Verification of EEDI at final stage Task and future direction

The 5th Asian Shipbuilding Experts' Forum

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A member of The Shipbuilder's Association of Japan (SAJ)

Discussion items

1. Outline of EEDI Verification Procedure

2. Correction method for speed trial

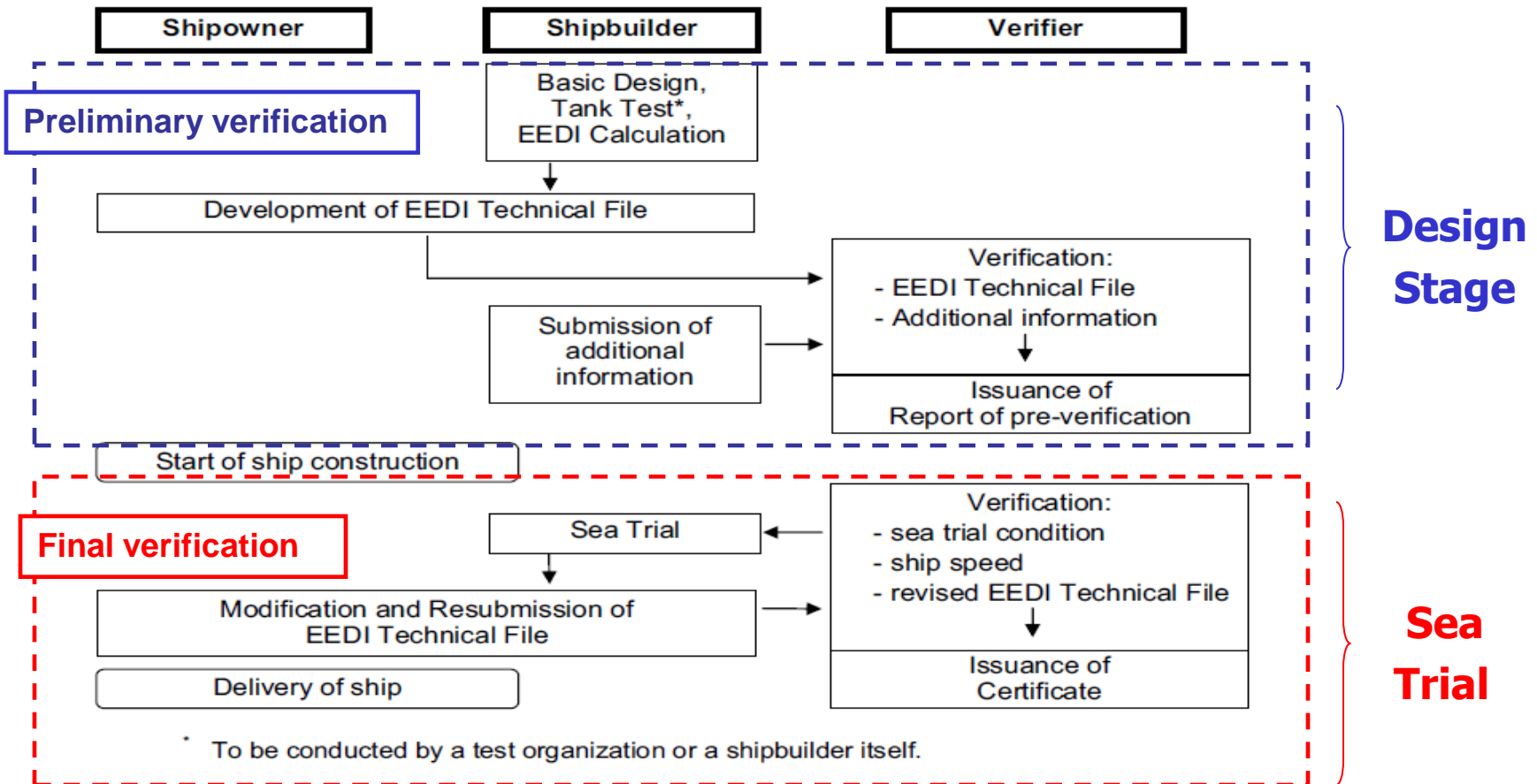3. Speed verification based on Sea Trial

4. Future Scope

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EEDI Verification Procedure

Figure 1 – Basic Flow of Survey and Certification Process

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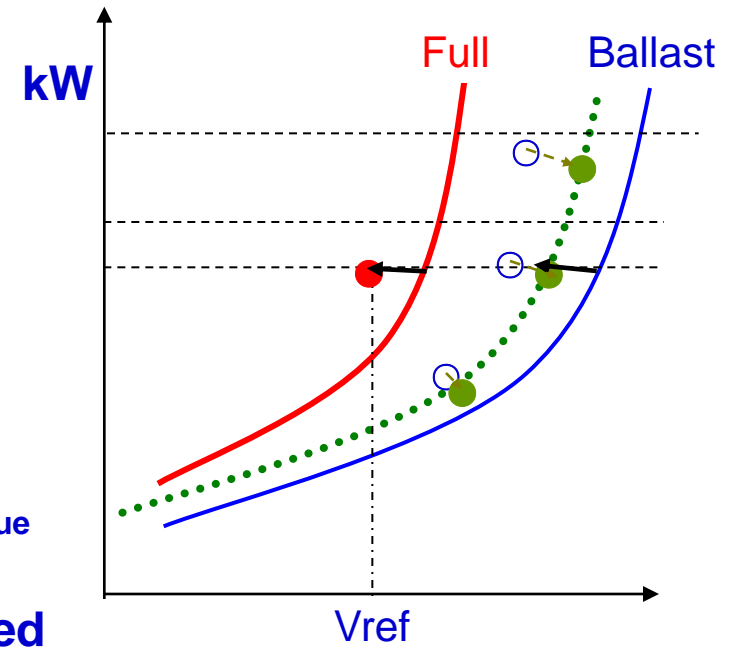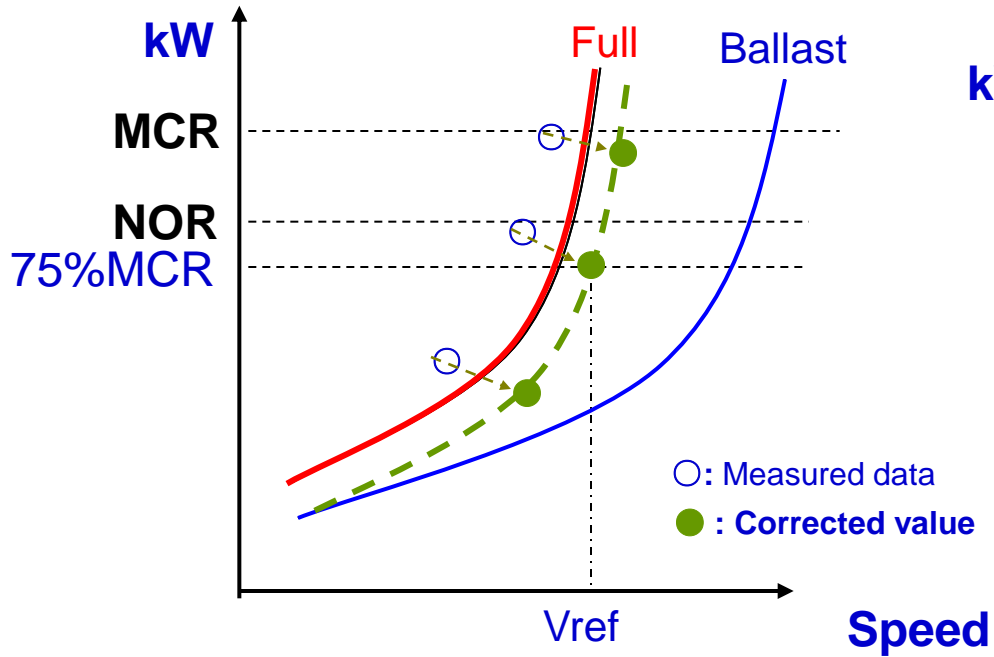
Verification of Attained EEDI at Sea Trial

Tanker

Dry Cargo

After **environmental correction,**
Attained EEDI can be verified directly

After **environmental correction,**
Attained EEDI shall be validated by
ballast trial results.

kW

MCR

NOR
75%MCR

Full   Ballast

○ : Measured data
● : **Corrected value**

Vref   **Speed**

kW

Full   Ballast

Vref

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Issues to be clarified

➢ **<u>Unification of correction method for speed trial</u>**

　　・ISO15016 or equivalent method
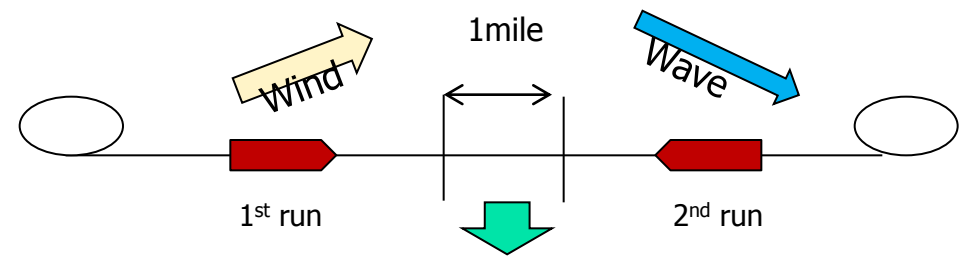
　　・Norway proposed the revision of ISO

➢ **<u>Speed correction from ballast to full load condition</u>**

　・Dry cargo vessel

　・Criteria for judgment of proper verification

　　　Ballast Trial result -> Full load Performance

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Correction method for speed trial

Basic Concept of ISO15016

Measurement

1mile

Wind

Wave

1st run

2nd run

Correction to No Wind, Wave, Current Condition

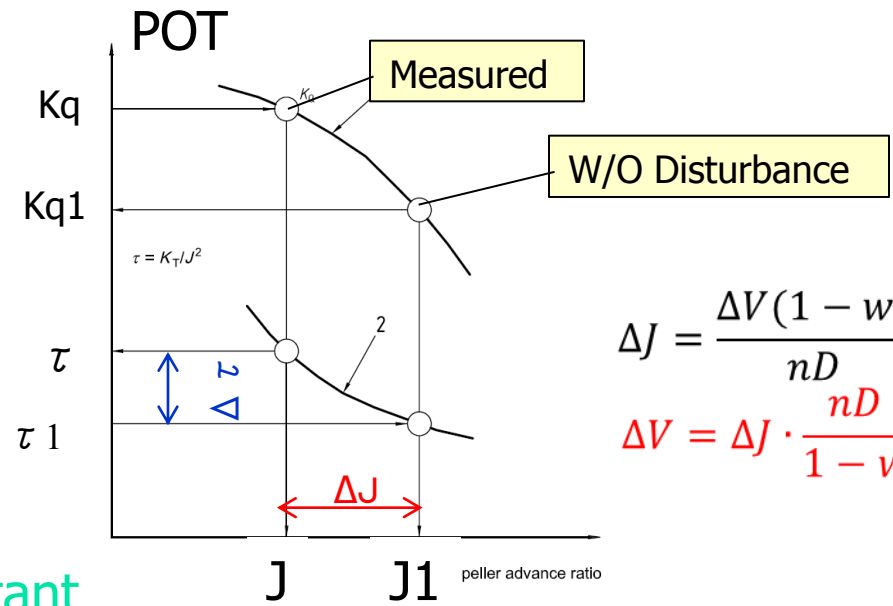**Basic concept : Propeller Load:τ**

$$Q = \frac{P_D}{2\pi n} \quad , \quad K_q = \frac{P_D \cdot \eta_R}{2\pi \rho n^2 D^5}$$

$$\tau = \frac{K_t}{J^2} = \frac{R_{Calm}}{\rho D^2 V^2 (1-w)^2 (1-t)}$$

$$\Delta\tau = \frac{\mathbf{R_{wind}} + \mathbf{R_{wave}}}{\rho D^2 V^2 (1-w)^2 (1-t)}$$

$$\tau 1 = \tau - \Delta\tau$$

Important

POT

Kq — Measured

Kq1 — W/O Disturbance

$\tau = K_T/J^2$

τ

$\Delta\tau$

$\tau 1$

ΔJ

J   J1   peller advance ratio

$$\Delta J = \frac{\Delta V (1-w)}{nD}$$

$$\Delta V = \Delta J \cdot \frac{nD}{1-w}$$

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Correction method for speed trial

Norway proposed the revision of ISO15016 based on MARIN-STA Report (MEPC62-5-5)

Wave Resistance

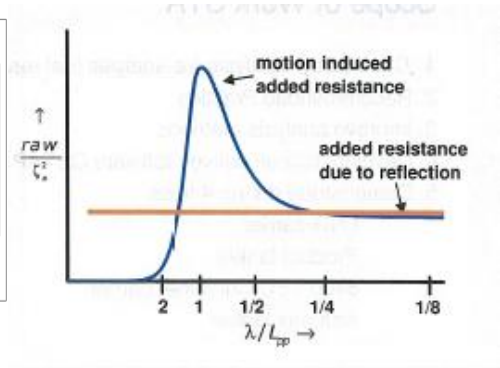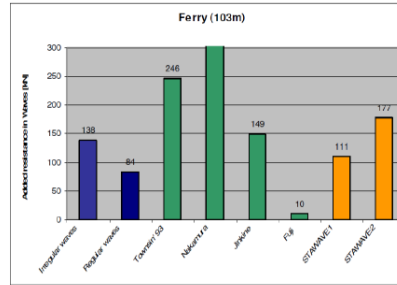MARIN STWAVE-1 & 2

ISO15016

➢ Strip Theory Calculation(MARUO)
  +Fujii-Takahashi,Faltinsen,Kwon・・・
➢   Model Test
➢   Other(Towsin-Kwon)

Ferry (103m)

Only Bow quartering

Wind resistance

Same Formula except・・・
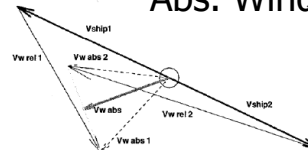
$$R_{AA} = 0.5\rho_A \cdot C_{AA}(\psi_{WR}) \cdot A_{XV} \cdot V_{WR}^2$$

$$C_{AA}(\psi_{WR}) = C_{AA0} \times K(\psi_{WR})$$

Definition of Abs. Wind

Height of anemometer

$$V_{wind}(z_{ref}) = V_{wind}(z)\left(\frac{z_{ref}}{z}\right)^{1/7}$$

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Correction method for speed trial

Following items to be discussed

◆ Calculation method for wave resistance

・ Applicability of STWAVE-1 & 2 ?

・ Limitation of wave direction ?

◆ Calculation of wind force

・ Validation of STA's assumption

-> Averaged absolute wind, Correction of anemometer

height, Applicability of CFD for C_x estimation

◆ Basis of speed correction for STA (and others)

・ The effect of propeller load taken into account ?

◆ Wave observation

・ Accuracy of observed wave height

・ Other possible method in the future (Wave radar, Buoy, etc.)

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Speed verification based on Sea Trial

Outcome from Workshop and JWG#3

➢ **Complete unification for correlation is quite complex**
  - ・No unified procedure is possible in the short and long term
  - ・Unified procedure to which correlates the model scale
    with trial results will results in a wrong prediction

➢ **Verifier need a threshold value for proper verification**
  Only for,
  - ・Dry cargo vessel
  - ・Relative correlation between full and ballast condition
       EG, ΔCF(Ballast)-ΔCF(Full)

Threshold value for correlation factor can be established ?

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Present state of the art for powering method
- 1978 ITTC performance prediction method -

Basic Flow is same
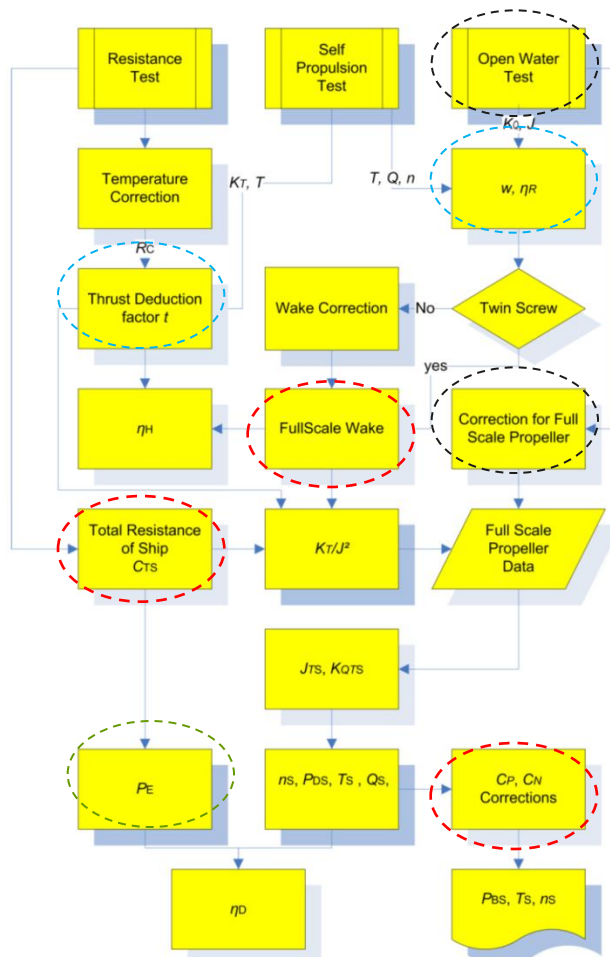
Model Test $\Rightarrow$ Required power : P_D

Resistance Test $\Rightarrow$ Effective Power: P_E

Propulsion Test $\Rightarrow$ Hull Efficiency: η_H

R.r.Efficiency: η_R

Open Water Test $\Rightarrow$ Propeller Efficiency: η_o

$$P_D = \frac{P_E}{\eta_H \cdot \eta_R \cdot \eta_o}$$

Correlation is the same

for all shipbuilders ?

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Present state of the art for powering method

- Model Ship Correlation - Reason of complexity

ΔCf

$$Ct = (1 + K)C_{fs} + C_w + \overbrace{\Delta C_f + C_A + C_{AAS}}$$

Effective Power: P_E

$$P_E = \frac{1}{2} \cdot \rho \cdot S_{app} \cdot V^3 \cdot C_t$$

⇒ Cf:ITTC1957,Schoenherr・・・

K:2dim or 3dim(Prohaska, Low Fn・・）

ΔCf: Discrete type, Integrated,ITTC,Empirical

Hull Efficiency: η_H

$$\eta_H = \frac{1 - t}{(1 - w_m) \cdot ei}$$

⇒ ITTC, Empirical, Yazaki, ・・・

Propeller Efficiency: η_o

$$\eta_o = \frac{J}{2\pi} \frac{K_t + \Delta K_t}{K_q + \Delta K_q}$$

⇒ΔKt,Kq:Scale Correction

Apply model POT directory

Power Correction: C_P, C_N

$$P_{DT} = C_P \cdot P_{DS}, \quad n_T = C_N \cdot n_s$$

⇒ Status is un-familiar

Correlation factors : $\Delta C_f, C_A, ei, C_P, C_N$

Absolute value would be different together with the different tank test and/or trial method

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Future Scope   - ITTC's Activity -

ITTC Special Committee on ' Performance of ship in service'
established by Japan & ITTC proposal (MEPC62-5-32)

Development of

➢ **Tank test quality**

➢ **Guideline for EEDI calculation including the threshold value of correlation**

➢ **Correction method for speed trial**

Participants from ASEF

·**Tsujimoto and Takai (NMRI & SHI-ME. Japan)**

·**H.Seo (HHI, Korea)**

·**J.Wang (MARIC, China)**

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Conclusion

- **Speed performance is moving from a commercial matter to regal requirement.**
  - ⇒**Verification should be done properly without loophole although it is very complex and challenging task**
- **ITTC Special Committee is a powerful board to clarify the task**
  - ⇒**Details of powering and sea trial could not be opened in the past because of their confidentiality**
  - ⇒**Comparative study should be carried out jointly with shipbuilding industry**
- **IPR should be kept in a rigorous manner Exact practice to be established**

ASEF member occupy a major part of ship building industry. Let's play a leading role to pursue the proper method of EEDI verification by our close cooperation !!

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Thank you for your attention !

고맙습니다

真谢谢你了

有難うございました

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