# **ISO15016 Revision Work**

- New Standard for Speed Trial Analysis -





27-28 November, 2014, The 8th ASEF, Jeju





## **Brief review of EEDI regulation (EEDI value)**



For all ships of 400 gross tonnages and above that engage in international voyages and whose building contract is placed on or after 1 January 2013, the attained EEDI shall be calculated and shall be as follows(<u>MARPOL ANNEX VI, Regulation 20 & 21</u>):



**Speed** in the attained EEDI is ship's speed in the condition assuming the weather is calm with no wind, no current and no waves

(\*): X is reduction factor depending on phase relative to the EEDI reference line, and a and c are parameters for determination of reference line.





is required in order to eliminate the effect of environmental condition during sea trial.

- Norway requested to revise the existing ISO15016:2002 analysis method. (April 2011, IMO MEPC62).
- Japan and ITTC proposed to review the analysis method and specialist committee on PSS started their study (December 2011).
- IMO MEPC65 (May 2013) assigned two international methods for Guidelines on survey and certificate of the EEDI,
  - > ITTC Recommended Procedure 7.5-04-01-01.2 (which is considered as preferable.)
  - > ISO 15016:2002
- It has been pointed out that there are some problems of both ITTC Recommended Procedure (e.g. containing black box, and inaccurate results) and ISO15016:2002 (e.g. too complicated, and ambiguous results).
- Since July 2012, ISO has started the revision of ISO15016:2002 by the experts, including ITTC members and STA-Group <sup>(\*)</sup>.
  - (\*) An international group of owners, shipyards, research institutes, classification societies and universities studying and improving sea trial procedures and Sea Trial Analyses (STA)
- IMO welcomed the collaborative efforts made by ISO and ITTC to harmonize their standards and urged ISO to submit the revised ISO15016 by early 2014, but the result of 1<sup>st</sup> voting was "disapproved" (April 2014).

# 1<sup>st</sup> voting result





537 comments were gathered from the member countries.

Technical comments (13 comments) should be solved for next 2<sup>nd</sup> voting.

These technical comments are narrowed down to only six items.

- Validation of "Iterative" method (It is also pointed out in MEPC66.)
- Run number of sister ships.
- Standard G modules for shaft torque meter
- Power setting range
- Preparation and conducting the speed trial
- Using the CFD for wind and wave correction



- ITTC and some other organizations studied the validation of iterative method after 1<sup>st</sup> voting.
- 4<sup>th</sup> expert meeting was held in 25-27 June, 2014, in London and they reported their validation work.
- Taking into consideration of the validation work by ITTC and the others, the group agreed that the "Iterative" method was fully validated and confirmed to be accurate enough to be used as a current correction method in the revised ISO draft.
- All the participants of this group agreed on the substance of the ISO working draft as it is a practical and preferable standard for speed trial analysis.
- The members agreed to request ISO/TC8/SC6 for the 2nd DIS voting of the revised ISO15016.
- 2<sup>nd</sup> voting was started on 6 October and will be terminated on 6 December, 2014.



The process in which current curve is fitted manually involve arbitrariness and ambiguity .

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#### **Current correction in BSRA method**



- 5. S-P curve is revised so that horizontal distances are as equal to the current speeds obtained from current curve as possible.
- 6. The above processes 2 5 are repeated until S-P curve converged (fixed).

- 2. Current speed at each time which is equal to the horizontal distance between curve and point in speed-power curve is obtained.
- 3. The obtained current speeds are plotted against time and a fair curve is fitted manually.
- 4. Current speeds on the current curve at each time  $(V_{Ci})$  are calculated. al as  $V_{Ci}$   $V_{Ci$

The process in which current curve is fitted manually involve arbitrariness and ambiguity .

Current effect is automatically eliminated with the following formula for each power setting as mentioned below:

$$\frac{V_{G1} + 3V_{G2} + 3V_{G3} + V_{G4}}{8} = V_S \qquad (1)$$

1. In this method, current speed is assumed to vary parabolically over time within comparatively short time, e.g. time taken for measurement during one power setting.



- 2. ship's speeds over ground at one power setting are expressed as follows using formula (2):  $V_{G1} = V_S + \{V_{C,2}(t + 3\Delta t)^2 - V_{C,1}(t + 3\Delta t) + V_{C,0}\}$  $V_{G2} = V_S - \{V_{C,2}(t + \Delta t)^2 - V_{C,1}(t + \Delta t) + V_{C,0}\}$  $V_{G3} = V_S + \{V_{C,2}(t - \Delta t)^2 - V_{C,1}(t - \Delta t) + V_{C,0}\}$  $V_{G4} = V_S - \{V_{C,2}(t - 3\Delta t)^2 - V_{C,1}(t - 3\Delta t) + V_{C,0}\}$
- By substituting the above 4 formulae for formula (1), all terms of current are eliminated and only V<sub>S</sub> remains.

There is possibility to reduce accuracy when it takes long time for measurement, since the current curve can't be assumed to vary parabolically for long time.



Iterative method is based on the current correction method in BSRA standard method.



- . A speed-power curve is determined temporally.
- Current speed at each time which is equal to the horizontal distance between curve and point in speed-power curve is obtained.
- 3. The obtained current speeds are plotted against time and a fair curve is fitted automatically using function.
- Current speeds on the current curve at each time (V<sub>Ci</sub>) are calculated.



- 5. S-P curve is revised so that horizontal distances are as equal to the current speeds obtained from current curve as possible.
- 6. The above processes 2 5 are repeated until S-P curve converged (fixed).

Validation by third party was required for this newly developed method.



- Starting time and time intervals are varied to calculate.
- If the correction method is accurate, the results should be on the estimated speed power curve based on the tank test results



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#### Some current profiles are used.



Starting time : 0h - 18h



Time intervals between consecutive runs: short and long uneven intervals, randomly

- Ship types : Container, Tanker, Cruise liner, LNG
- Added resistance : 0% 10%
- Run number :

Iterative method : 1+2+1(1+1+1) double runs Mean of Means method : 1+2+2 double runs







ITTC concluded as follows based on their study:

- Using the "Mean of Means" method, two double runs for each power setting (2+2+2 double runs) should be made to keep the enough accuracy.
- In general, the "Iterative" method of "1+1+1 double runs" leads to less errors on average of the tested cases when "1+2+2 double runs" are used in the "Mean of Means" method.
- In the case of shorter time periods between the runs (up to 60 minutes), the both methods are equally adequate.
- In specific cases the "Mean of Means" method has advantages over the "Iterative" method.



The other members reported the results of their validation study:

- BV conducted the validation study by their own procedure and showed the results that the "Iterative" method leads to less errors around the EEDI.
- According to the comparative study by ClassNK using actual trial data, both methods showed the same level accuracy.
- MOL expressed their views from the standpoint of the Ship Owner that the "Iterative" method is practical and allowed to be applied in the new ISO15016

Taking into consideration of the Validation work by ITTC and others, the group agreed that the Iterative method was fully validated and confirmed to be accurate enough to be used as a current correction method in the ISO draft.



The group agreed to follow the ITTC's recommendation of the run numbers of the Iterative method and the Mean of Means method in order to achieve equivalent accuracy as follows:

- Iterative method
  - 1+2+1 Double Runs for the first ship
  - 1+1+1 Double Runs for sister ships
- Mean of Means method
  - 2+2+2 Double Runs for the first ship
  - 1+1+1 Double Runs for sister ships
  - For sister ships, when a current variation of above 0.2 knots within one Double Run is observed, one additional Double Run is needed for that power setting.

## Concept of ISO/DIS 15016.2



#### DRAFT INTERNATIONAL STANDARD ISO/DIS 15016.2

ISO /TC 8/SC 6	
Voting begins on:	
2014-10-06	

Secretariat: HSC Voting terminates on: 2014-12-06

#### Ships and marine technology - Guidelines for the assessment of speed and power performance by analysis of speed trial data

Navires et technologie maritime - Lignes directrices pour l'évaluation des performances de vitesse et de puissance par analyse des données d'essais de vitesse

ICS: 47.020.01

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Reference number

@ ISO 2014

- "ISO/DIS 15016 2" is a 2<sup>nd</sup> version of revised international standard draft for Speed Trial Analysis.
- This standard is more advanced, fair and transparent method than any other analysis method of speed trial.
- This standard has been developed with the fully cooperation of the ITTC and STA-group.
- This standard covers trial preparation, conduct and the analysis of speed trial data.
- ITTC would revise their recommended procedure of speed trial analysis based on this standard in next three years.
- The description of the draft in English has been well-polished by the experts including UK member.



"ISO/DIS 15016.2", which as been developed based on ITTC Recommended Procedure & Guideline (2014), achieves substantial improvements as follows:

- In addition to the "Mean of means" method for current correction, the newly developed "Iterative" method is introduced and applied.
- The required run number is re-established based on the validation results in order to achieve the same level of accuracy.
- The practical standard value of G-modulus for torsion meter is established.
- The appropriate restrictions are defined for the theoretical method with simplified tank test of added resistance due to waves based on their validation results.
- The following items of sea trial preparations, conditions, procedures and analysis are defined for clarity and to avoid arbitrary applications;
  - Sea trial area
  - Draft measurement method
  - Sister ships
  - Measured parameters
  - Application of shallow water correction
  - Power settings
  - Ship's profiles for Dataset of wind correction
  - Standard water temperature
  - ••••

### Main improvements from the old methods



	ISO15016:2002	BSRA	ISO/DIS15016.2
Power correction	<ul> <li>Powers are corrected via propeller loads.</li> </ul>	<ul> <li>Powers are corrected directly.</li> </ul>	<ul> <li>Powers are corrected directly.</li> <li>(Direct Power Method)</li> </ul>
	<ul> <li>Load variation is also corrected when estimating propeller load.</li> </ul>	<ul> <li>It may be assumed that load variation effect due to propeller isn't expected to be significantly large.</li> </ul>	<ul> <li>Load variation effect is considered.</li> </ul>
Wind resistance	<ul> <li>Wind resistance coefficients shall be based on wind tunnel test.</li> <li>The data obtained from model tests are also provided in the document for guidance.</li> </ul>	• Wind resistance coefficients for various ship types are provided in the document.	<ul> <li>Followings are accepted.</li> <li>Wind tunnel test</li> <li>Data set provided by STA-group</li> <li>Regression formula by Fujiwara et al.</li> </ul>
Wave resistance	<ul> <li>Followings are accepted.</li> <li>Theoretical methods</li> <li>Tank test</li> </ul>		<ul> <li>Followings are accepted.</li> <li>Simplified method (STAWAVE1)</li> <li>Empirical method (STAWAVE2)</li> <li>Theoretical method (NMRI)</li> <li>Tank test</li> </ul>

### Main improvements from the old methods



	ISO15016:2002	BSRA	ISO/DIS15016.2
Current correction	<ul> <li>Current speed at each time is obtained from a current curve determined manually using all current speeds at mean times of double runs.</li> </ul>	<ul> <li>Current curve and speed-power curve are obtained by iterative process.</li> <li>In each step of iterative process, a current curve is determined manually using all current speeds.</li> </ul>	<ul> <li>Mean of Means method</li> <li>Current effect is eliminated automatically with four ship's speeds of two double runs.</li> <li>In fact, current curve is approximated by quadratic function at each power setting.</li> <li>Iterative Method</li> <li>Current curve and speed-power curve are obtained by iterative process.</li> <li>In each step, a current curve is determined automatically using all current speeds.</li> </ul>



All the participants of this group agreed on the substance of the ISO working draft as it is a practical and preferable standard for speed trial analysis. The members agreed to request ISO/TC8/SC6 for the 2<sup>nd</sup> DIS voting of the revised ISO15016.

- After 4<sup>th</sup> meeting, informal resolution meeting to finalize the 2<sup>nd</sup> DIS draft was held on September 16-17 in London.
- ITTC reported the validation result of the Iterative method at MEPC67.
- ISO and ITTC reported the work progress of the revision work of ISO15016 at MEPC67.
- MEPC67 GHG-WG noted these reports by ITTC and ISO and agreed that the revised ISO15016 should be used for the final verification of the attained EEDI at sea trial when the ISO/DIS draft has been passed the voting.
- 2<sup>nd</sup> DIS voting of the revised ISO15016 was requested to ISO/TC8 in the early October.
- 2<sup>nd</sup> DIS voting was started on 6 October and will be terminated on 6 December.