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To whom it may concern

Powering performance of a bulk carrier during speed trials in ballast condition reduced to nominal no wind condition

Still work in progress,
open for discussion!

Preface

Preamble

The present analysis of a powering trial is the first of my 'post-ANONYMA trial evaluations'. And again I have learned a number of lessons. Thus this document is in fact a new paper contributing to the development and promotion of the rational approach I have developed over the past two decades.

Data provided

The powering trial analysed according to the rational procedure promoted is one of the reference cases of an ongoing research project. As usual only the anonymised data, just mean values of measured quantities and crude estimates of wind and waves, have been made available for the analysis.

Further, for comparison with the evaluation according to an unspecified, more or less traditional procedure, few results have been provided, thus permitting to demonstrate the inherent deficiencies of the traditional procedure.

Rational evaluation

The following analysis is solely based on extremely simple propeller, current and environment conventions and on the mean data reported, though without their confidence ranges. No prior data and parameters will be used, particularly not those derived from corresponding model tests. Thus the procedure and its results are as transparent and observer independent as necessary for the rational resolution of 'conflicts' of any type!

Subsequent trustworthy predictions (!) of the powering performance at loading conditions and sea states differing from those prevailing during the trials are *not* subject of this exercise. But in the Conclusions at the end serious doubts concerning any traditional convention based on prior data are being expressed and future solutions are being outlined.

'Disclaimer'

In spite of utmost care the following evaluation, in the meantime a document of more than thirty pages, may still contain mistakes. The author will gratefully appreciate and acknowledge any of those brought to his attention, so that he can correct them.

Concepts and symbols

Table of names and symbols

Names		Symbols	
rational	**traditional**	**rational**	**traditional**
'Bodies'			
Ground		G	
Water		W	
Air	Wind	A	
Hull		H	
Shaft		S	
Propeller		P	
'Speeds'			
Hull speed relative to ground	ship speed over ground	V_{HG}	V_G
Hull speed relative to water	ship speed in water	V_{HW}	V_H, V_S
Hull speed relative to air	relative wind velocity	$V_{HA} = - V_{AH}$	$V_{Wind\ rel}$
Water speed relative to ground	current velocity	V_{WG}	
Water speed relative to hull	relative current velocity	V_{WH}	
Air speed relative to ground	wind velocity	V_{AG}	V_{Wind}
Air speed relative to hull		V_{AH}	
Evaluations			
rational		rat	
traditional		trad	
Conditions			
trials		trial	
reference		ref	

Remarks

Speeds

The speeds relative to the hull are the longitudinal speeds, positive in the forward direction.

The notational conventions for speeds imply sign reversal with the reversal of indices, e. g.

$$V_{WH} = -V_{HW} \,.$$

Thus the speed of the incoming water is negative at positive forward hull speed, while traditionally the speed of wind incoming from ahead is 'counted' positive.

This inconsistency is particularly evident at the no-wind condition, precisely the 'no wind relative to the water' condition

$$V_{AW} = V_{AH} + V_{HW} = 0 \,,$$

resulting correctly in the negative relative wind speed

$$V_{AH} = -V_{HW} \,.$$

and in the relation

$$V_{HA} = V_{HW} \,.$$

The reason for this confusion is to be found in the inconsistent traditional jargon. In the analysis not the air speed is being used, but the hull speed relative to the air as is the hull speed relative to the water.

Powers

Further, the shaft power supplied is positive and, as matter of convenience, the shaft power required is traditionally counted positive as well, in accordance with the balance of powers

$$P_{S.sup} - P_{S.req} = 0$$

at steady conditions, 'hopefully' prevailing at traditional trials.

While the supplied power convention introduced

$$P_{S.sup} = p_0 \, N^3 + p_1 \, N^2 \, V_{HW}$$

is straightforward, the required power convention introduced

$$P_{S.req} = q_0 \, V_{HW}^{\;2} \, V_{HW} + q_1 \, |V_{HA}| \, V_{HA} \, V_{HW}$$

in cases of constant sea state during the trials needs careful consideration.

Writing the convention in detail

$$-P_{S.req} = q_0 \, V_{WH}^{\;2} \, V_{WH} + q_1 \, |V_{HA}| \, V_{HA} \, V_{WH}$$

results in the original format

$$P_{S.req} = q_0 \, V_{HW}^{\;2} \, V_{HW} + q_1 \, |V_{HA}| \, V_{HA} \, V_{HW}$$

thus only, if not the incoming wind is considered, but the speed of the ship relative to the air, as is usually done and has been .stated before.

Units

Data in SI-Units, if not explicitly stated otherwise, and non-dimensionalised in view of further use in some mathematical subroutines, which by definition cannot handle arguments of different units!

length	m	$nm := 1852 \cdot m$
angle	rad	$deg := \frac{\pi}{180} \cdot rad$
time	sec	$min := 60 \cdot sec$
		$hr := 3600 \cdot sec$
frequency	$Hz := \frac{1}{sec}$	$rpm := \frac{1}{min}$
speed	$kts := \frac{nm}{hr}$	$kts = 0.514 \frac{m}{s}$
mass	kg	$t := 10000 \cdot kg$
force	$N := newton$	$kN := 10^3 \cdot N$
		$MN := 10^3 \cdot kN$
power	$W := watt$	$kW := 10^3 \cdot W$
		$MW := 10^3 \cdot kW$

General constants

'field strength'	$g := 9.81 \cdot \frac{m}{s^2}$	$g := 9.81$	
density of seawater	$\rho := 1.025 \cdot 10^3 \cdot kg \cdot m^{-3}$	$\rho := \frac{\rho}{kg \cdot m^{-3}}$	Assumed1
tidal frequency	$\omega_T := \frac{2 \cdot \pi}{12.417 \cdot hr}$	$\omega_T := \omega_T \cdot hr$	

Sample 95 % confidence radius

$$St_{95}(f) := 2 + \frac{10}{f^2}$$

95 % Student's fractiles

$$C_{95}(\Delta v, f) := \left| \begin{array}{l} s \leftarrow Stdev(\Delta v) \\ \Delta v_{95} \leftarrow \frac{St_{95}(f) \cdot s}{\sqrt{f}} \\ \Delta v_{95} \end{array} \right.$$

Trial identification

$TID := \text{"PATE\_01"}$

'Constants'

$D_P := 7.05 \cdot m$ $\quad D_P := D_P \cdot \frac{1}{m}$ $\quad$ diameter of propeller

$h_S := 3.85 \cdot m$ $\quad h_S := h_S \cdot \frac{1}{m}$ $\quad$ height of shaft above base

Trials conditions

$T_{aft} := 7.42 \cdot m$ $\quad T_{aft} := T_{aft} \cdot \frac{1}{m}$ $\quad$ draft aft

Nominal propeller submergence

$h_{P.Tip} := h_S + \frac{D_P}{2}$ $\quad h_{P.Tip} = 7.375$

$s_{P.Tip} := T_{aft} - h_{P.Tip}$ $\quad s_{P.Tip} = 0.045$

At this small nominal submergence and the sea state reported the propeller may have been ventilating even at the down wind conditions.

Wave

$H_{Wave} := 3.3 \cdot m$ $\quad H_{Wave} := \frac{H_{Wave}}{m}$ $\quad$ wave height

$$\psi_{WaveH} := \begin{bmatrix} 5 \\ 175 \\ 175 \\ 5 \\ 5 \\ 175 \\ 175 \\ 5 \end{bmatrix} \cdot deg$$

Water depth

$d_{Water} := 65 \cdot m$

'Duration' of measurements

$s_{mean} := 1\ nm$ $\quad s_{mean} := \frac{s_{mean}}{m}$ $\quad$ Distances sailed at each run

Sailing the same distance at different speeds, here one nautical mile, is in accordance with the name 'miles runs', in German 'Meilen-Fahrten', but has the disadvantage, that the average values derived from the sampled values have wider confidence ranges at the higher speeds.

Mean values

For ready reference the matrices of the mean values of the measured magnitudes, alias 'quantities', are printed here and converted to SI Units. Further down intermediate results are printed as well to permit checks óf plausibility.

It is noted here explicitly, that no confdence radii of the mean values have been reported.

Day time

$$time := \begin{bmatrix} 5 & 21 \\ 5 & 48 \\ 6 & 04 \\ 6 & 28 \\ 6 & 44 \\ 7 & 7 \\ 7 & 25 \\ 7 & 46 \\ 8 & 10 \\ 8 & 29 \\ 8 & 41 \\ 9 & 5 \end{bmatrix}$$

Heading

$$\psi_{HG} := \begin{bmatrix} 180 \\ 0 \\ 0 \\ 180 \\ 180 \\ 0 \\ 0 \\ 180 \\ 180 \\ 0 \\ 0 \\ 180 \end{bmatrix} \cdot deg$$

Rel. wind velocity

$$V_{HA} := \begin{bmatrix} 35 \\ 11 \\ 11 \\ 35 \\ 41 \\ 10 \\ 10 \\ 42 \\ 44 \\ 8 \\ 7 \\ 45 \end{bmatrix} \cdot kts$$

Rel. wind direction

$$\psi_{HA} := \begin{bmatrix} 5 \\ 160 \\ 160 \\ 5 \\ 5 \\ 160 \\ 155 \\ 5 \\ 5 \\ 165 \\ 160 \\ 0 \end{bmatrix} \cdot deg$$

Shaft frequency

$$N_S := \begin{bmatrix} 52.47 \\ 52.47 \\ 66.58 \\ 66.60 \\ 82.26 \\ 82.27 \\ 94.85 \\ 94.86 \\ 102.81 \\ 102.88 \\ 104.89 \\ 104.87 \end{bmatrix} \cdot \frac{1}{min}$$

Measured shaft power

$$P_S := \begin{bmatrix} 1924 \\ 1758 \\ 3232 \\ 3639 \\ 6358 \\ 6038 \\ 9344 \\ 9730 \\ 12425 \\ 12055 \\ 12778 \\ 13248 \end{bmatrix} \cdot kW$$

Ship speed over ground

$$V_{HG} := \begin{bmatrix} 6.657 \\ 8.210 \\ 11.044 \\ 7.967 \\ 11.442 \\ 14.018 \\ 15.784 \\ 13.049 \\ 14.256 \\ 17.152 \\ 17.380 \\ 14.211 \end{bmatrix} \cdot kts$$

Further it is mentioned here, that in Mathcad the operational indices standardly start from zero as usual in mathematics and thus in the mathematical subroutines available in the Numericl Recipes package. Thus the possible change of the standard, resulting in intransparent code, is not a viable choice..

'Non-dimensionalise' magnitudes

$V_{HA} := V_{HA} \cdot \frac{sec}{m}$ $\quad N_S := N_S \cdot sec$ $\quad P_S := P_S \cdot \frac{1}{MW}$ $\quad V_{HG} := V_{HG} \cdot \frac{sec}{m}$

Times of measurements

$ni := last\left(time^{\langle 0 \rangle}\right)$ $\quad i := 0 .. ni$

$dur_i := \frac{s_{mean}}{V_{HG_i}}$ $\quad t := time^{\langle 0 \rangle} + time^{\langle 1 \rangle} \cdot \frac{min}{hr} + \frac{dur}{2} \cdot \frac{sec}{hr}$

$t_m := mean(t)$ $\quad \Delta t := t - t_m$

Normalise data

At this stage for preliminary check of consistency only!

$J(D, V, N) := \frac{V}{D \cdot N}$ $\quad KP(\rho, D, P, N) := \frac{10^6 \cdot P}{\rho \cdot D^5 \cdot N^3}$

$J_{HG_i} := J\left(D_P, V_{HG_i}, N_{S_i}\right)$ $\quad K_{P.orig_i} := KP\left(\rho, D_P, P_{S_i}, N_{S_i}\right)$

Sort data in down and up-wind runs

```
Sort_runs(J_HG, K_P, ψ_HG) := | j_0 ← 0
                              | j_1 ← 0
                              | for i ∈ 0 .. last(ψ_HG)
                              |   | if ψ_HG_i > π/2
                              |   |   | S_(j_0, 0) ← J_HG_i
                              |   |   | S_(j_0, 1) ← K_P_i
                              |   |   | j_0 ← j_0 + 1
                              |   | otherwise
                              |   |   | S_(j_1, 2) ← J_HG_i
                              |   |   | S_(j_1, 3) ← K_P_i
                              |   |   | j_1 ← j_1 + 1
                              | S
```

$$S := \text{Sort\_runs}\left(J_{HG}, K_{P.orig}, \Psi_{HG}\right)$$

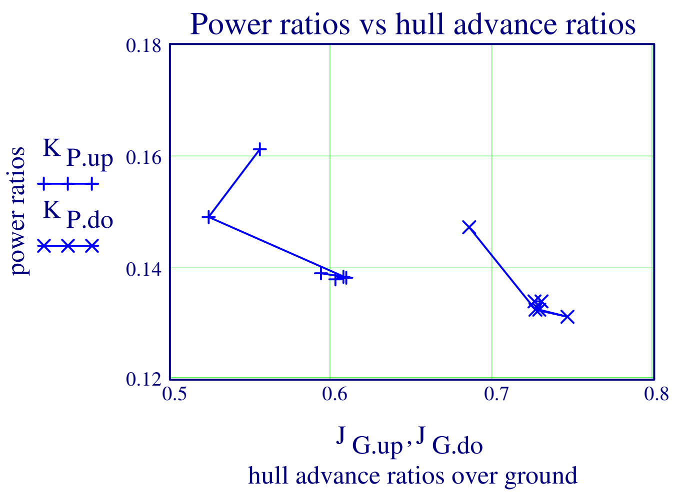
$$J_{G.up} := S^{\langle 0 \rangle} \qquad K_{P.up} := S^{\langle 1 \rangle}$$

$$J_{G.up} = \begin{bmatrix} 0.555 \\ 0.524 \\ 0.609 \\ 0.602 \\ 0.607 \\ 0.593 \end{bmatrix} \qquad K_{P.up} = \begin{bmatrix} 0.161 \\ 0.149 \\ 0.138 \\ 0.138 \\ 0.138 \\ 0.139 \end{bmatrix}$$

$$J_{G.do} := S^{\langle 2 \rangle} \qquad K_{P.do} := S^{\langle 3 \rangle}$$

$$J_{G.do} = \begin{bmatrix} 0.685 \\ 0.726 \\ 0.746 \\ 0.729 \\ 0.730 \\ 0.725 \end{bmatrix} \qquad K_{P.do} = \begin{bmatrix} 0.147 \\ 0.133 \\ 0.131 \\ 0.132 \\ 0.134 \\ 0.134 \end{bmatrix}$$

Scrutinise data



Evidently the values at the first double run are outliers to be eliminated without further study of possible reasons.
In the traditional evaluation the values at the first two double runs, i. e. the first four data sets have been ignored.

Outlying data eliminated

$ne := 2$ $\qquad$ $ni := last(t) - ne$

$i := 0 .. ni$

$\Delta t_{red_i} := \Delta t_{i+ne}$ $\qquad$ $\psi_{HG.red_i} := \psi_{HG_{i+ne}}$ $\qquad$ $V_{HA.red_i} := V_{HA_{i+ne}}$

$\Delta t := \Delta t_{red}$ $\qquad$ $\psi_{HG} := \psi_{HG.red}$ $\qquad$ $V_{HA} := V_{HA.red}$

$N_{S.red_i} := N_{S_{i+ne}}$ $\qquad$ $P_{S.red_i} := P_{S_{i+ne}}$ $\qquad$ $V_{HG.red_i} := V_{HG_{i+ne}}$

$N_S := N_{S.red}$ $\qquad$ $P_S := P_{S.red}$ $\qquad$ $V_{HG} := V_{HG.red}$

Normalise reduced data

$J_{HG_i} := J\left(D_P, V_{HG_i}, N_{S_i}\right)$ $\qquad$ $K_{P_i} := KP\left(\rho, D_P, P_{S_i}, N_{S_i}\right)$

$S := Sort\_runs\left(J_{HG}, K_P, \psi_{HG}\right)$

$J_{HG.up} := S^{\langle 0 \rangle}$ $\qquad$ $K_{P.up} := S^{\langle 1 \rangle}$

$$J_{HG.up} = \begin{bmatrix} 0.524 \\ 0.609 \\ 0.602 \\ 0.607 \\ 0.593 \end{bmatrix} \qquad K_{P.up} = \begin{bmatrix} 0.149 \\ 0.138 \\ 0.138 \\ 0.138 \\ 0.139 \end{bmatrix}$$

$J_{HG.do} := S^{\langle 2 \rangle}$ $\qquad$ $K_{P.do} := S^{\langle 3 \rangle}$

$$J_{HG.do} = \begin{bmatrix} 0.726 \\ 0.746 \\ 0.729 \\ 0.730 \\ 0.725 \end{bmatrix} \qquad K_{P.do} = \begin{bmatrix} 0.133 \\ 0.131 \\ 0.132 \\ 0.134 \\ 0.134 \end{bmatrix}$$

Directions of runs

$$dir\left(\psi_{HG}\right) := if\left(\psi_{HG} > \frac{\pi}{2}, 1, -1\right)$$

Analyse power supplied

including identification of tidal current

Conventions adopted

Propeller power convention

$$PS_{sup}(p, N, V) := p_0 \cdot N^3 + p_1 \cdot N^2 \cdot V$$

Tidal current velocity convention

$$VC(v, \omega_T, \Delta t) := v_0 + v_1 \cdot \cos(\omega_T \cdot \Delta t) + v_2 \cdot \sin(\omega_T \cdot \Delta t)$$

Analyse power supplied

$$Supplied(\rho, D, \Delta t, V_{HG}, \psi_{HG}, N_S, P_S) :=$$

for $j \in 0 .. last(\Delta t)$

- $A_{sup_{j,0}} \leftarrow (N_{S_j})^3$
- $A_{sup_{j,1}} \leftarrow (N_{S_j})^2 \cdot V_{HG_j}$
- $A_{sup_{j,2}} \leftarrow -(N_{S_j})^2 \cdot dir(\psi_{HG_j})$
- $A_{sup_{j,3}} \leftarrow A_{sup_{j,2}} \cdot \cos(\omega_T \cdot \Delta t_j)$
- $A_{sup_{j,4}} \leftarrow A_{sup_{j,2}} \cdot \sin(\omega_T \cdot \Delta t_j)$

$X_{sup} \leftarrow geninv(A_{sup}) \cdot P_S$

$P_{S.sup} \leftarrow A_{sup} \cdot X_{sup}$

$\Delta P_{S.sup} \leftarrow P_S - P_{S.sup}$

for $k \in 0 .. 1$

- $p_k \leftarrow X_{sup_k}$
- $p_{n_k} \leftarrow \dfrac{10^6 \cdot p_k}{\rho \cdot D^{(5-k)}}$

$p_2 \leftarrow Stdev(\Delta P_{S.sup})$

$c \leftarrow svds(A_{sup})$

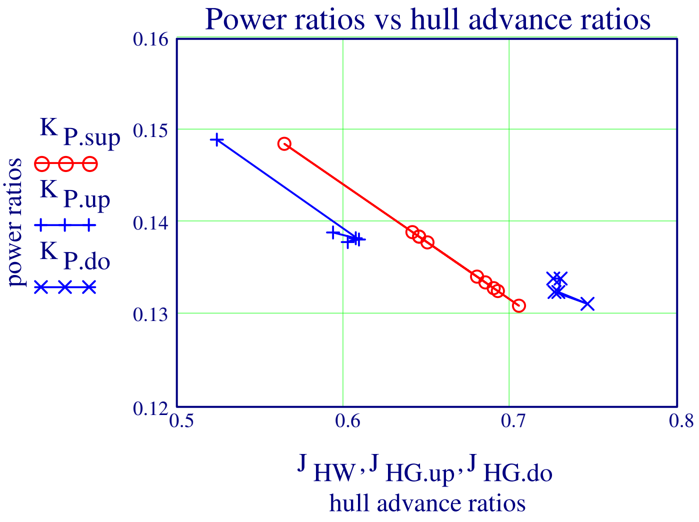
$p_3 \leftarrow \dfrac{c_4}{c_0}$

for $k \in 0 .. 2$

$$
\begin{array}{l}
v_k \leftarrow \dfrac{X_{sup_{2+k}}}{X_{sup_1}} \\
\text{for } j \in 0 .. \text{last}(\Delta t) \\
\quad V_{WG_j} \leftarrow VC\left(v, \omega_T, \Delta t_j\right) \\
\quad V_{HW_j} \leftarrow V_{HG_j} - V_{WG_j} \cdot dir\left(\psi_{HG_j}\right) \\
\quad J_{HW_j} \leftarrow J\left(D, V_{HW_j}, N_{S_j}\right) \\
\quad K_{P.sup_j} \leftarrow KP\left(\rho, D, P_{S.sup_j}, N_{S_j}\right) \\
\begin{bmatrix} \Delta P_{S.sup} & v & V_{WG} \\ V_{HW} & p & P_{S.sup} \\ J_{HW} & p_n & K_{P.sup} \end{bmatrix}
\end{array}
$$

$$Res_{sup} := Supplied\left(\rho, D_P, \Delta t, V_{HG}, \psi_{HG}, N_S, P_S\right)$$

$$\begin{bmatrix} \Delta P_{S.sup} & v & V_{WG} \\ V_{HW} & p & P_{S.sup} \\ J_{HW} & p_n & K_{P.sup} \end{bmatrix} := Res_{sup}$$



$$p = \begin{bmatrix} 3.914 \\ -0.317 \\ 0.027 \\ 2.402 \cdot 10^{-3} \end{bmatrix}$$

$$p_n = \begin{bmatrix} 0.219 \\ -0.125 \end{bmatrix}$$

Accounting for the power convention and the 'universal' tidal period the powering performance of the propeller in the behind condition and the mean current and the tidal current amplitude are identified.

Nota bene: The propeller performance in the behind condition identified is that at the hull condition, the loading condition and the sea condition prevailing at the trials!

Even at the very small nominal submergence the propeller does not show the typical signs of ventilation!

In order to check the condition of the linear system of equations solved the singular values are determined, indicating that the condition is not too bad.

In view of the very intricate tidal currents in the East China Sea, see below, the extremely simple current convention adopted is very crude, but sufficient for the purpose at hand and consequently the current identified is correctly called *nominal* current.

While the time of the trials has been reported precisely, as 'place of sea trials' just 'East China Sea' is being mentioned. In view of the following quotation there is evidently no chance to cross-check the tidal current identified.

Yanagi, Tetsuo and Kouichi Inoue: Tide and Tidal Current in the Yellow /East China Seas. La mer 32 (1994) 153-165.

"**The Yellow East China Seas** (including Bohai Sea) **are one of the largest shelf sea in the world**. Much land-derived materials flow into this shelf sea from large rivers such as Huanghe, Changjiang and so on. They are advected by residual flow and dispersed mainly by **tidal current, which is the most dominant flow there**, and some of them deposit to the bottom of this shelf sea and others flow out to the Pacific Ocean through the shelf edge or to the Japan Sea through the Tsushima Strait. It is very important to reveal the characteristics of tidal cur rent in the Yellow East China Seas in order to clarify the material transport there.

AN (1977) carried out a numerical experiment with the Cartesian co-ordinate of f-plane including the tide-generating potentials on M2 tide in the Yellow Sea. **CHOI (1980) revealed the characteristics of four major tidal components, M2, S2, K, and 0, in the Yellow/East China Seas** with use of the horizontal two-dimensional numerical model under the spherical co-ordinate of ß plane neglecting the tide-generating potentials. Moreover, CHOI (1984) revealed the three dimensional structure of M2 tidal current in the Yellow/East China Seas with use of linear numerical model except a quadratic bottom.friction."

Supplied power residua

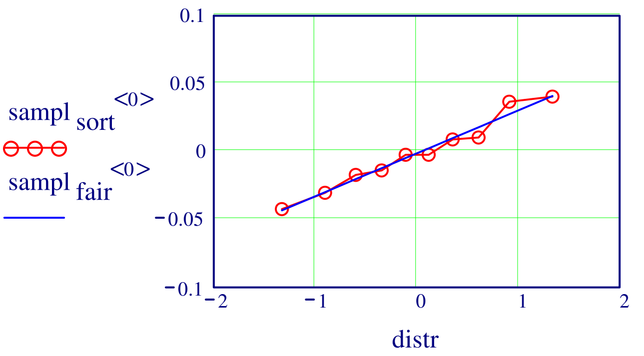
Check distributions

Values of random variables need to be tested for normal distribution before using mean values and and standard deviations.

$$\text{norm\_distr(sampl)} := \left| \begin{array}{l} r \leftarrow \text{rows(sampl)} \\ c \leftarrow \text{cols(sampl)} \\ \text{for } i \in 0..r-1 \\ \quad \left| \begin{array}{l} \text{fract} \leftarrow \dfrac{2\cdot(i+1)}{r+1} - 1 \\ \text{dst} \leftarrow \text{fract} \\ \text{distr}_i \leftarrow \sqrt{2}\cdot\text{root}(\text{erf(dst)} - \text{fract}, \text{dst}) \\ \text{for } j \in 0..1 \\ \quad A_{\text{distr}_{i,j}} \leftarrow \left(\text{distr}_i\right)^j \end{array} \right. \\ \text{for } j \in 0..c-1 \\ \quad \text{sampl}_{\text{sort}}^{\langle j \rangle} \leftarrow \text{sort}\left(\text{sampl}^{\langle j \rangle}\right) \\ \text{distr}_{\text{par}} \leftarrow \text{geninv}\left(A_{\text{distr}}\right)\cdot\text{sampl}_{\text{sort}} \\ \text{sampl}_{\text{fair}} \leftarrow A_{\text{distr}}\cdot\text{distr}_{\text{par}} \\ \text{for } j \in 0..c-1 \\ \quad \text{distr}_{\text{par}_{2,j}} \leftarrow \dfrac{\text{distr}_{\text{par}_{1,j}}}{\sqrt{r}} \\ \left[\text{distr} \;\; \text{sampl}_{\text{sort}} \;\; \text{sampl}_{\text{fair}} \;\; \text{distr}_{\text{par}} \right] \end{array} \right.$$

Check distribution

$$\left[distr \;\; sampl_{sort} \;\; sampl_{fair} \;\; distr_{par} \right] := norm\_distr\left(\Delta P_{S.sup}\right)$$



$$distr_{par} = \begin{bmatrix} -1.080\cdot 10^{-3} \\ 0.032 \\ 9.987\cdot 10^{-3} \end{bmatrix}$$

According to the result plotted the following error analysis is justified.

95 % confidence radius

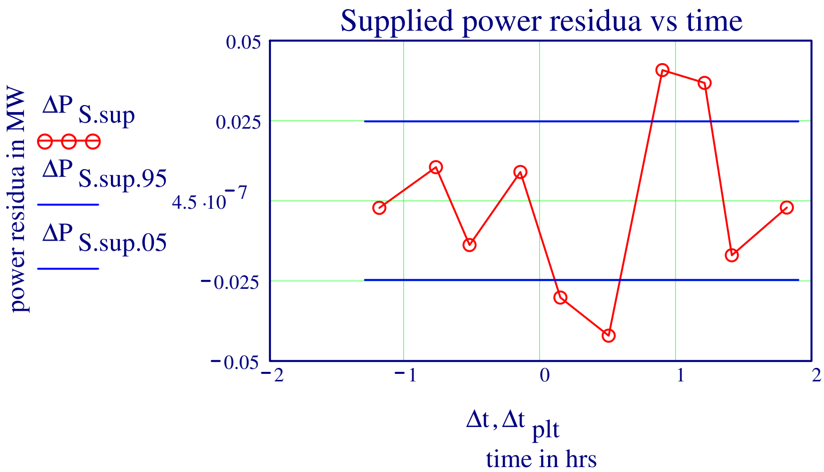
number of samples $\quad$ of parameters $\quad$ of degrees of freedom

$n_s := ni + 1 \qquad n_p := 4 \qquad f := n_s - n_p$

$P_{S.sup.95} := C_{95}\left(\Delta P_{S.sup}, f\right) \qquad P_{S.sup.95} \cdot \frac{MW}{kW} = 24.739$ kW

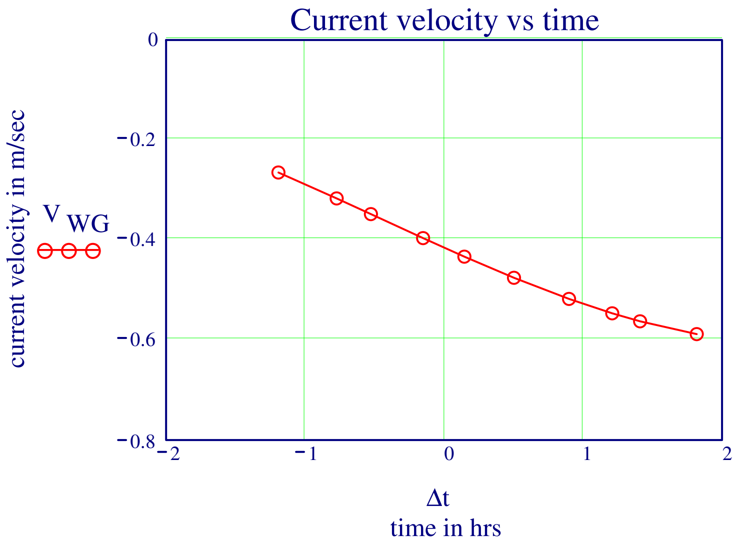
$k := 0 .. 1 \qquad \Delta t_{plt_0} := -1.3 \qquad \Delta t_{plt_1} := 1.9$

$\Delta P_{S.sup.95_k} := P_{S.sup.95} \qquad \Delta P_{S.sup.05_k} := -P_{S.sup.95}$



Accordingly the conventions adopted 'describe' the power data perfectly well! The relatively small value of the confidence radius cannot be judged objectively, as the confidence ranges of the mean values have not been provided as in case of the analysis of the ANONYMA trials.

Current velocity identified



$$V_{WG} \cdot \frac{m}{kts \cdot sec} = \begin{bmatrix} -0.516 \\ -0.616 \\ -0.678 \\ -0.771 \\ -0.843 \\ -0.925 \\ -1.007 \\ -1.062 \\ -1.094 \\ -1.144 \end{bmatrix} kts$$

During the trials the current changed more than half a knot!

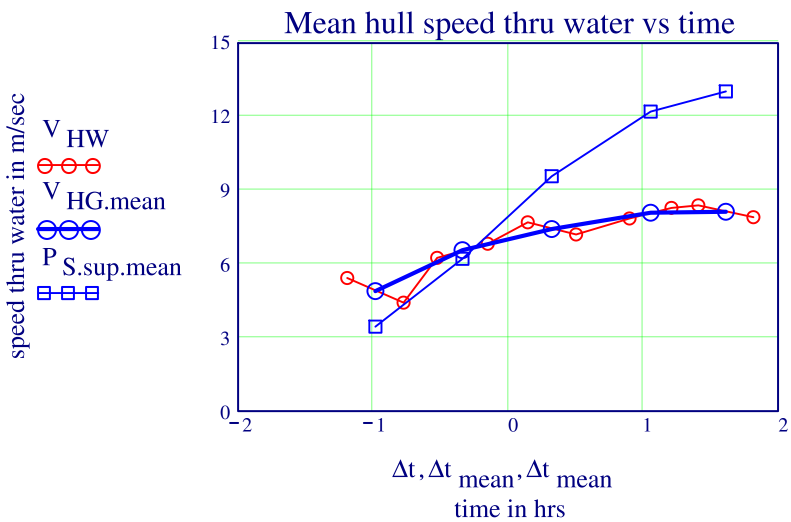
$V_{WG.mean} := v_0$ $\qquad V_{WG.mean} \cdot \frac{m}{kts \cdot sec} = -0.694$ Nominal mean current in kts

$V_{WG.ampl} := \sqrt{(v_1)^2 + (v_2)^2}$ $\qquad V_{WG.ampl} \cdot \frac{m}{kts \cdot sec} = 0.493$ Nominal tidal amplitude in kts

Mean velocity over ground and mean power

$nj := \frac{ni - 1}{2}$ $\qquad j := 0 .. nj$ $\qquad \Delta t_{mean_j} := \frac{\Delta t_{2 \cdot j} + \Delta t_{2 \cdot j + 1}}{2}$

$V_{HG.mean_j} := \frac{V_{HG_{2 \cdot j}} + V_{HG_{2 \cdot j + 1}}}{2}$ $\qquad P_{S.sup.mean_j} := \frac{P_{S.sup_{2 \cdot j}} + P_{S.sup_{2 \cdot j + 1}}}{2}$



In the present case the mean speed over ground happens to be equal to the speed over ground at the mean time between the two corresponding runs.

Scrutinise results of an undisclosed traditional evaluation **Part 1** concerning the speed through the water

Data used in the traditional evaluation

$j := 0 .. ni - 2$

$\Delta t_{trad_j} := \Delta t_{j+2}$ $\qquad \Psi_{HG.trad_j} := \Psi_{HG_{j+2}}$ $\qquad V_{WG.trad_j} := V_{WG_{j+2}}$

$N_{S.trad_j} := N_{S_{j+2}}$ $\qquad P_{S.trad_j} := P_{S_{j+2}}$ $\qquad V_{HG.trad_j} := V_{HG_{j+2}}$

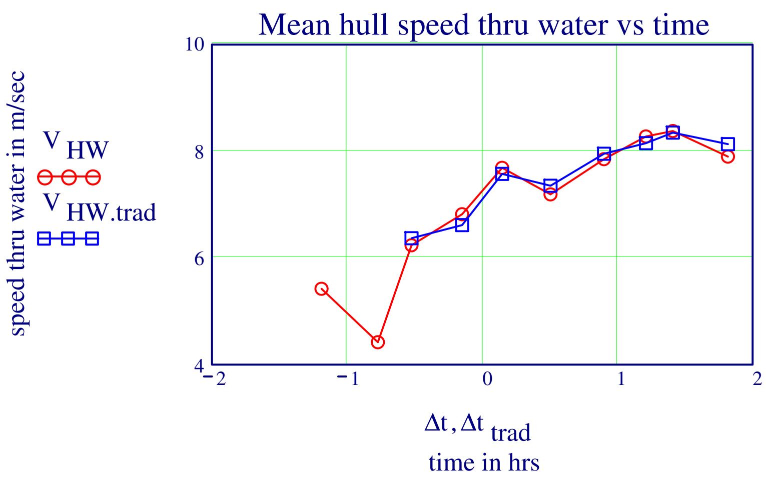
$V_{HW.rat_j} := V_{HW_{j+2}}$ $\qquad V_{WG.rat_j} := V_{WG_{j+2}}$

$J_{HW.rat_j} := J_{HW_{j+2}}$ $\qquad K_{P.rat_j} := K_{P_{j+2}}$ $\qquad K_{P.sup.rat_j} := K_{P.sup_{j+2}}$

Hull speed thru water reported

$$V_{HW.trad} := \begin{bmatrix} 12.38 \\ 12.85 \\ 14.72 \\ 14.29 \\ 15.46 \\ 15.84 \\ 16.23 \\ 15.80 \end{bmatrix} \cdot kts \qquad V_{HW.trad} := V_{HW.trad} \cdot \frac{sec}{m}$$

$$J_{HW.trad_j} := \frac{V_{HW.trad_j}}{D_P \cdot N_{S.trad_j}} \qquad J_{HW.trad} = \begin{bmatrix} 0.659 \\ 0.684 \\ 0.679 \\ 0.660 \\ 0.658 \\ 0.674 \\ 0.677 \\ 0.660 \end{bmatrix}$$



Current velocity identified by traditional procedure

$$V_{WG.trad_j} := \left(V_{HG.trad_j} - V_{HW.trad_j}\right) \cdot dir\left(\psi_{HG.trad_j}\right)$$

Tidal approximation as in the rational evaluation

$$A_{WG.trad_{j,0}} := 1$$

$$A_{WG.trad_{j,1}} := \cos\left(\omega_T \cdot \Delta t_{trad_j}\right)$$

$$A_{WG.trad_{j,2}} := \sin\left(\omega_T \cdot \Delta t_{trad_j}\right)$$

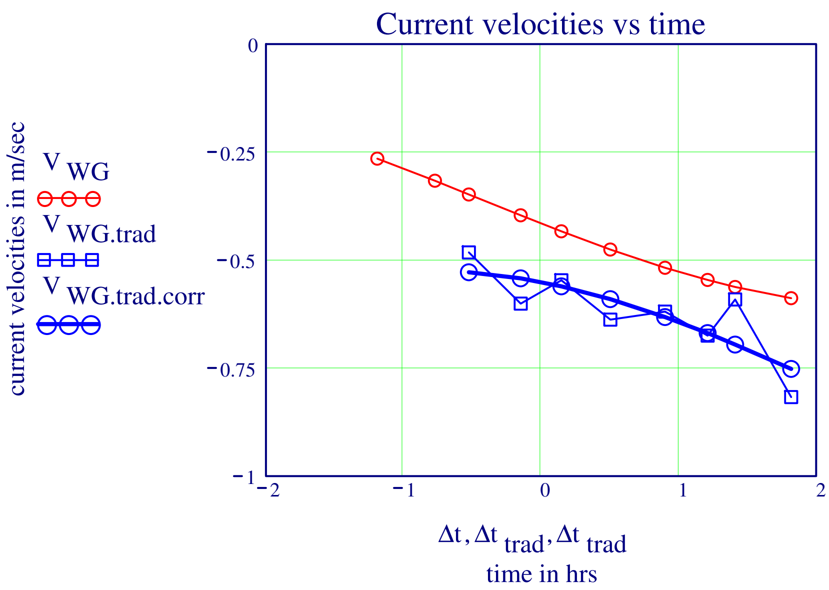
$$X_{WG.trad} := geninv\left(A_{WG.trad}\right) \cdot V_{WG.trad}$$

$$X_{WG.trad} = \begin{bmatrix} -0.816 \\ 0.264 \\ -0.122 \end{bmatrix}$$

$$V_{WG.trad.corr} := A_{WG.trad} \cdot X_{WG.trad}$$

$$\Delta V_{WG.trad} := V_{WG.trad} - V_{WG.trad.corr}$$

$$V_{HW.trad.corr_j} := V_{HG.trad_j} + V_{WG.trad.corr_j} \cdot dir\left(\psi_{HG.trad_j}\right)$$



Nominal mean currents and tidal amplitudes compared

Nominal mean currents in kts

Rational

$$V_{WG.mean} \cdot \frac{m}{kts \cdot sec} = -0.694$$

Traditional

$$v := X_{WG.trad}$$

$$V_{WG.mean} := v_0$$

$$V_{WG.mean} \cdot \frac{m}{kts \cdot sec} = -1.586$$

Nominal tidal amplitudes in kts

$$V_{WG.ampl} \cdot \frac{m}{kts \cdot sec} = 0.493$$

$$V_{WG.ampl} := \sqrt{\left(v_1\right)^2 + \left(v_2\right)^2}$$

$$V_{WG.ampl} \cdot \frac{m}{kts \cdot sec} = 0.566$$

Mean difference of traditionally identified current

In view of the intricate current conditions in the East China Sea the comparison of the nominal tidal currents is not particularly meaningful, while the results plotted suggest the comparison of the mean difference in the currents identified being more reasonable in the present context.

$$\Delta V_{WG} := V_{WG.trad} - V_{WG.rat}$$

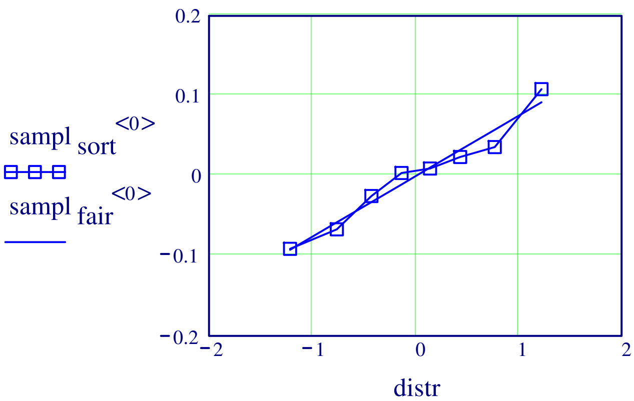
$$\Delta V_{WG.mean} := \text{mean}\left(\Delta V_{WG}\right)$$

$$\Delta V_{WG.mean} \cdot \frac{m}{kts \cdot sec} = -0.268 \quad kts$$

Check distribution of differences in current

$$\Delta\Delta V_{WG_j} := \Delta V_{WG_j} - \Delta V_{WG.mean}$$

$$\left[distr \quad sampl_{sort} \quad sampl_{fair} \quad distr_{par} \right] := \text{norm\_distr}\left(\Delta\Delta V_{WG}\right)$$



$$distr_{par} = \begin{bmatrix} 0.000 \\ 0.076 \\ 0.027 \end{bmatrix}$$

According to the plot of differences in currents identified and the subsequent check of the distribution the differences are 'of cause' not quite normally distributed. Thus the following analysis is not quite justified.

95 % confidence radius

number of samples — of parameters — of degrees of freedom

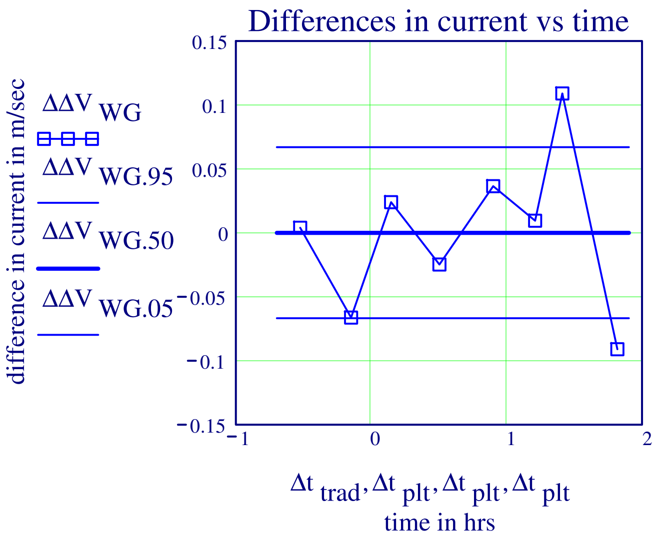
$n_s := ni - 1$ $\quad n_p := 3$ $\quad f := n_s - n_p$

$\Delta\Delta V_{WG.95.rad} := C_{95}(\Delta\Delta V_{WG}, f)$ $\quad \Delta\Delta V_{WG.95.rad} \cdot \frac{m}{kts \cdot sec} = 0.130$ kts

$k := 0..1$ $\quad \Delta t_{plt_0} := -0.7$ $\quad \Delta t_{plt_1} := 1.9$

$\Delta\Delta V_{WG.50_k} := 0$

$\Delta\Delta V_{WG.95_k} := \Delta\Delta V_{WG.95.rad}$ $\quad \Delta\Delta V_{WG.05_k} := -\Delta\Delta V_{WG.95.rad}$



As has been observed again and again the traditional method does not permit correctly to identify the current.

Shaft power ratios vs hull advance ratios

$$V_{HW.trad.corr_j} := V_{HW.rat_j} - \Delta V_{WG.mean} \cdot dir\left(\Psi_{HG.trad_j}\right)$$

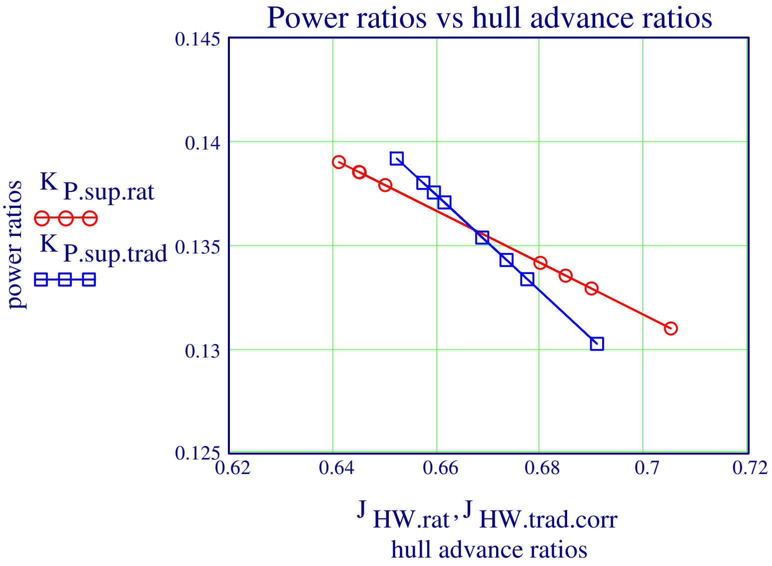
$$J_{HW.trad.corr_j} := \frac{V_{HW.trad.corr_j}}{D_P \cdot N_{S.trad_j}}$$

Fairing power ratios

$$A_{KP_{j,k}} := \left(J_{HW.trad.corr_j}\right)^k$$

$$X_{KP} := geninv\left(A_{KP}\right) \cdot K_{P.rat}$$

$$K_{P.sup.trad} := A_{KP} \cdot X_{KP}$$



Evidently the power ratios versus the advance ratios identified differ significantly in tendency. There may be many reasons, among them the surface effect due to the extremely small nominal propeller submergence not correctly being accounted for in the undisclosed traditional procedure.

Scrutinise results of an undisclosed traditional evaluation

End of Part 1 concerning the hull speed through the water

Analyse power required

Specify relative environmental conditions

Relative wind from ahead

$$V_{HA.x_i} := -V_{HA_i} \cdot \cos\left(\psi_{HA_i}\right)$$

$$V_{HA.x} = \begin{bmatrix} -5.637 \\ 16.920 \\ 19.820 \\ -5.125 \\ -5.125 \\ 20.304 \\ 20.515 \\ -4.100 \\ -3.587 \\ 22.361 \end{bmatrix}$$

Check wind speed over ground

$$V_{AG_i} := \left(V_{HA.x_i} - V_{HG_i}\right) \cdot dir\left(\psi_{HG_i}\right)$$

Approximate quadratically

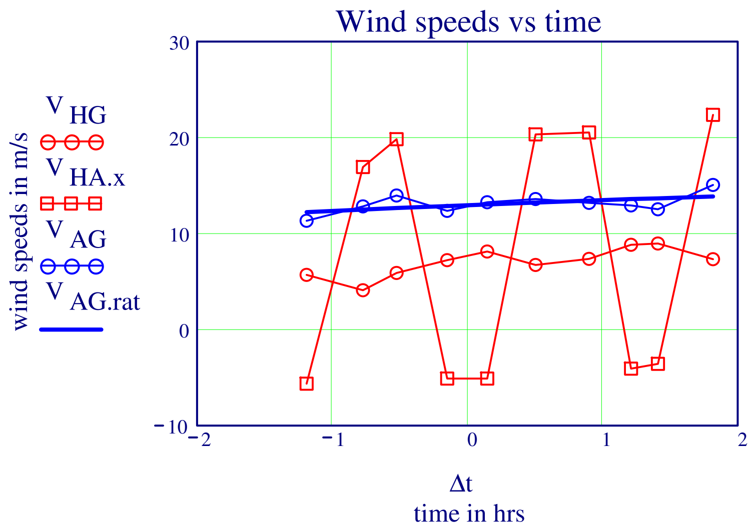
$$k := 0..2$$

$$A_{AG_{i,k}} := \left(\Delta t_i\right)^k$$

$$X_{AG} := geninv\left(A_{AG}\right) \cdot V_{AG}$$

$$X_{AG} = \begin{bmatrix} 12.949 \\ 0.572 \\ -0.046 \end{bmatrix}$$

$$V_{AG.rat} := A_{AG} \cdot X_{AG}$$



$$V_{AG.rat} = \begin{bmatrix} 12.202 \\ 12.479 \\ 12.635 \\ 12.861 \\ 13.031 \\ 13.224 \\ 13.425 \\ 13.573 \\ 13.663 \\ 13.835 \end{bmatrix}$$

Relative wind speed corrected

$$\Delta V_{AG} := V_{AG.rat} - V_{AG}$$

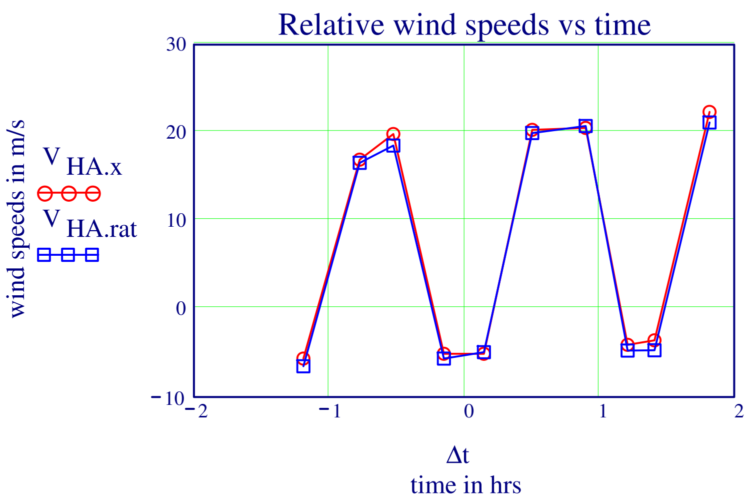
$$\Delta V_{AG} = \begin{bmatrix} 0.883 \\ -0.342 \\ -1.299 \\ 0.525 \\ -0.214 \\ -0.367 \\ 0.245 \\ 0.649 \\ 1.135 \\ -1.215 \end{bmatrix}$$

Evidently the differences depend on the direction of the runs relative the wind.

As oscillations of the wind speed over ground are not expected to correlate with the varying directions of the runs, a correction of this systematic effect, in the measured relative wind speed, maybe due to the installation of the wind meter, is appropriate. But it is worth noting, that the corrected values remain nominal values!

$$V_{HA.rat_i} := V_{HG_i} + V_{AG.rat_i} \cdot dir\left(\psi_{HG_i}\right)$$

$$V_{HA.rat} = \begin{bmatrix} -6.521 \\ 16.577 \\ 18.521 \\ -5.650 \\ -4.911 \\ 19.937 \\ 20.759 \\ -4.749 \\ -4.722 \\ 21.146 \end{bmatrix}$$



Conventions adopted

First power' convention

$$P_{S.req.0}(q, V_{HW}) := q_0 \cdot V_{HW}^3$$

Second power convention

$$P_{S.req.1}(q, V_{HW}, V_{HA}) := q_1 \cdot V_{HA} \cdot \left| V_{HA} \right| \cdot V_{HW}$$

Analyse power required: wind and wave speeds correlated!

$$\text{Required}(V_{HW}, P_S, V_{HA}) := \left| \begin{array}{l} \text{for } i \in 0 .. \text{last}(V_{HW}) \\ \quad \left| \begin{array}{l} A_{req_{i,0}} \leftarrow \left(V_{HW_i}\right)^3 \\ A_{req_{i,1}} \leftarrow V_{HA_i} \cdot \left| V_{HA_i} \right| \cdot V_{HW_i} \end{array} \right. \\ X_{req} \leftarrow \text{geninv}(A_{req}) \cdot P_S \\ P_{S.req} \leftarrow A_{req} X_{req} \\ \Delta P_{S.req} \leftarrow P_S - P_{S.req} \\ \text{for } k \in 0 .. 1 \\ \quad q_k \leftarrow X_{req_k} \\ q_2 \leftarrow \text{Stdev}(\Delta P_{S.req}) \\ c \leftarrow \text{svds}(A_{req}) \\ q_3 \leftarrow \dfrac{c_1}{c_0} \\ \left[\Delta P_{S.req} \;\; q \;\; P_{S.req} \;\; A_{req} \;\; X_{req} \right] \end{array} \right.$$

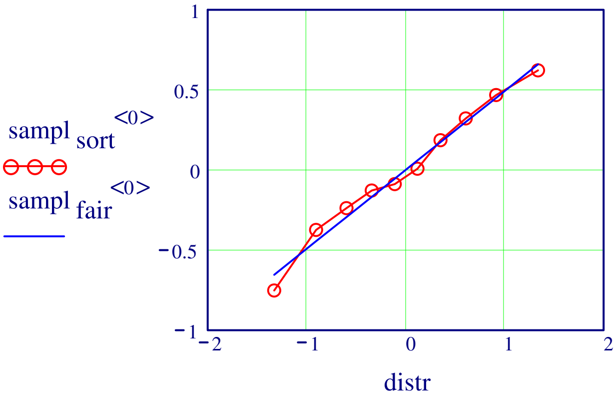
Evaluation

$$\text{Res}_{req} := \text{Required}(V_{HG}, P_{S.sup}, V_{HA.rat})$$

$$\left[\Delta P_{S.req} \;\; q \;\; P_{S.req} \;\; A_{req} \;\; X_{req} \right] := \text{Res}_{req}$$

Check distribtution

$$\begin{bmatrix} distr & sampl_{sort} & sampl_{fair} & distr_{par} \end{bmatrix} := norm\_distr\left(\Delta P_{S.req}\right)$$



$$distr_{par} = \begin{bmatrix} 3.798\cdot 10^{-3} \\ 0.492 \\ 0.156 \end{bmatrix}$$

According to this plot the power residua are normally distributed, so that the following analysis is justified.

95 % confidence radius

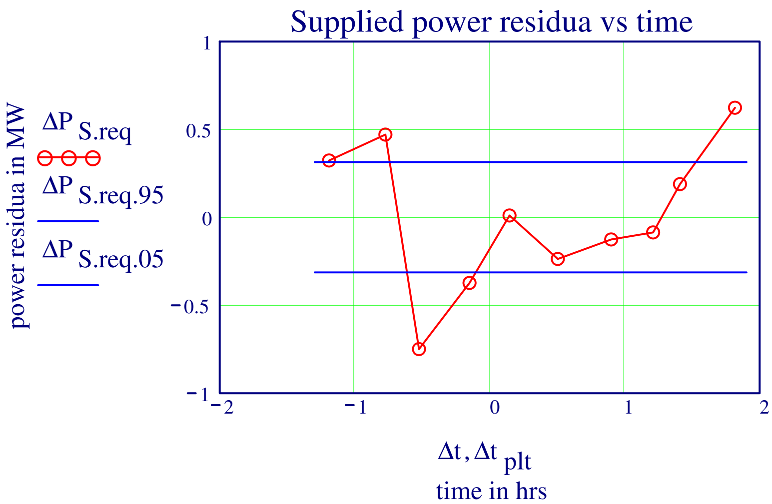
number of samples | of parameters | of degrees of freedom

$n_s := ni + 1$ $\quad n_p := 2$ $\quad f := n_s - n_p$

$P_{S.req.95} := C_{95}\left(\Delta P_{S.req}, f\right)$ $\quad P_{S.req.95} = 0.314$ $\quad$ 95% radius = 315 kW

$k := 0 .. 1$ $\quad \Delta t_{plt_0} := -1.3$ $\quad \Delta t_{plt_1} := 1.9$

$\Delta P_{S.req.95_k} := P_{S.req.95}$ $\quad \Delta P_{S.req.05_k} := -P_{S.req.95}$



$$q = \begin{bmatrix} 0.018 \\ 1.698\cdot 10^{-3} \\ 0.412 \\ 0.214 \end{bmatrix}$$

As usual the required power residua are much larger than in case of the supplied power due to the uncertainties in the wind measurements and the crude wave observations.

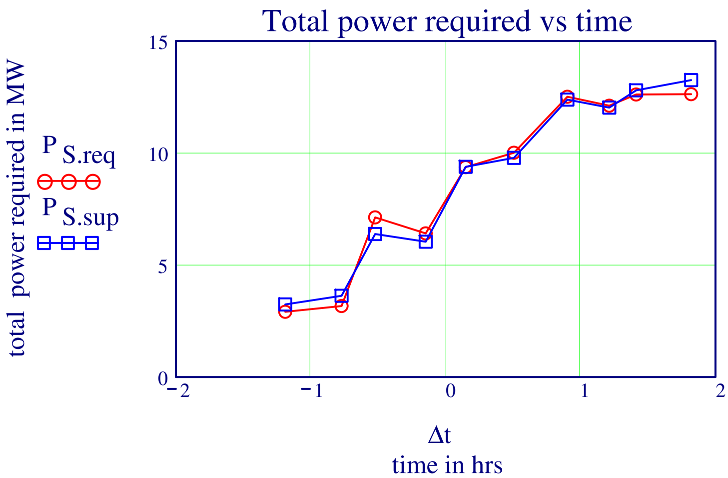
In view of the values of the powers measured the value of the confidence radius is felt to be quite realistic, the relative values ranging from 10 to 2.5 %.

$$p_{S_i} := \frac{P_{S.req.95}}{P_{S_i}}$$

$$p_S = \begin{bmatrix} 0.097 \\ 0.086 \\ 0.049 \\ 0.052 \\ 0.034 \\ 0.032 \\ 0.025 \\ 0.026 \\ 0.025 \\ 0.024 \end{bmatrix}$$

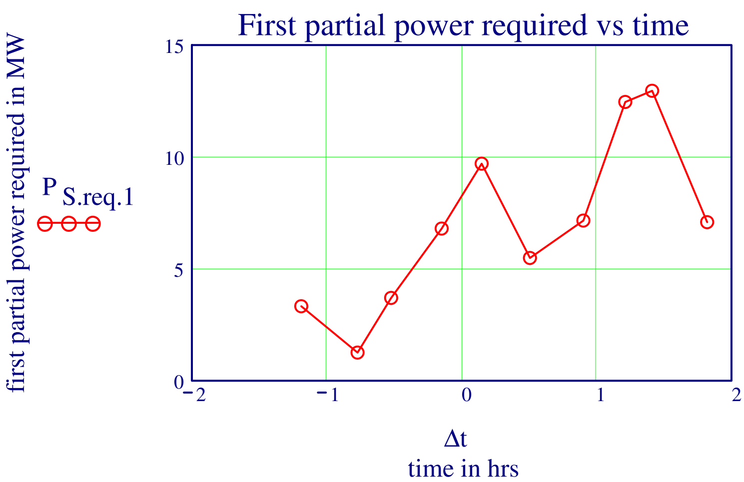
Powers required

Total power required



First partial power required

$$P_{S.req.1} := A_{req}^{\langle 0 \rangle} \cdot X_{req_0}$$

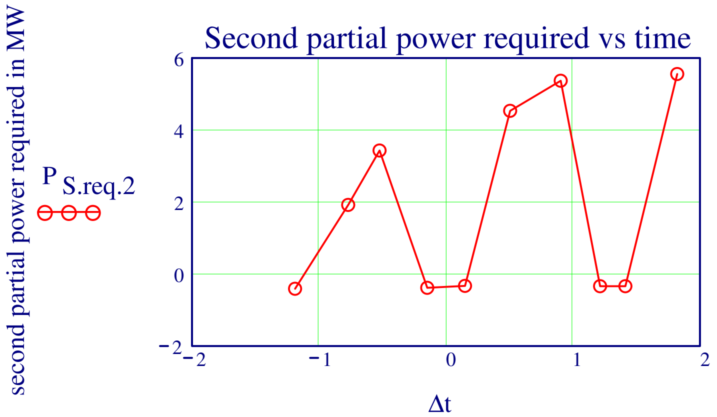


$$P_{S.req.1} = \begin{bmatrix} 3.322 \\ 1.247 \\ 3.694 \\ 6.793 \\ 9.697 \\ 5.479 \\ 7.145 \\ 12.443 \\ 12.946 \\ 7.077 \end{bmatrix}$$

This concept has formerly, m*isleadingly* been called 'water' power.

Second partial power required

$P_{S.req.2} := A_{req}^{\langle 1 \rangle} \cdot X_{req_1}$



$P_{S.req.2} = \begin{bmatrix} -0.410 \\ 1.912 \\ 3.428 \\ -0.391 \\ -0.332 \\ 4.531 \\ 5.366 \\ -0.338 \\ -0.339 \\ 5.551 \end{bmatrix}$

This concept has formerly, *misleadingly* been called 'wind and wave' power.

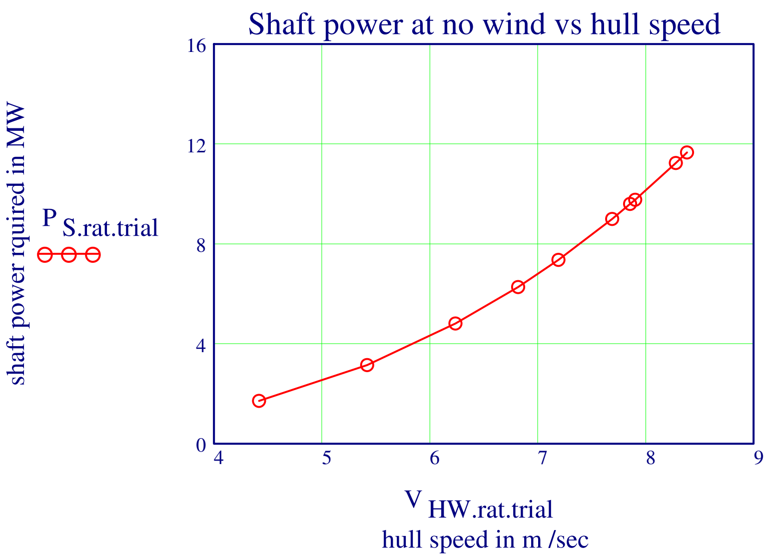
Re-order runs

$R_{i,0} := i + 3$ $R^{\langle 1 \rangle} := V_{HW}$ $R := \mathrm{csort}(R, 1)$ $Run := R^{\langle 0 \rangle}$

Nominal power vs hull speed
at the nominal no wind condition

$V_{HW.rat.trial} := R^{\langle 1 \rangle}$

$C_{PV} := q_0 + q_1$ $C_{PV} = 0.01981$ $P_{S.rat.trial_i} := C_{PV} \cdot \left(V_{HW.rat.trial_i}\right)^3$



$P_{S.rat.trial} = \begin{bmatrix} 1.705 \\ 3.147 \\ 4.801 \\ 6.270 \\ 7.359 \\ 8.996 \\ 9.589 \\ 9.764 \\ 11.234 \\ 11.651 \end{bmatrix}$

Nota bene: The power at the nominal no wind condition identified is that at the hull condition, the loading condition and the sea condition prevailing at the trials!

Powering performance
at the nominal no wind condition

Normalise power coefficient

$$C_{PV.n} := \frac{C_{PV} \cdot 10^6}{\rho \cdot D_P{}^2}$$

Identify equilibrium

$J := 0.5$ $K := 0.15$ Initial values

Given

$$K = p_{n_0} + p_{n_1} \cdot J$$

$$K = C_{PV.n} \cdot J^3$$

Solve

$$\begin{bmatrix} J_{HW.noVAW} \\ K_{P.noVAW} \end{bmatrix} := \mathrm{Find}(J, K)$$

$J_{HW.noVAW} = 0.697$ $K_{P.noVAW} = 0.132$

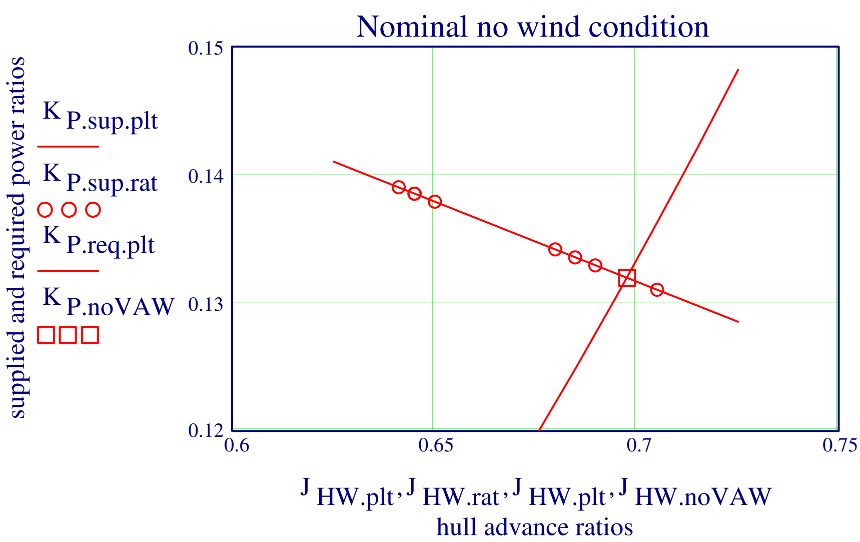
Results plotted

$k := 0 .. 10$

$$J_{HW.plt_k} := 0.625 + 0.01 \cdot k$$

$$K_{P.sup.plt_k} := p_{n_0} + p_{n_1} \cdot J_{HW.plt_k}$$

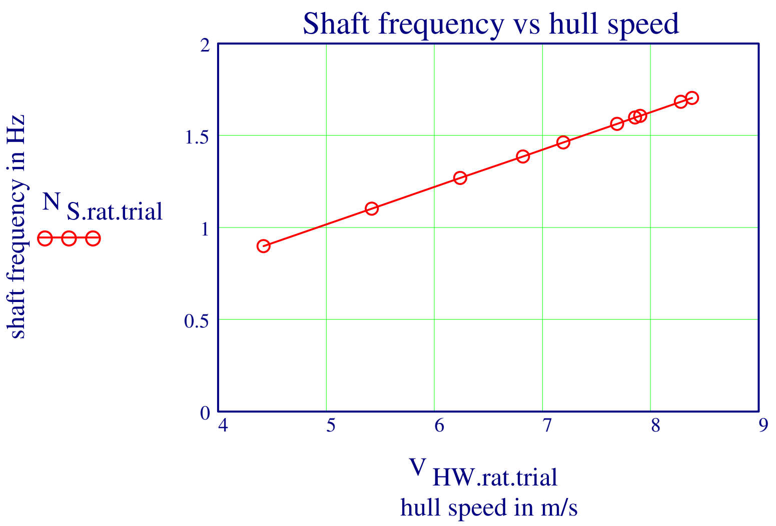
$$K_{P.req.plt_k} := C_{PV.n} \cdot \left(J_{HW.plt_k}\right)^3$$



Frequency of shaft rev's
at the nominal no wind condition

According to the conventions adopted the result is obtained according to the following simple rule.

$$N_{S.rat.trial_i} := \frac{V_{HW.rat.trial_i}}{J_{HW.noVAW} \cdot D_P}$$



$$N_{S.rat.trial} = \begin{bmatrix} 0.898 \\ 1.101 \\ 1.268 \\ 1.386 \\ 1.462 \\ 1.563 \\ 1.597 \\ 1.606 \\ 1.683 \\ 1.704 \end{bmatrix}$$

The very clumsy check of consistency performed in case of ANONYMA was neither necessary nor transparent!

Recording results of the rational evaluation at the trials condition reduced to the nominal no wind condition

Original runs re-ordered
according to increasing hull speed through speed

$$Results^{<0>} := Run$$

$$Results^{<1>} := V_{HW} \cdot \frac{m}{kts \cdot sec} \quad \text{in kts}$$

$$Results^{<2>} := P_{S.rat.trial} \quad \text{in MW}$$

$$Results^{<3>} := N_{S.rat.trial} \cdot \frac{min}{sec} \quad \text{in rpm}$$

Results =

4.000	10.528	1.705	53.878
3.000	8.583	3.147	66.086
5.000	12.120	4.801	76.076
6.000	13.247	6.270	83.153
8.000	14.941	7.359	87.713
7.000	13.974	8.996	93.788
9.000	15.263	9.589	95.806
12.000	16.090	9.764	96.384
10.000	16.286	11.234	100.996
11.000	15.355	11.651	102.232

WRITEPRN("Results_PATE_01") := Results

Scrutinise results of an undisclosed traditional evaluation

Part 2 concerning the powers supplied and required

The results of the traditional evaluation are those predicted for the reference condition, which differes only slightly from the trials condition.

Trials condition	**Reference condition**
$T_{aft.trial} := 7.42 \cdot m$	$T_{aft.ref} := 7.60 \cdot m$
$T_{fore.trial} := 6.12 \cdot m$	$T_{fore.ref} := 6.10 \cdot m$
$D_{Vol.trial} := 58894.1 \cdot m^3$	$D_{Vol.ref} := 59649.0 \cdot m^3$

Propeller power supplied (delivered) and shaft frequency at reference condition reported

$$V_{HW.trad} = \begin{bmatrix} 6.369 \\ 6.611 \\ 7.573 \\ 7.351 \\ 7.953 \\ 8.149 \\ 8.349 \\ 8.128 \end{bmatrix} \quad P_{P.trad} := \begin{bmatrix} 4.4224 \\ 5.8975 \\ 9.2628 \\ 7.4969 \\ 9.8683 \\ 12.0176 \\ 12.7595 \\ 10.5436 \end{bmatrix} \cdot MW \quad N_{P.trad} := \begin{bmatrix} 75.8 \\ 81.8 \\ 94.6 \\ 89.4 \\ 97.5 \\ 102.7 \\ 105.0 \\ 99.7 \end{bmatrix} \cdot rpm \quad \eta_D := \begin{bmatrix} 0.828 \\ 0.824 \\ 0.801 \\ 0.808 \\ 0.788 \\ 0.780 \\ 0.770 \\ 0.781 \end{bmatrix}$$

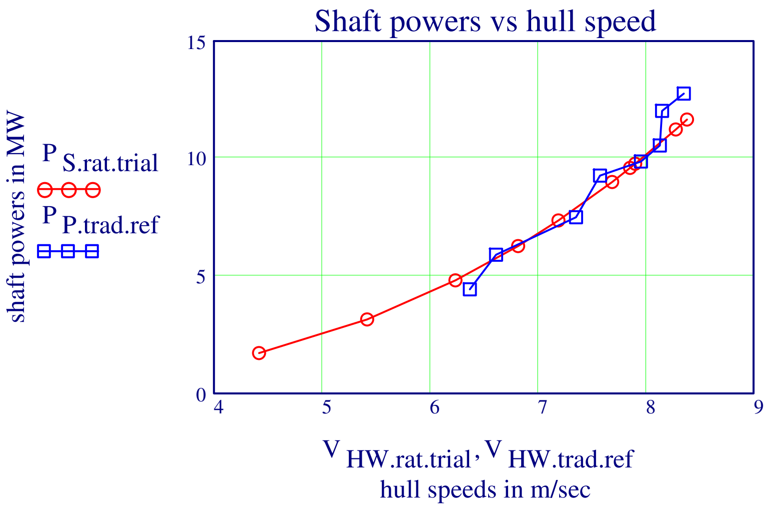
$$P_{P.trad} := \frac{P_{P.trad}}{MW} \qquad N_{S.trad} := \frac{N_{P.trad}}{Hz}$$

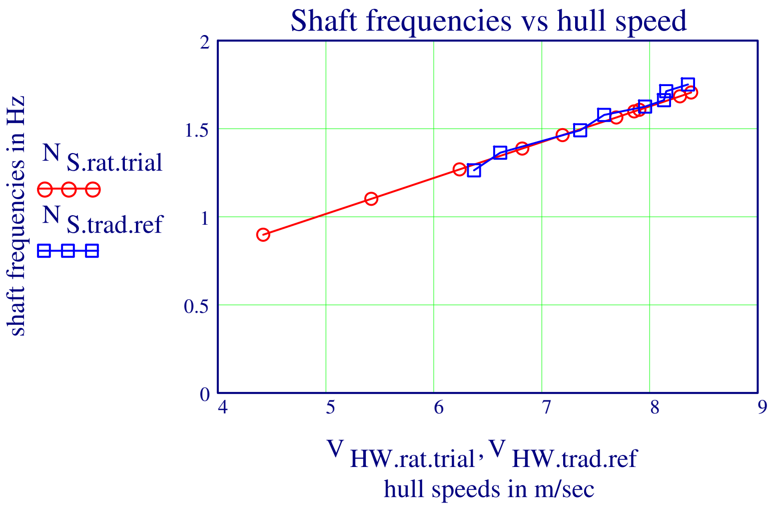
$$ref^{\langle 0 \rangle} := V_{HW.trad} \qquad ref^{\langle 1 \rangle} := P_{P.trad} \qquad ref^{\langle 2 \rangle} := N_{S.trad} \qquad ref^{\langle 3 \rangle} := \eta_D$$

$$ref := csort(ref, 0)$$

$$V_{HW.trad.ref} := ref^{\langle 0 \rangle} \qquad P_{P.trad.ref} := ref^{\langle 1 \rangle} \qquad N_{S.trad.ref} := ref^{\langle 2 \rangle} \qquad \eta_{D.trad} := ref^{\langle 1 \rangle}$$

As far as has been disclosed the results of the traditional evaluation are based on the considerable number of nine small corrections and most importantly on the 'calculated propulsive efficiency values' reported, as has been explicitly stated in a remark.





Evidently the results of the rational evaluation at the trials condition, requiring no prior data, and the results of the traditional evaluation at the only slightly different reference condition, requiring very many prior data, last but not least the computed values of the propulsive efficiency, are very nearly the same, not to say 'identical'.

For the rational evaluation the change from the trials condition to the reference condition results in an increase in resistance due to the change in the displacement volume, and in an increase in the propulsive efficiency due to the larger nominal submergence of the propeller, maybe compensating each other.

But the result of the rational evaluation still includes the power required for moving in the sea state reported. **Thus the strictly accidental coincidence of the results remains as unexplained as the whole undisclosed traditional procedure. In fact any traditional procedure is doomed to fail in any case where no prior experience and data are available.**

Computed values of the propulsive efficiency analysed

$k := 0 .. 1$

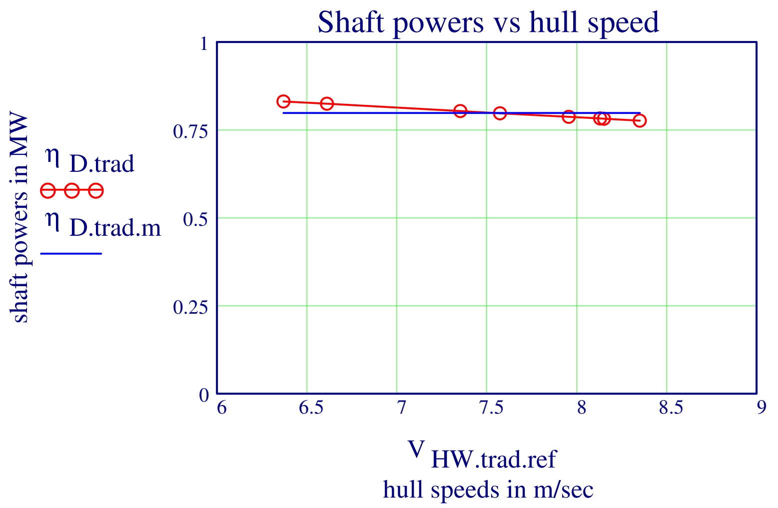
$A_{eta_{j,k}} := \left(V_{HW.trad.ref_j}\right)^k$

$X_{eta} := \mathrm{geninv}\left(A_{eta}\right) \cdot \eta_D$

$\eta_{D.trad} := A_{eta} \cdot X_{eta}$

$\eta_{D.trad.mean} := \mathrm{mean}\left(\eta_{D.trad}\right)$

$\eta_{D.trad.m_j} := \eta_{D.trad.mean}$



This analysis shows that the traditional evaluation is practically in accordance with the convention, implying that the propeller is permanently operating at the same normalised condition, resulting in the quadratic resistance law..

$C_{RV.tot} := \eta_{D.trad.mean} \cdot C_{PV}$

$R_{HW.trad.tot_j} := C_{RV.tot} \cdot \left(V_{HW.trad.ref_j}\right)^2$

How the computed values of the propulsive efficiency have been arrived at in the traditional evaluation remains undisclosed, while **the resistance and the propulsive efficiency can be identified in a rational way solely from data acquired at quasi-steady monitoring tests without any prior information what-so-ever being necessary,** as has been shown in a 'model' study published on my website and in the Festschrift 'From METEOR 1988 to ANONYMA 2013 and further' also to be found on the website.

Scrutinise results of an undisclosed traditional evaluation

End of Part 2 concerning the powers supplied and required

Conclusions

Rational procedure

As has already been stated in the Preface, the foregoing analysis is **solely based on extremely simple propeller, current and environment conventions and on the mean data reported**, though without their confidence ranges. **No prior data and parameters have been used, particularly not those derived from corresponding model tests.**

Thus the rational procedure and its results are as transparent and observer independent as possible and as necessary (!) for the rational resolution of 'conflicts' of any type!

Assessment of results

But as Wittgenstein clearly stated at the end of the introduction to his Tractatus (1918):
"Ich bin also der Meinung, die Probleme endgültig gelöst zu haben. Und wenn ich mich nicht irre, besteht der Wert dieser Arbeit zweitens darin, daß sie zeigt, wie wenig damit getan ist, dass die Probleme gelöst sind."

The solution provided does in fact not solve all the problems, if the trials are performed at conditions widely differing from the conditions contracted. The remaining, the 'essential' part of the 'analysis' is thus the prediction (!) of the performance at the service condition contracted.

Traditional procedures

Contrary to rational procedure promoted and demonstrated all traditonal procedures are based on prior data, and this not only for the prediction mentioned, but incorrectly already for the evaluation of the powering performance at the trials conditions.

But both these essential operations cannot meet the requirements of transparency and observer independence unless based on additional data observed at various conditions, permitting to identify all parameters necessary for the trustworthy prediction.

In a way the situation is still similar to the conduct and evaluation of model tests according to Froude's procedure, where the 'essential', the frictional part cannot be modelled, but is being based on prior data.

'Direct power method'

The STAimo-System aggressively promoted by MARIN is based on the propulsive efficiency as input value (!) (as required to be) pulled as joker from the sleeve and is still being based on the unsubstantiated claims, already pinpointed in the chapter on 'The Emperor's New Clothes' in my paper on 'Future Ship Powering Trials Now!' brought to the attention of colleagues worldwide in May 2013.

And the name STAimo publicly confirms my earlier suspicion, that IMO, the Marine Environment Protection Committee (MEPC) in particular, is just an 'appendix' of MARIN, following the emperor in his new clothes, as are the ITTC Specialists Committee on Powering of Ships in Service (SC PSS) and the groups working on the revision of the standard ISO 15016.

Monitoring of performance

The only way rationally to solve this problem, is to get away from the traditional delivery trials and rely only on the results of subsequent monitoring trials under varying service conditions.

In order to provide trustworthy monitoring of the powering performance two fundamental problems have to be solved, the first one considered to be essential part of the standard ISO 15016 currently under revision, while the second one is considered to be essential part of the standard ISO 19030 currently under development.

The first task is to develop an efficient, sound method of quasi-steady trials. A number of problems faced have already been identified in the analysis of a quasi-steady 'model' test.

This analysis is part of an ongoing research project documented in my 'Festschrift' titled 'From METEOR 1988 to ANONYMA 2013 and further! Future Ship Powering Trials and Monitoring Now!' and published on occasion of the 108th Annual Meeting of the Schiffbautechnische Gesellschaft at Berlin, November 20-22, 2013' and in Section 'News on ship powering trials' on my website www.m-schmiechen.de.

The second task is to develop a transparent method for the continued (!) analysis of the results of repeated (!) applications of the method of quasi-steady trials under varying service conditions. A number of commercial systems claimed to have solved the problems are already being marketed successfully, details are proprietary.

END
Powering performance of a bulk carrier during speed trials in ballast condition reduced to nominal no wind condition