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To whom it may concern

Sub: **New ISO/CD 15016 Example**
here: **Re-evaluation according to the proposed rational method**
Ref.: Evaluations ISO_fin4 to _fin9.mcd and EVEREST_04 to _08.mcd

The present re-evaluation of the new ISO/CD 15016 example includes **the reduction to the no-wind and no-waves condition** according to the rational method. **In order to obtain the maximum size of the sample and to avoid the impression that data have been excluded purposely the data of all ten runs have been included.**
Following systematic scrutinity of the data during the former evaluations the power during the third run, i = 2, has been changed from 11**3**49 kW to 11**5**49 kW. Maybe there has been a misprint in the data at some stage?
Values computed according to the rational procedure are plotted in red, results of the full sample denoted by boxes, where appropriate. The values taken from ISO/CD 15016 are plotted in blue and denoted by circles.

Units	$kN := 10^3 \cdot newton$	$N := newton$	
		$W := watt$	
Constants	Field strength	$g := 9.81 \cdot m \cdot sec^{-2}$	$g := \frac{g}{m \cdot sec^{-2}}$
Test identification	TID := "23010"	New ISO/CD 15016 example	
Constants	Length of ship	$L := 318 \cdot m$	$L := \frac{L}{m}$
	Diameter of propeller	$D := 9.5 \cdot m$	$D := \frac{D}{m}$
	Density of sea water	$\rho := 1.024 \cdot 10^3 \cdot kg \cdot m^{-3}$	$\rho := \frac{\rho}{kg \cdot m^{-3}}$
	Density of air	$\rho_A := 1.225 \cdot kg \cdot m^{-3}$	$\rho_A := \frac{\rho_A}{kg \cdot m^{-3}}$

Functions and subroutines

Normalise data

$JH(V,N) := \frac{V}{D \cdot N}$

$KP(P,N) := \frac{P}{\rho \cdot D^5 \cdot N^3}$

$Fn(V) := \frac{V}{\sqrt{g \cdot L}}$

$CP(P,V) := \frac{P}{\rho \cdot D^2 \cdot V^3}$

Basic functions

$PS(p,N,V) := p_0 \cdot N^3 + p_1 \cdot N^2 \cdot V$

Sort runs

$Sort(J_H, K_P, \psi) :=$

```
j_0 ← 0
j_1 ← 0
for i ∈ 0..last(J_H)
    if ψ_i > π
        S_{j_0,0} ← J_H_i
        S_{j_0,1} ← K_P_i
        j_0 ← j_0 + 1
    otherwise
        S_{j_1,2} ← J_H_i
        S_{j_1,3} ← K_P_i
        j_1 ← j_1 + 1
S
```

Compute left-inverse

$LeftInv(A) :=$

```
r ← rows(A)
c ← cols(A)
s ← svds(A)
for i ∈ 0..c − 1
    ISV_{i,i} ← (s_i)^-1
UV ← svd(A)
U ← submatrix(UV, 0, r − 1, 0, c − 1)
V ← submatrix(UV, r, r + c − 1, 0, c − 1)
A_inv ← V·ISV·U^T
A_inv
```

Solve cubic equations

$$\text{Revs}(p,V,P,N) := \left| \begin{array}{l} n_i \leftarrow \text{last}(V) \\ \text{for } i \in 0..n_i \\ \quad \left| \begin{array}{l} q_0 \leftarrow P_i \\ q_1 \leftarrow V_i \\ n \leftarrow N_i \\ N_{rat_i} \leftarrow \text{root}\left(q_0 - p_0 \cdot n^3 - p_1 \cdot n^2 \cdot q_1, n\right) \end{array} \right. \\ N_{rat} \end{array} \right.$$

Analyse power supplied

$$\text{Supplied}\left(D,\rho,t,\psi_0,V_G,n,P\right) := \left| \begin{array}{l} \text{for } i \in 0..\text{last}(t) \\ \quad \left| \begin{array}{l} A_{sup_{i,0}} \leftarrow \left(n_i\right)^3 \\ A_{sup_{i,1}} \leftarrow \left(n_i\right)^2 \cdot V_{G_i} \\ d_{FM_i} \leftarrow \text{if}\left(\psi_{0_i} < \pi, -1, 1\right) \\ A_{sup_{i,2}} \leftarrow \left(n_i\right)^2 \cdot d_{FM_i} \\ \text{for } j \in 3..5 \\ \quad A_{sup_{i,j}} \leftarrow A_{sup_{i,2}} \cdot \left(t_i\right)^{j-2} \end{array} \right. \\ X_{sup} \leftarrow \text{LeftInv}\left(A_{sup}\right) \cdot P \\ E_{sup} \leftarrow P - A_{sup} \cdot X_{sup} \\ p_0 \leftarrow X_{sup_0} \\ p_1 \leftarrow X_{sup_1} \\ \text{for } j \in 0..3 \\ \quad v_j \leftarrow \dfrac{X_{sup_{2+j}}}{X_{sup_1}} \\ \text{for } i \in 0..\text{last}(t) \\ \quad \left| \begin{array}{l} V_{F.rat_i} \leftarrow \displaystyle\sum_{j=0}^{3} v_j \cdot \left(t_i\right)^j \\ V_{S0.rat_i} \leftarrow V_{G_i} + V_{F.rat_i} \cdot d_{FM_i} \end{array} \right. \end{array} \right.$$

$$P_{S.rat_i} \leftarrow PS\left(p, n_i, V_{S0.rat_i}\right)$$
$$J_{H.rat_i} \leftarrow JH\left(V_{S0.rat_i}, n_i\right)$$
$$K_{P.rat_i} \leftarrow KP\left(P_{S.rat_i}, n_i\right)$$
$$\left[E_{sup}\;\; V_{F.rat}\;\; V_{S0.rat}\;\; P_{S.rat}\;\; J_{H.rat}\;\; K_{P.rat}\;\; p\;\; v\right]$$

Analyse power required

$$Required\left(V_{S0}, P_S, Env\right) :=$$

$$V_{WindR} \leftarrow \left(Env_{0,0}\right)_{0,0}$$
$$\psi_{WindR} \leftarrow \left(Env_{0,0}\right)_{0,1}$$
$$V_{SeasR} \leftarrow \left(Env_{0,1}\right)_{0,0}$$
$$\psi_{SeasR} \leftarrow \left(Env_{0,1}\right)_{0,1}$$
$$H_{Seas} \leftarrow \left(Env_{0,1}\right)_{0,2}$$
$$V_{SwellR} \leftarrow \left(Env_{0,2}\right)_{0,0}$$
$$\psi_{SwellR} \leftarrow \left(Env_{0,2}\right)_{0,1}$$
$$H_{Swell} \leftarrow \left(Env_{0,2}\right)_{0,2}$$

for $i \in 0 .. last\left(V_{S0}\right)$

for $j \in 0 .. 2$

$$A_{req_{i,0}} \leftarrow \left(V_{S0_i}\right)^{j+1}$$
$$V_{WindR.x_i} \leftarrow V_{WindR_i} \cdot \cos\left(\psi_{WindR_i}\right)$$
$$A_{req_{i,3}} \leftarrow V_{WindR.x_i} \cdot V_{WindR_i} \; V_{S0_i}$$
$$V_{SeasR.x_i} \leftarrow V_{SeasR_i} \cdot \cos\left(\psi_{SeasR_i}\right)$$
$$A_{req_{i,4}} \leftarrow \left(H_{Seas_i}\right)^2 \cdot V_{SeasR.x_i} \cdot V_{SeasR_i} \cdot V_{S0_i}$$
$$V_{SwellR.x_i} \leftarrow V_{SwellR_i} \cdot \cos\left(\psi_{SwellR_i}\right)$$
$$A_{req_{i,5}} \leftarrow \left(H_{Swell_i}\right)^2 \cdot V_{SwellR.x_i} \cdot V_{SwellR_i} \cdot V_{S0_i}$$

$$X_{req} \leftarrow LeftInv\left(A_{req}\right) \cdot P_S$$
$$E_{req} \leftarrow P_S - A_{req} \cdot X_{req}$$
$$P_{AWind} \leftarrow A_{req}^{\langle 3 \rangle} \cdot X_{req_3}$$
$$P_{ASeas} \leftarrow A_{req}^{\langle 4 \rangle} \cdot X_{req}$$

$$\left|\begin{array}{l} P_{ASwell} \leftarrow A_{req}^{\langle 5 \rangle} \cdot X_{req_5} \\ P_{AWaves} \leftarrow P_{ASeas} + P_{ASwell} \\ \text{for } i \in 0..\,\text{last}\left(V_{S0}\right) \\ \quad P_{AAir_i} \leftarrow \left(V_{S0_i}\right)^3 \cdot X_{req_3} \\ P_{S0} \leftarrow P_S - P_{AWaves} - P_{AWind} + P_{AAir} \\ \left[E_{req} \;\; P_{AWind} \;\; P_{AWaves} \;\; P_{S0}\right] \end{array}\right.$$

Compute relative wave motion

$$\text{Relative}\left(V_G, T, \psi\right) := \left|\begin{array}{l} \text{for } i \in 0..\,\text{last}\left(V_G\right) \\ \quad \left|\begin{array}{l} V \leftarrow \dfrac{g \cdot T_i}{2 \cdot \pi} \\ V_{Rx} \leftarrow V_{G_i} + V \cdot \cos\left(\pi + \psi_i\right) \\ V_{Ry} \leftarrow V \cdot \sin\left(\pi + \psi_i\right) \\ V_{R_i} \leftarrow \sqrt{V_{Rx}^2 + V_{Ry}^2} \\ \psi_{R_i} \leftarrow \text{angle}\left(V_{Rx}, V_{Ry}\right) \end{array}\right. \\ \left[V_R \;\; \psi_R\right] \end{array}\right.$$

Power supplied

Data reported from traditional trial measurements

time: row 48	course: row 3	speed over ground: row 4	rate of revolution: row 5	shaft power row 6

$$t := \begin{bmatrix} 16.792 \\ 18.830 \\ 20.826 \\ 23.053 \\ 24.986 \\ 26.682 \\ 30.597 \\ 32.433 \\ 34.231 \\ 35.849 \end{bmatrix} \cdot \text{hr} \quad \psi_0 := \begin{bmatrix} 5.901 \\ 2.909 \\ 5.901 \\ 2.909 \\ 5.901 \\ 2.909 \\ 2.909 \\ 5.901 \\ 2.909 \\ 5.901 \end{bmatrix} \cdot \text{rad} \quad V_G := \begin{bmatrix} 4.409 \\ 5.561 \\ 6.050 \\ 7.182 \\ 7.218 \\ 8.082 \\ 8.416 \\ 7.773 \\ 8.437 \\ 7.922 \end{bmatrix} \cdot \frac{m}{sec} \quad n := \begin{bmatrix} 0.7317 \\ 0.7300 \\ 0.9267 \\ 0.9267 \\ 1.0467 \\ 1.0467 \\ 1.0933 \\ 1.0950 \\ 1.1167 \\ 1.1133 \end{bmatrix} \cdot \text{Hz} \quad P_S := \begin{bmatrix} 5711 \\ 5533 \\ 11349 \\ 11140 \\ 16200 \\ 16190 \\ 18500 \\ 18330 \\ 19450 \\ 19756 \end{bmatrix} \cdot \text{kW}$$

$P_{S_2} := 11549 \cdot kW$ **This value is being modified!**

Data non-dimensionalized in view of further use in some mathematical subroutines, which by definition cannot handle arguments with (different) dimensions

$t := \frac{t}{hr}$ $\psi_0 := \frac{\psi_0}{rad}$ $V_G := \frac{V_G}{m \cdot sec^{-1}}$ $n := \frac{n}{Hz}$ $P_S := \frac{P_S}{W}$

$t_m := mean(t)$ $t := t - t_m$

Normalised data

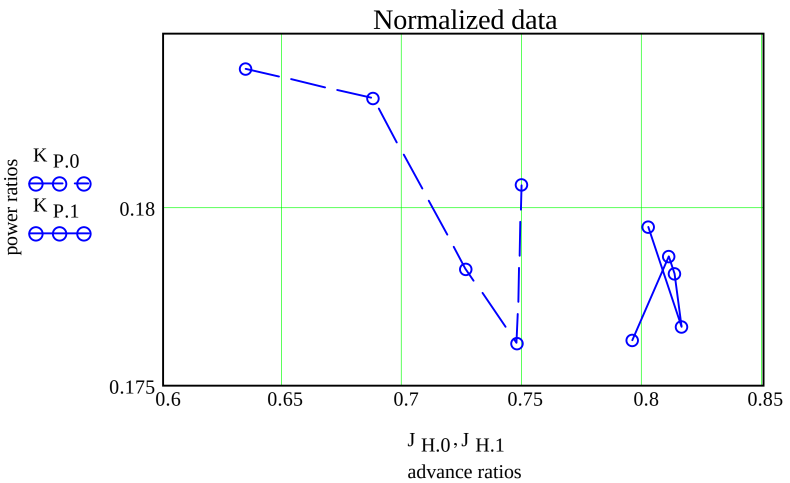
$i := 0 .. last(t)$

$J_{H_i} := JH\left(V_{G_i}, n_i\right)$ $K_{P_i} := KP\left(P_{S_i}, n_i\right)$

First check of consistency

$J_{H.0} := Sort\left(J_H, K_P, \psi_0\right)^{<0>}$ $K_{P.0} := Sort\left(J_H, K_P, \psi_0\right)^{<1>}$

$J_{H.1} := Sort\left(J_H, K_P, \psi_0\right)^{<2>}$ $K_{P.1} := Sort\left(J_H, K_P, \psi_0\right)^{<3>}$



Input data for statistical analysis: all possible subsets of nine runs

$i := 0 .. last(t)$

$j := 0 .. last(t) - 1$

$K_{j,i} := if(j<i, j, j+1)$

$t_{S_{j,i}} := t_{K_{j,i}}$ $\psi_{0S_{j,i}} := \psi_{0_{K_{j,i}}}$ $V_{GS_{j,i}} := V_{G_{K_{j,i}}}$ $n_{S_{j,i}} := n_{K_{j,i}}$ $P_{SS_{j,i}} := P_{S_{K_{j,i}}}$

Evaluation

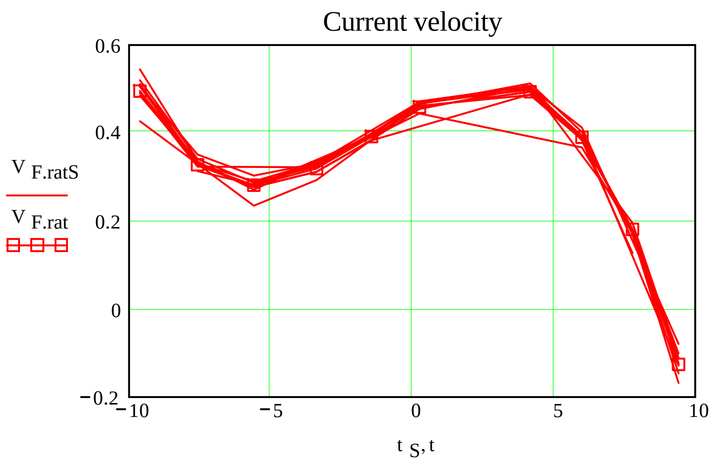
$Res_{supS_i} := Supplied\left(D, \rho, t_S^{<i>}, \psi_{0S}^{<i>}, V_{GS}^{<i>}, n_S^{<i>}, P_{SS}^{<i>}\right)$

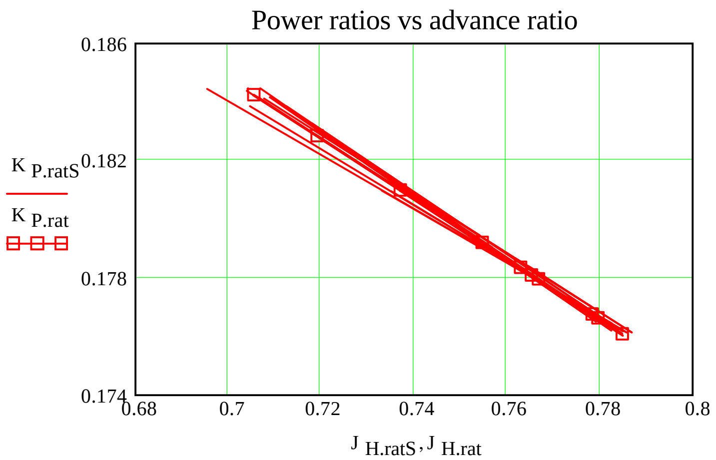
$$\left[E^{<i>}\ V_{F.ratS}^{<i>}\ V^{<i>}\ P^{<i>}\ J_{H.ratS}^{<i>}\ K_{P.ratS}^{<i>}\ p_{ratS}^{<i>}\ v_{ratS}^{<i>}\right] := Res_{supS_i}$$

$$Res_{sup} := Supplied\left(D, \rho, t, \psi_0, V_G, n, P_S\right)$$

$$\left[E_{sup}\ V_{F.rat}\ V_{S.rat}\ P_{S.rat}\ J_{H.rat}\ K_{P.rat}\ p_{rat}\ v_{rat}\right] := Res_{sup}$$

Second check of consistency





These two results of all possible subsets of nine runs show, that after correction of the 'misprint' the data are consistent.

Interpolations

$m := 36$

$k := 0..m$

$$t_{rat_k} := min(t) + \frac{(max(t) - min(t))}{m} \cdot k$$

$$V_{F.rat_k} := \sum_{l=0}^{3} v_{rat_l} \cdot \left(t_{rat_k}\right)^l$$

$$J_{H.rat_i} := JH\left(V_{S.rat_i}, n_i\right)$$

Final performance data
according to **ISO evaluation**

frequency of revolution:
row 61 (5)

ship speed:
row 65

brake power:
row 63

$$n_{0.ISO} := \begin{bmatrix} 0.7317 \\ 0.7300 \\ 0.9267 \\ 0.9267 \\ 1.0467 \\ 1.0467 \\ 1.0933 \\ 1.0950 \\ 1.1167 \\ 1.1133 \end{bmatrix} \cdot Hz \qquad V_{S0.ISO} := \begin{bmatrix} 5.230 \\ 5.238 \\ 6.852 \\ 6.861 \\ 7.932 \\ 7.946 \\ 8.315 \\ 8.327 \\ 8.501 \\ 8.480 \end{bmatrix} \cdot \frac{m}{sec} \qquad P_{S0.ISO} := \begin{bmatrix} 5331 \\ 5293 \\ 10839 \\ 10838 \\ 15582 \\ 15578 \\ 17945 \\ 17696 \\ 18606 \\ 19022 \end{bmatrix} \cdot kW$$

Non-dimensional values, not normalized(!), in coherent units

$$n_{0.ISO} := \frac{n_{0.ISO}}{Hz} \qquad V_{S0.ISO} := \frac{V_{S0.ISO}}{m \cdot sec^{-1}} \qquad P_{S0.ISO} := \frac{P_{S0.ISO}}{W}$$

Normalised values

$$i := 0 .. \mathrm{last}\left(n_{0.ISO}\right)$$

$$J_{H0.ISO_i} := JH\left(V_{S0.ISO_i}, n_{0.ISO_i}\right) \qquad K_{P0.ISO_i} := KP\left(P_{S0.ISO_i}, n_{0.ISO_i}\right)$$

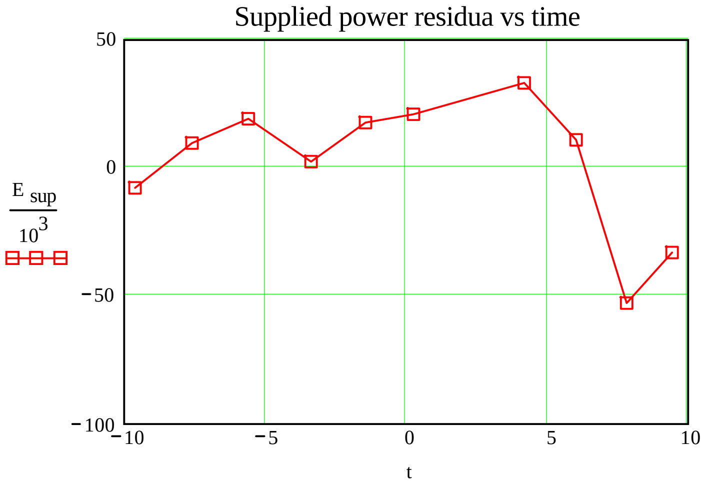
ISO/CD results:

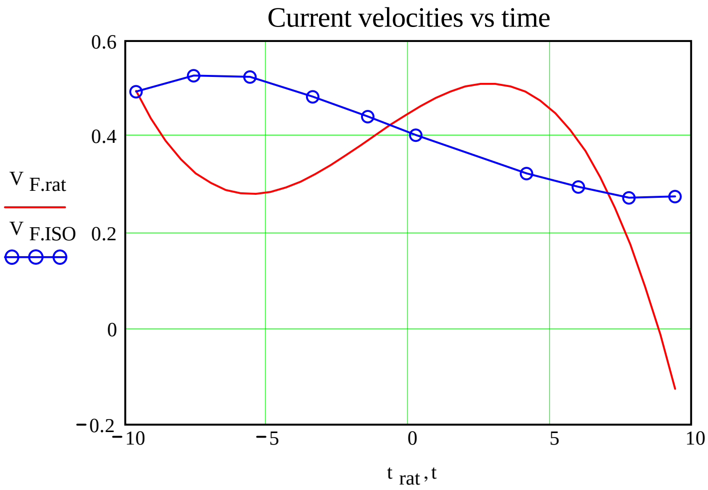
current at each run:
row 52

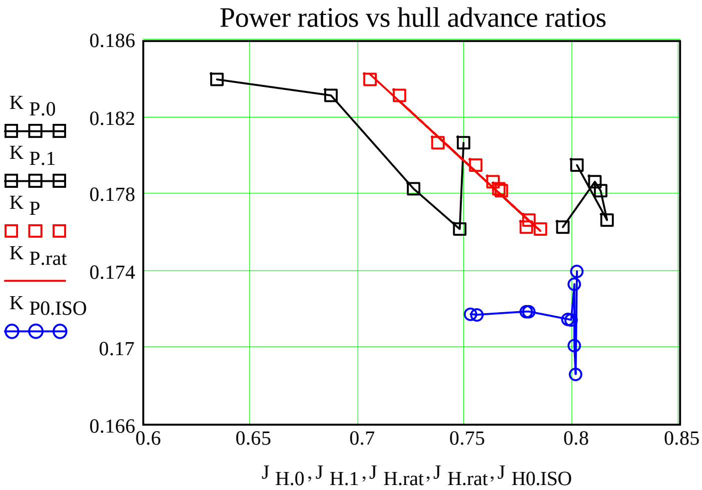
$$V_{F.ISO} := \begin{bmatrix} 0.494 \\ 0.527 \\ 0.525 \\ 0.484 \\ 0.442 \\ 0.404 \\ 0.324 \\ 0.296 \\ 0.273 \\ 0.275 \end{bmatrix} \cdot \frac{m}{sec}$$

$$V_{F.ISO} := \frac{V_{F.ISO}}{m \cdot sec^{-1}}$$

Plots of results







Attention! At this stage the power has not yet been reduced to the no wind and no wave conditon in the rational evaluation while it has been reduced in the traditional evaluation! But these results already show, that the results according to the proposed ISO procedure are outside the law of the shaft power.

Power required

Relative wind measured

relative wind velocity:
row 7

$$V_{WindR} := \begin{bmatrix} 13.5 \\ 4.0 \\ 15.0 \\ 2.8 \\ 16.0 \\ 0.7 \\ 0.4 \\ 16.5 \\ 0.0 \\ 16.5 \end{bmatrix} \cdot \frac{m}{sec}$$

relative wind direction:
row 8

$$\psi_{WindR} := \begin{bmatrix} -0.1745 \\ 2.5307 \\ -0.1745 \\ 2.3562 \\ 0.0873 \\ 2.6180 \\ 2.3562 \\ 0.0873 \\ 2.5307 \\ -0.1745 \end{bmatrix} \cdot rad$$

Non-dimensional values, not normalized(!), in coherent units

$$V_{WindR} := \frac{V_{WindR}}{m \cdot sec^{-1}} \qquad \psi_{WindR} := \frac{\psi_{WindR}}{rad}$$

Sea state observed

mean wave period (seas)
row 12

$$T_{Seas} := \begin{bmatrix} 3.90 \\ 3.90 \\ 3.90 \\ 3.90 \\ 3.90 \\ 3.90 \\ 2.80 \\ 2.80 \\ 2.80 \\ 2.80 \end{bmatrix} \cdot sec$$

significant wave height (seas)
row 13

$$H_{Seas} := \begin{bmatrix} 1.00 \\ 1.00 \\ 1.00 \\ 1.00 \\ 1.00 \\ 1.00 \\ 0.50 \\ 0.50 \\ 0.50 \\ 0.50 \end{bmatrix} \cdot m$$

incident angle of wave (seas)
row 14

$$\psi_{Seas} := \begin{bmatrix} 2.97 \\ -0.17 \\ 2.97 \\ -0.17 \\ 2.97 \\ -0.17 \\ -0.17 \\ 2.97 \\ -0.17 \\ 2.97 \end{bmatrix}$$

$$T_{Seas} := \frac{T_{Seas}}{sec} \qquad H_{Seas} := \frac{H_{Seas}}{m}$$

$$\begin{bmatrix} V_{SeasR} & \psi_{SeasR} \end{bmatrix} := \mathrm{Relative}\left(V_G, T_{Seas}, \psi_{Seas}\right)$$

Swell state observed

mean wave period (swell) row 15

significant wave height (swell) row 16

incident angle of wave (swell) row 17

$$T_{Swell} := \begin{bmatrix} 10.59 \\ 10.59 \\ 10.59 \\ 10.59 \\ 11.32 \\ 11.32 \\ 11.32 \\ 11.32 \\ 11.32 \\ 11.32 \end{bmatrix} \cdot sec \qquad H_{Swell} := \begin{bmatrix} 2.00 \\ 2.00 \\ 2.00 \\ 2.00 \\ 2.50 \\ 2.50 \\ 2.50 \\ 2.50 \\ 3.00 \\ 3.00 \end{bmatrix} \cdot m \qquad \Psi_{Swell} := \begin{bmatrix} 0.6981 \\ -2.4435 \\ 0.6981 \\ -2.4435 \\ 0.6981 \\ -2.4435 \\ -2.4435 \\ 0.6981 \\ -2.4435 \\ 0.6981 \end{bmatrix}$$

$$T_{Swell} := \frac{T_{Swell}}{sec} \qquad H_{Swell} := \frac{H_{Swell}}{m}$$

$$\begin{bmatrix} V_{SwellR} & \Psi_{SwellR} \end{bmatrix} := \text{Relative}\left(V_G, T_{Swell}, \Psi_{Swell}\right)$$

Input data for statistical analysis

$$Wind := \begin{bmatrix} V_{WindR} & \Psi_{WindR} \end{bmatrix}$$

$$Seas := \begin{bmatrix} V_{SeasR} & \Psi_{SeasR} & H_{Seas} \end{bmatrix}$$

$$Swell := \begin{bmatrix} V_{SwellR} & \Psi_{SwellR} & H_{Swell} \end{bmatrix}$$

$$Env := (Wind \quad Seas \quad Swell)$$

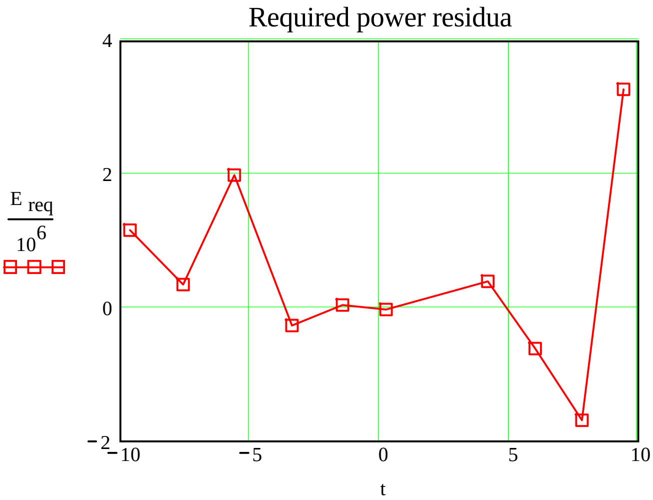
Evaluation

$$Res_{req} := \text{Required}\left(V_{S.rat}, P_S, Env\right)$$

$$\begin{bmatrix} E_{req} & P_{AWind.rat} & P_{AWaves.rat} & P_{S.rat} \end{bmatrix} := Res_{req}$$

Plots of results

Power residua



After six runs the trials had to be stopped for a while in view of the large swell height due to the passing of a typhoon!

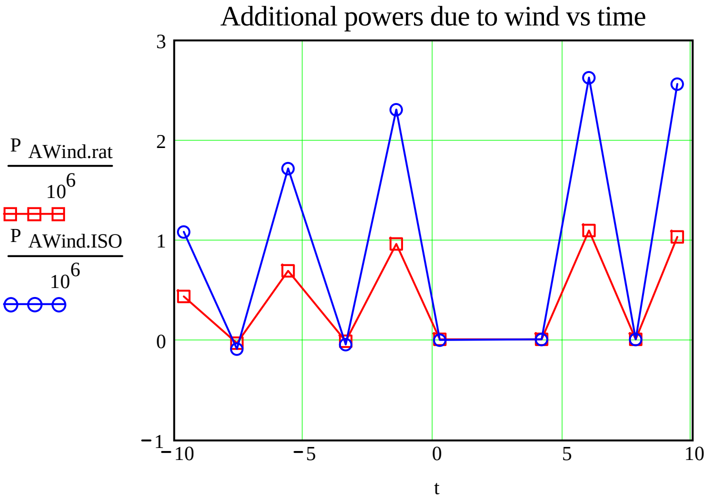
Additional power and resistance due to wind according to ISO/CD evaluation

$\eta_D := 0.6$

Propulsive efficiency, crude estimate for plausibility checks only!

$$R_{AWind.ISO} := \frac{R_{AWind.ISO}}{N}$$

$$P_{AWind.ISO_i} := \frac{R_{AWind.ISO_i} \cdot V_{S.rat_i}}{\eta_D}$$



resistance increase due to wind row 29:

$$R_{AWind.ISO} := \begin{bmatrix} 131.5 \\ -10.9 \\ 162.3 \\ -4.5 \\ 181.2 \\ -0.3 \\ -0.1 \\ 192.7 \\ 0 \\ 196.5 \end{bmatrix} \cdot 10^3 \cdot N$$

$$\frac{\left|P_{AWind.rat}\right|}{\left|P_{AWind.ISO}\right|} = 0.409$$

Additional power and resistance due to waves

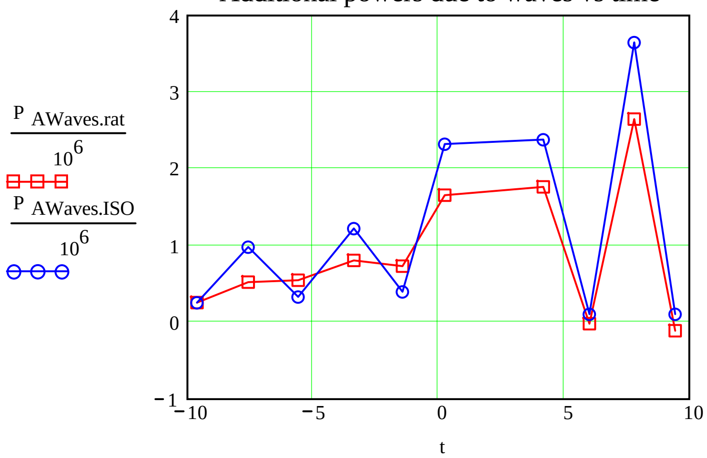
according to ISO/CD evaluation

resistance increase due to waves
row 30:

$$R_{AWaves.ISO} := \begin{pmatrix} 31.4 \\ 111.8 \\ 31.4 \\ 106.9 \\ 31.4 \\ 182.6 \\ 180.1 \\ 7.9 \\ 264.7 \\ 7.9 \end{pmatrix} \cdot 10^3 \cdot N$$

$$R_{AWaves.ISO} := \frac{R_{AWaves.ISO}}{N}$$

$$P_{AWaves.ISO_i} := \frac{R_{AWaves.ISO_i} \cdot V_{S.rat_i}}{\eta_D}$$



$$\frac{\left| P_{AWaves.rat} \right|}{\left| P_{AWaves.ISO} \right|} = 0.736$$

Fairing

$i := 0 .. \text{last}(t) - 3$ $\quad j := 0 .. 3$ $\quad$ cubic 'spline'!

Actually only runs 8and 9 needed to be disregarded!

$A_{i,j} := \left(V_{S.rat_i}\right)^j$ $\quad B_i := P_{S.rat_i}$

$X := \text{LeftInv}(A) \cdot B$

Interpolating

$$V_{S0.rat_k} := \min\left(V_{S.rat}\right) + \frac{\max\left(V_{S.rat}\right) - \min\left(V_{S.rat}\right)}{m} \cdot k$$

$A_{k,j} := \left(V_{S0.rat_k}\right)^j$

$P_{S0.rat} := A \cdot X$

$n_{rat_k} := 1$ $\quad$ initial values

Final performance

Final performance data according to rational evaluation

$n_{0.rat} := \mathrm{Revs}\left(p_{rat}, V_{S0.rat}, P_{S0.rat}, n_{rat}\right)$

Normalized values

Advance ratios, power ratios

$J_{H0..rat_k} := \mathrm{JH}\left(V_{S0.rat_k}, n_{0.rat_k}\right)$ $\quad$ $K_{P0k.rat_k} := \mathrm{KP}\left(P_{S0.rat_k}, n_{0.rat_k}\right)$

$p := 0..1$

$J_{H0.rat_0} := \min\left(J_{H0..rat}\right)$ $\quad$ $K_{P0.rat_0} := \max\left(K_{P0k.rat}\right)$

$J_{H0.rat_1} := \max\left(J_{H0..rat}\right)$ $\quad$ $K_{P0.rat_1} := \min\left(K_{P0k.rat}\right)$

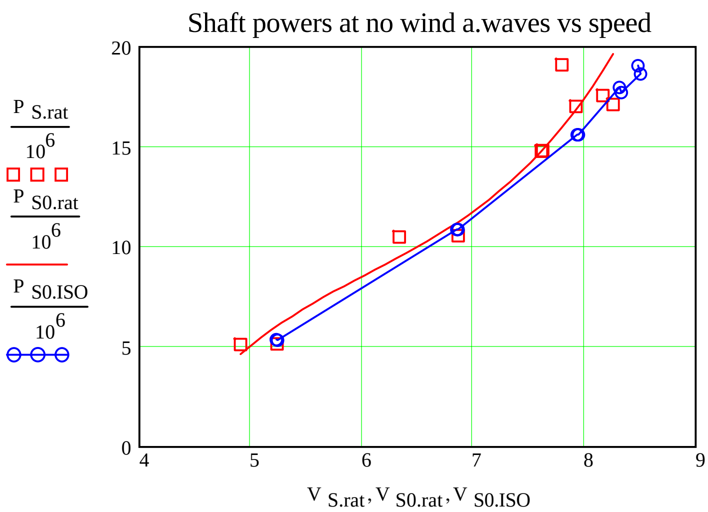
$J_{H0.ISO_i} := \mathrm{JH}\left(V_{S0.ISO_i}, n_{0.ISO_i}\right)$ $\quad$ $K_{P0.ISO_i} := \mathrm{KP}\left(P_{S0.ISO_i}, n_{0.ISO_i}\right)$

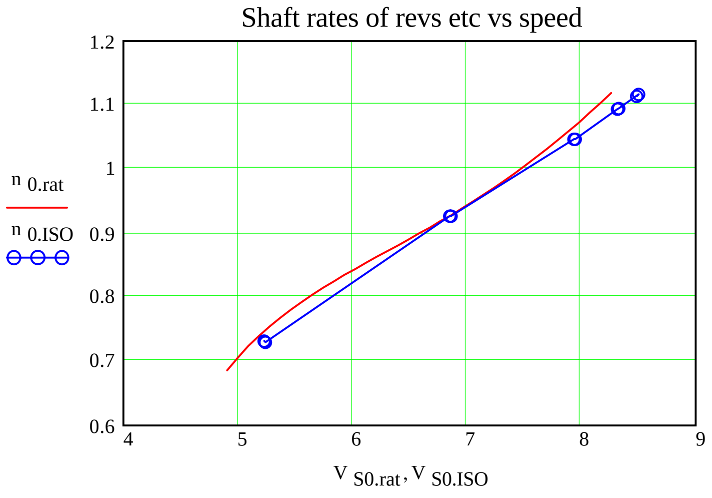
Froude numbers, power numbers

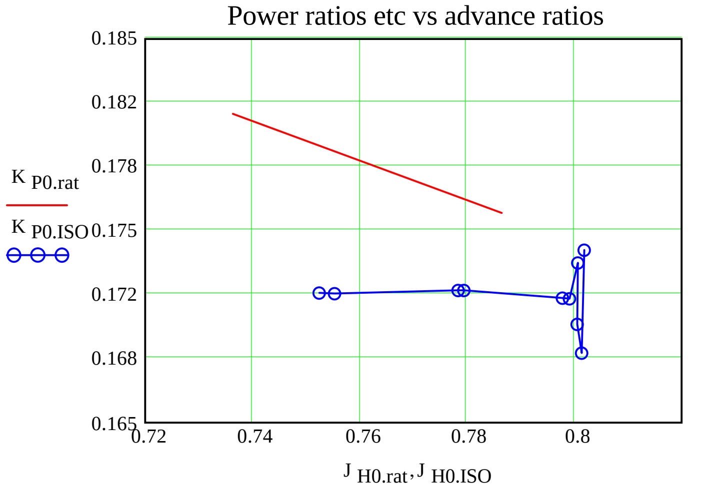
$F_{n0.rat_k} := \mathrm{Fn}\left(V_{S0.rat_k}\right)$ $\quad$ $C_{P0.rat_k} := \mathrm{CP}\left(P_{S0.rat_k}, V_{S0.rat_k}\right)$

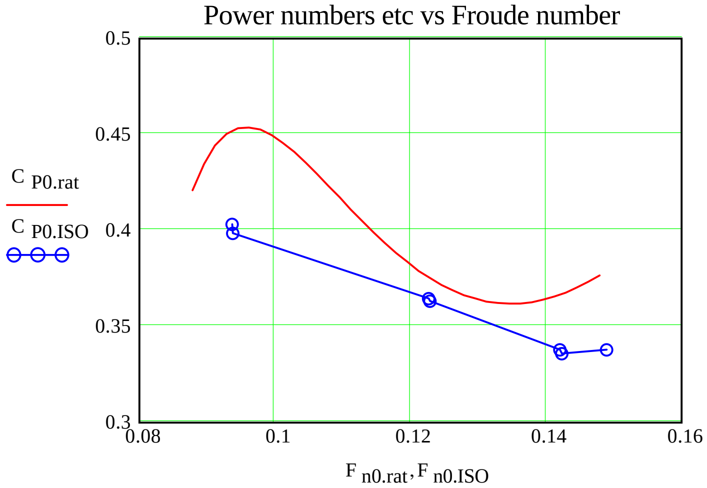
$F_{n0.ISO_i} := \mathrm{Fn}\left(V_{S0.ISO_i}\right)$ $\quad$ $C_{P0.ISO_i} := \mathrm{CP}\left(P_{S0.ISO_i}, V_{S0.ISO_i}\right)$

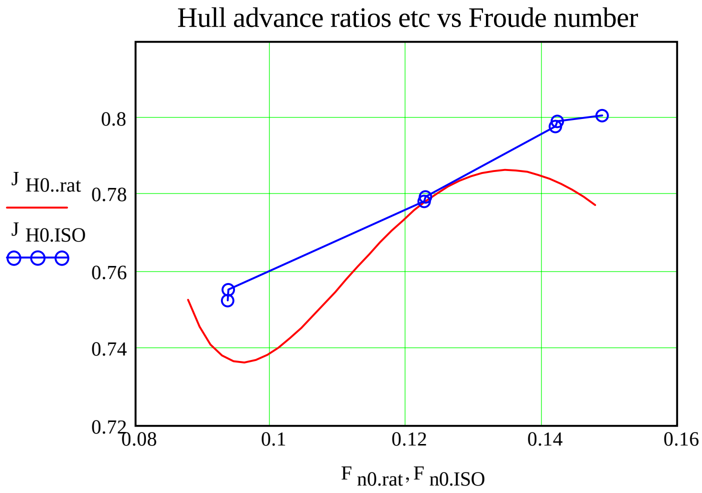
Plots of final results




Shaft rates of revs etc vs speed
n 0.rat
n 0.ISO
1.2
1.1
1
0.9
0.8
0.7
0.6
4
5
6
7
8
9
V S0.rat, V S0.ISO


Power ratios etc vs advance ratios
K P0.rat
K P0.ISO
0.185
0.182
0.178
0.175
0.172
0.168
0.165
0.72
0.74
0.76
0.78
0.8
J H0.rat, J H0.ISO


Power numbers etc vs Froude number
C P0.rat
C P0.ISO
0.5
0.45
0.4
0.35
0.3
0.08
0.1
0.12
0.14
0.16
F n0.rat, F n0.ISO



END Rational re-evaluation of new ISO/CD 15016 example

Fr Mrz 02 20:20:20 2001