption descriptions** for their ships **at various speeds and conditions of load** which they update from time to time based on the ship's observed performance.

Charterers monitor a ship's speed/consumption performance daily using routing companies. This way they calculate overconsumption or underperformance, if any.

Since these speed and consumption descriptions are legally binding there is no reason to ask for third party verifications. A ship's recent speed and consumption warranties **are known on the market and verified by the fact that both owners and charterers accept them**.

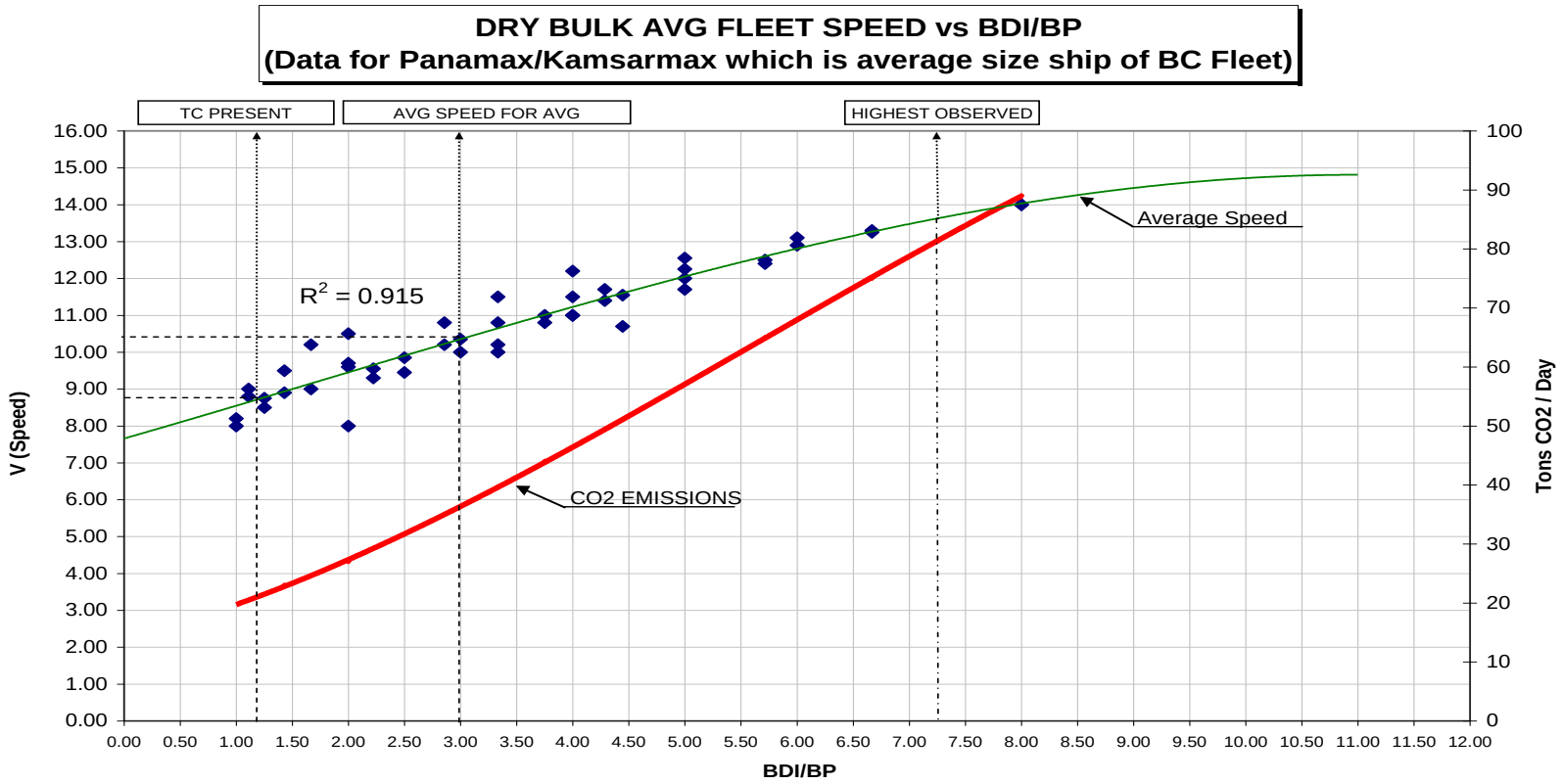
This is (and has been) how ships are rated on a daily basis.

Shipping reacts to cost inputs and profitability criteria

To improve shipping's already **very good environmental performance** we must think clearly, **free of ideological constraints** and **avoid meaningless, unnecessary complications.**

Ships trade at the speed at which they maximize earnings for any given freight rate and bunker price. Ship emissions vary with the cube (or more) of the speed. **Ships operate in an environment producing many variables most of which are not controlled by the shipowner.**

All affect speed, resistance and consumption.



Ships will proceed at the speed at which they maximize earnings. This speed is a function of the ratio of the freight market to the bunker price.

The above shows that increasing the bunker price will predictably reduce the fleet's profitable operating speed, therefore its emissions.

The only practical solution for reducing emission is a fixed bunker levy

A bunker Levy alone could act as both:

- A ship design improvement mechanism, and
- An automatic speed regulating mechanism with a bias for slow steaming

It would do this while reducing emissions, increasing ship profitability, eliminating unnecessary complexities and uncertainty.

A bunker Levy will not create underpowered ships.

Because of its simplicity the Levy is also **2 to 5 times more cost efficient from ETS** (USA CBO) thus increasing environmental benefits at a lower overall cost to society.

“Any intelligent fool can make things bigger, more complex and more violent. It takes a touch of genius - and a lot of courage – to move in the opposite direction.”

Albert Einstein

I hope SHOPERA shows “a touch of genius and a lot of courage” to simplify this unrealistically complicated exercise.

Life is not one dimensional. Try some lateral thinking.

Thank you

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