

Development & application for the sea trial analysis program (i-STAP) based on IMO guidelines under discussion

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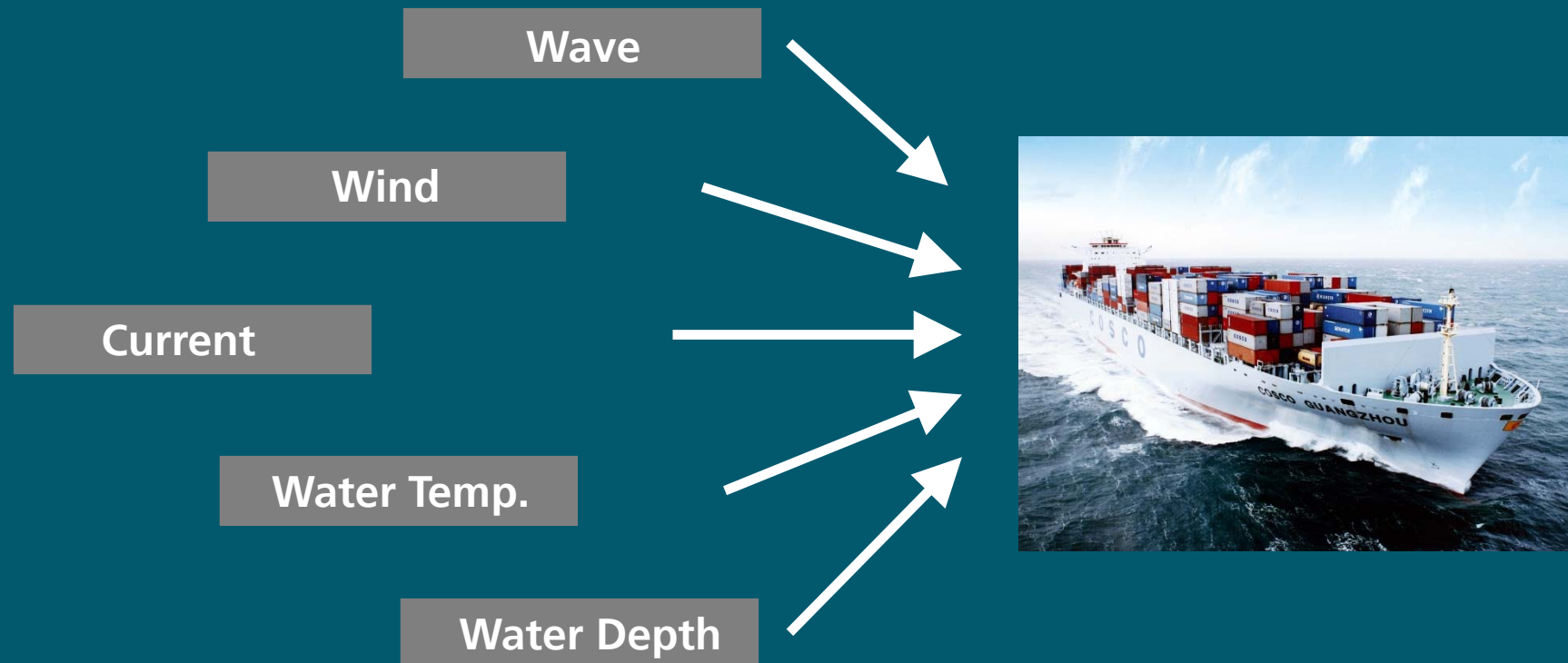
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1. Background

- EEDI is most important issue for protection environments in international society.
- Validation of speed performance becomes important.
- Ship owner's mistrust for speed trial results.
- Clear and fair method for speed trial analysis is required.
- IMO ordered harmonization between ISO and ITTC.
- Revised ISO 15106 is in voting.
- Ship yards have to prepare for these trends.

Added Resistance Factors in Sea



- In real sea, a ship meets with various environmental conditions during speed trials(EEDI) and services(EEOI).

2. ISO Standards for Speed Trial(2014)

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Correction Factor	ISO (2002)	ISO (2014)
Analysis Method	Taniguchi-Tamura	Direct Power
Wave	0	0
Wind	0	0
Steering	0	X
Drifting	0	X
Water Temperature	0	0
Water Depth	0	0
Tidal Current	0	0
Displacement	0	0

- ISO (2014) method is in voting until next month.
- Steering and drifting corrections are excluded.
- Many of correction method and procedure are changed for each factor.

3. Development of i-STAP

- i-STAP(ISO Speed Trial Analysis Program) in developing
- Until confirmation of revised ISO 15016
- Sponsored by KOSHIPA
- Programed by KRISO (Korea Research Institute of Ship & Ocean Engineering)
- Based on ISO 15016(2014) – in voting until Dec. 2014
- Korean ship yards joined

4. Introduction of i-STAP

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Overview

- Fully support speed trial analysis as defined in ongoing amendments to ISO15016
 - Wind resistance with 3 options for wind resistance coefficients
 - 4 options of wave resistance
 - Water temperature and density correction
 - 2 options for current correction
 - 2 options for speed power correction
 - Shallow water correction
 - Displacement correction
 - Load conversion
- Ease of input using GUI with error checking and guidance
- Provide detailed calculation results for experts
- Output chart, summary report (pdf) and detail report (excel)
- Compatible with any PC running windows XP or later

Graphic User Interface

The screenshot shows the 'Sea Trial Analysis ISO/DIS 15016:2014 - [Input Data]' window. The interface includes a menu bar (File, Result, Print, Help) and a toolbar (Open, Setup, S-P Result, S-P Curve, Current Curve). A vertical sidebar on the left contains buttons for 'Calculation', 'Project', 'Wind resistance', 'Wave resistance', 'Temperature Correction', 'Speed Power Estimation', 'displacements', 'Load Conversion', and 'Measured data at each trial run'. The main area is titled 'Project' and contains input fields for 'Project name', 'Reference Time' (2014-09-17 15:09:35), 'No. of Double Runs' (1), and 'No. of engine settings' (1), along with a checkbox for 'Delete Previous Wave Calculation Results'. A status bar at the bottom left displays the message 'Chart data has not been specified.'.

Main Menu: Points to the top menu bar.

Begin Calculation: Points to the 'Calculation' button in the sidebar.

Data Input Status Indicator: Points to the sidebar buttons.

Input Data Page Selection: Points to the 'displacements' button in the sidebar.

Input Area: Points to the main input fields.

Guidance to Input Data: Points to the bottom status bar.

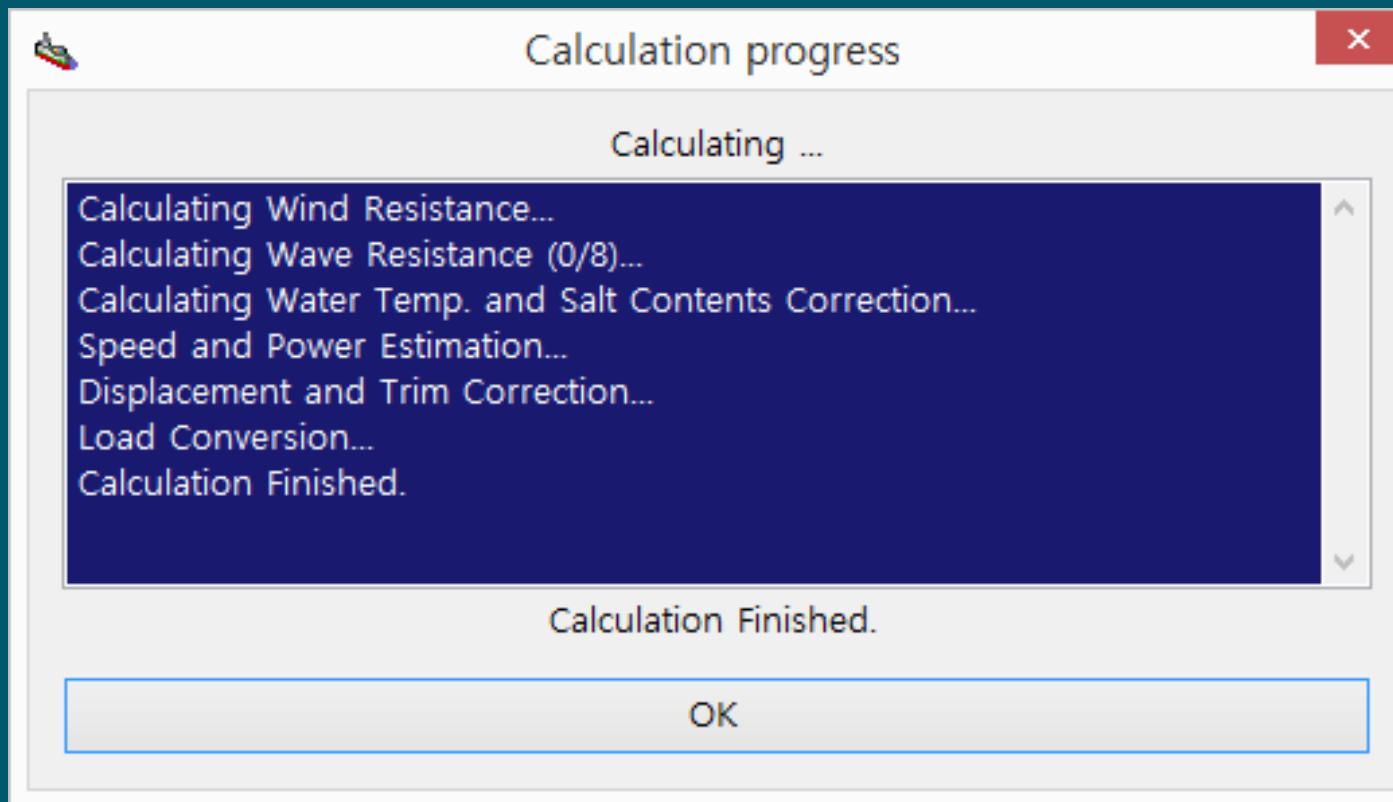
System Message: Points to the 'Chart data has not been specified.' message.

Data Input

- **Input data is categorized into 8 logical groups.**
 - **Project**
 - **Wind resistance**
 - **Wave resistance**
 - **Temperature correction**
 - **Speed and power estimation**
 - **Displacement correction**
 - **Load conversion**
 - **Measured data at each trial run**

Calculation

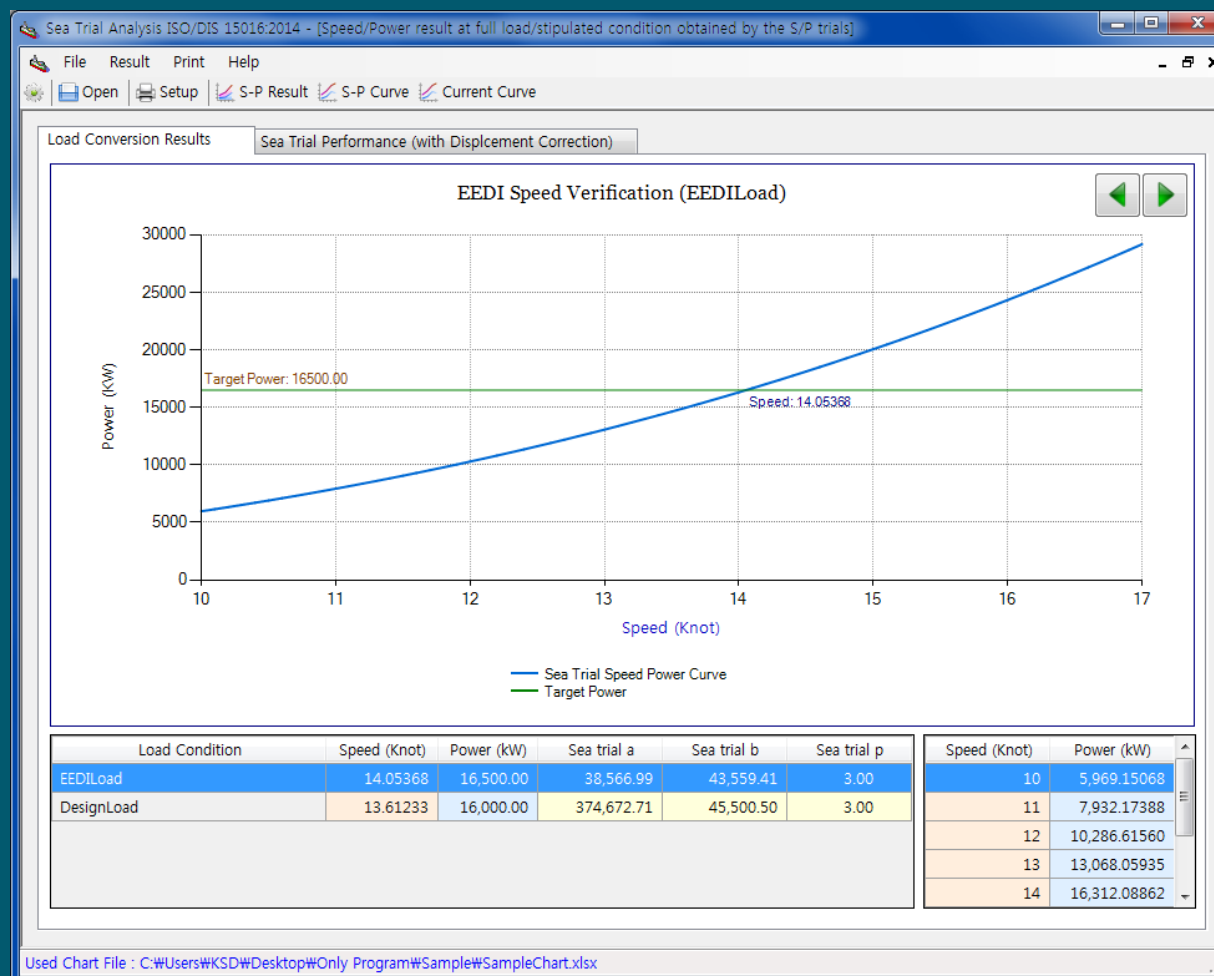
- **Log window**
 - Shows progress
 - Error message



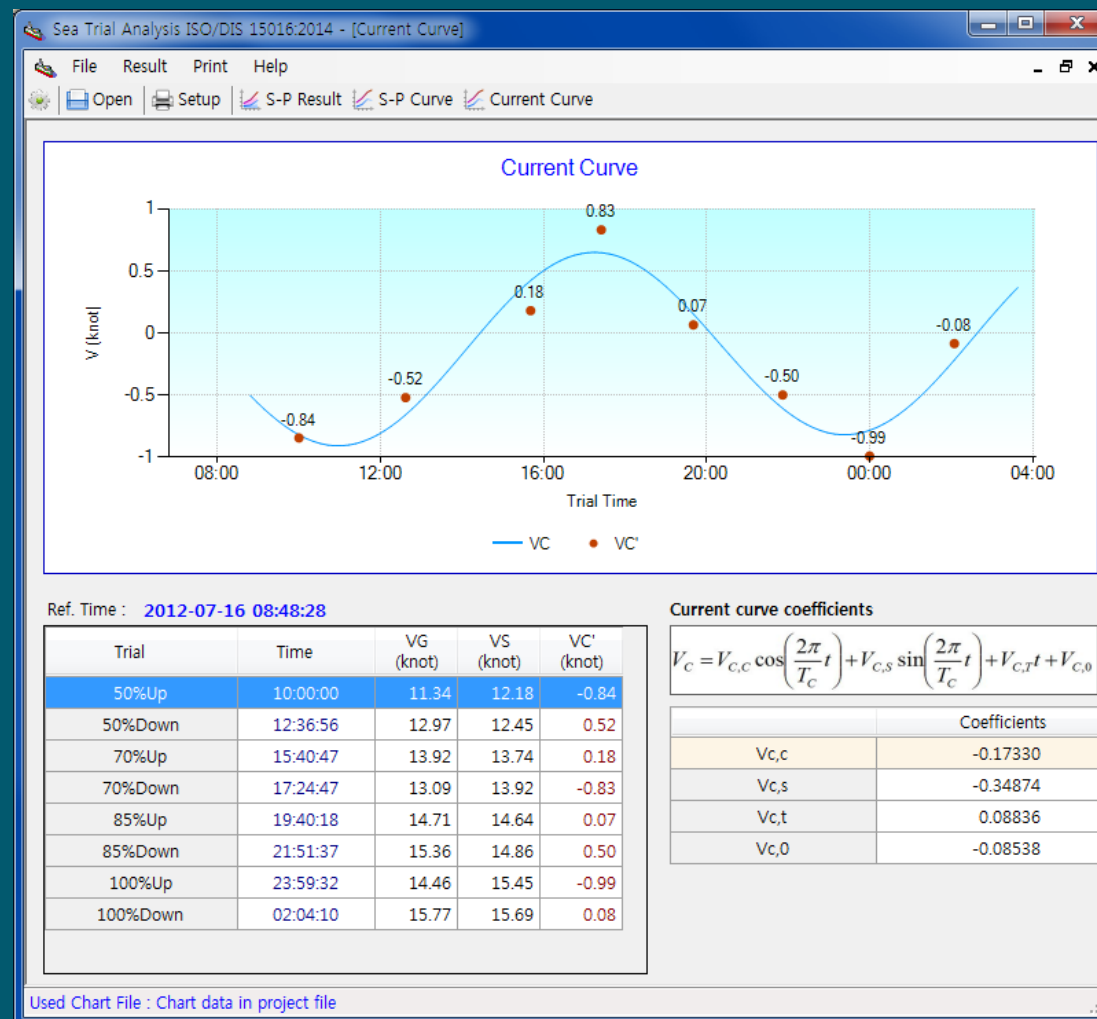
Output

- 3 kinds of outputs
 - Graphic output
 - PDF output for report
 - Excel file of detailed output

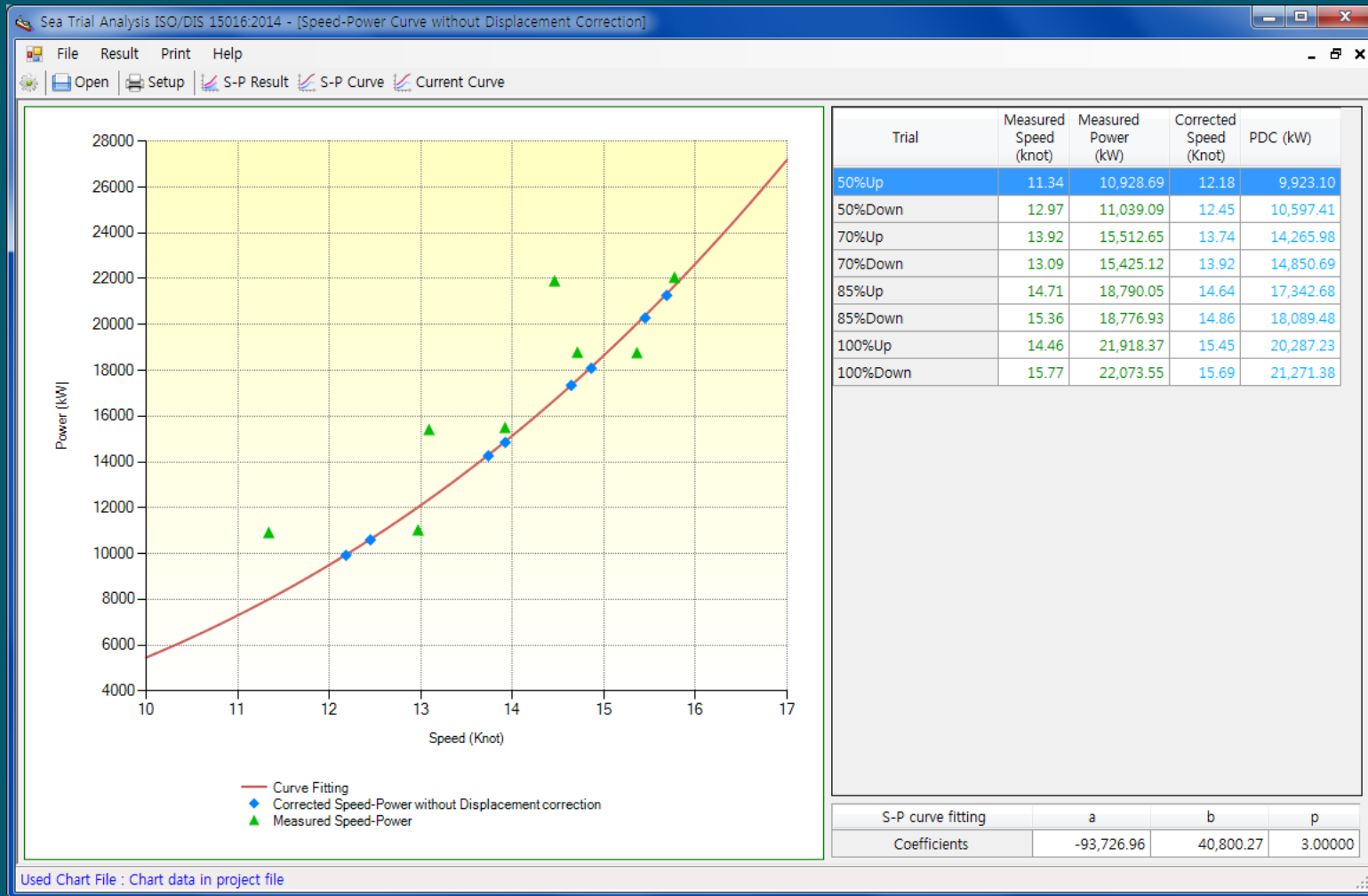
- Graphic output
 - Load conversion results



- Graphic output
 - Current correction result



- Graphic output
 - Speed power curve



PDF output for report

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Project Name	Sample Data	Reference Time	2012-07-16
No. of Double Run	4	No. of Engine Setting	4

Calculation Method Summary

Wind Vector	Not Averaging
Wind Coefficients	Wind Tunnel Test Results
Wave Resistance	Theoretical with Formulae
Water Temp. Correction	Trial: 19.3°C (Standard: 15°C)
Shallow Water Correction	No Correction
DPM	DPM for Power Evaluation
Current Correction	Iterative
Displacement Correction	From 100,000 ton to 101,990 ton

Load Condition	Target Power (Kw)	Vref (Knot)
EEDI Load	16,500.00	14.05368
Design Load	16,000.00	13.61233

Sea Trial Data

ENGINE Setting	Name	Time	VO	PstD	VWVR	Pst(VWR)	W Temp	PSM	MR	HWCD	SW	TW1	WCD	DB	YB1
0	50% up	00:00	11.34	0	12.4	16.38	14.8	10.228	89.4	1.5	0	6.0	0	0	0
0	50% down	02:30	12.87	0	13.6	18.18	14.8	11.228	89.4	1.5	0	6.0	0	0	0
1	70% up	05:40	13.52	0	13.68	14.22	14.8	15.514	99.0	1.5	0	6.0	0	0	0
1	70% down	07:24	13.08	0	13.6	79.16	14.8	15.428	99.0	1.5	0	6.0	0	0	0
2	80% up	08:40	14.71	0	14.01	14.48	14.8	16.794	102.5	1.5	0	6.0	0	0	0
2	80% down	11:51	15.34	0	13.95	42.28	14.8	15.771	102.5	1.5	0	6.0	0	0	0
3	100% up	13:59	14.48	0	13.95	14.23	14.8	21.918	73.9	1.5	0	6.0	0	0	0
3	100% down	16:04	15.71	0	13.8	59.69	14.8	22.074	74.4	1.5	0	6.0	0	0	0

Sea Trial Performance (with displacement correction)

Name	R04 (kN)	R06 (kN)	RAS (kN)	ΔP (kN Temp)	ΔV (knot, shallow)	P1 (TIB)	Power (BHP, COF)	RPM	Vr (knot)
50% Up	48.46	29.39	-0.17	16.68	0.00	9,923.10	10,264.31	59.90	12.10
50% Down	-15.42	31.10	-0.22	12.47	0.00	10,559.41	10,737.54	59.40	12.45
70% Up	54.56	30.67	-0.23	36.59	0.00	14,265.98	14,454.62	66.00	13.74
70% Down	-15.69	31.31	-0.22	12.41	0.00	14,892.69	15,247.06	66.30	13.92
80% Up	55.42	33.92	-0.21	40.81	0.00	17,242.69	17,572.00	70.30	14.64
80% Down	-22.38	34.97	-0.20	12.29	0.00	18,099.40	18,328.08	70.00	14.96
100% Up	55.98	33.82	-0.27	39.11	0.00	20,287.20	20,555.49	73.90	15.45
100% Down	-22.91	35.64	-0.31	12.41	0.00	21,211.36	21,662.66	74.40	15.69

Speed corresponds to Target Power

Load Condition	Speed (Knot)	Power (kW)
EEDI Load	14.05368	16,500.00
Design Load	13.61233	16,000.00

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Load Condition Results

Speed (knot)	EEDI Load	Design Load
10	5,982.15	6,589.53
11	7,932.17	8,620.03
12	10,296.62	11,079.39
13	13,088.06	13,984.78
14	16,312.09	17,373.37
15	20,064.29	21,282.33
16	24,330.24	25,748.83
17	29,115.82	30,810.03
18	34,625.73	36,503.10

EEDI Speed Verification (EEDI Load)

EEDI Speed Verification (Design Load)

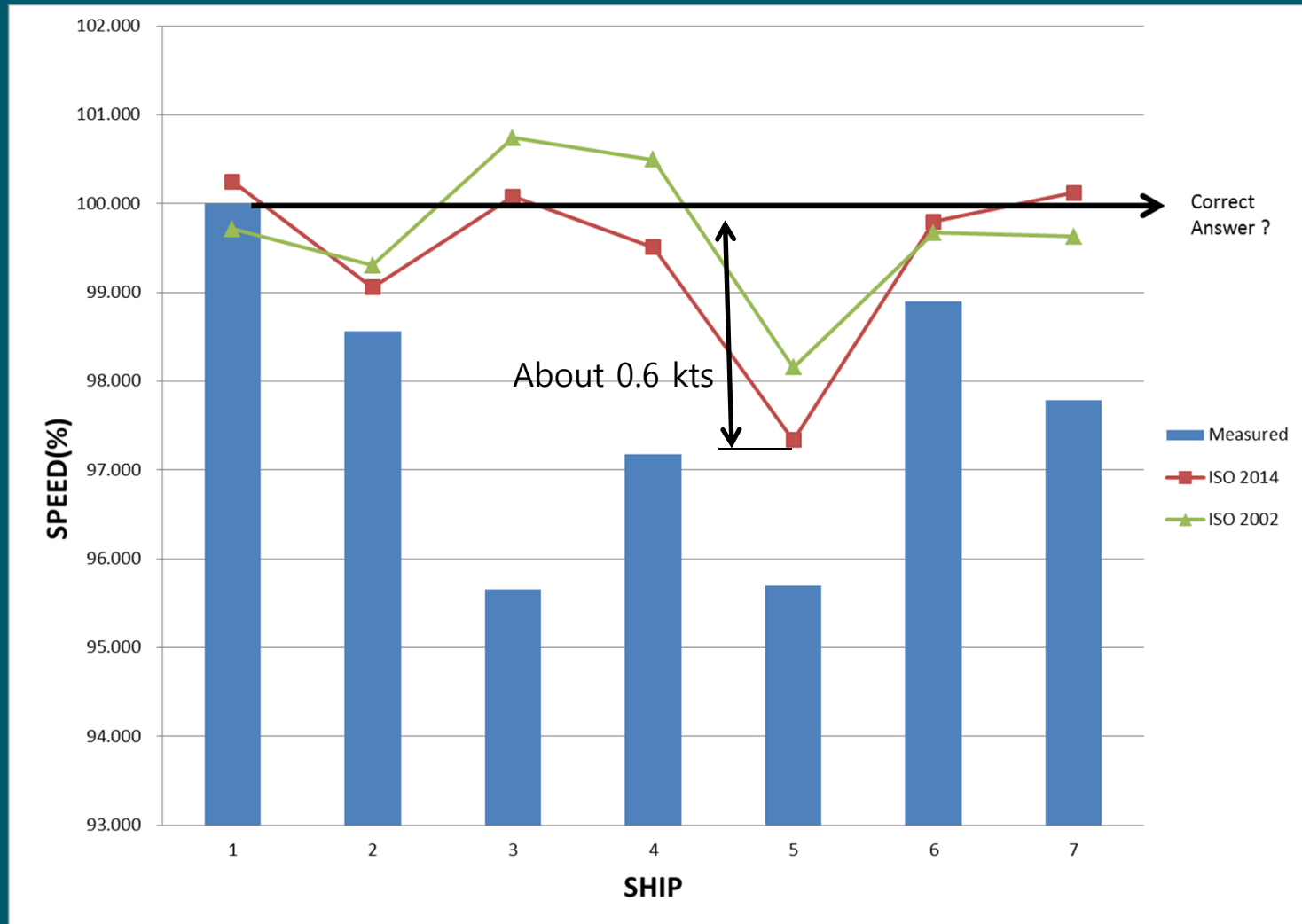
- Excel file of detailed output

Wind resistance calculation results:									
	50%Up	50%Down	70%Up	70%Down	85%Up	85%Down	100%Up	100%Down	
VG (m/s)	5.83	6.67	7.16	6.73	7.57	7.90	7.44	8.11	
Psi0 (deg)	0.00	180.00	0.00	180.00	0.00	180.00	0.00	180.00	
VWR (m/s)	12.40	3.55	13.68	3.56	14.07	3.95	13.95	4.06	
PsiWR (deg)	16.39	-80.08	14.82	-79.15	14.40	-62.29	14.53	-59.66	
VWT (m/s)	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	
PsiWT (deg)	29.99	29.98	29.99	29.97	30.00	29.97	29.99	30.03	
VWTref (m/s)	5.74	5.74	5.74	5.74	5.74	5.74	5.74	5.74	
VWRref (m/s)	11.18	3.33	12.47	3.36	12.86	4.10	12.74	4.26	
PsiWRref (deg)	14.87	-59.34	13.31	-58.47	12.89	-44.43	13.02	-42.47	
RhoA (kg/m3)	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	
RhoStd (kg/m3)	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	
CAA(Psi)	0.85	0.50	0.84	0.51	0.83	0.80	0.83	0.84	
CAA(0)	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	
RAA (kN)	48.46	-18.42	54.56	-18.68	56.42	-22.38	55.86	-22.91	
Water temp. and salt contents calculation results:									
	50%Up	50%Down	70%Up	70%Down	85%Up	85%Down	100%Up	100%Down	
VG (knot)	11.34	12.97	13.92	13.09	14.71	15.36	14.46	15.77	
CF	1.43E-3	1.41E-3	1.40E-3	1.41E-3	1.39E-3	1.38E-3	1.39E-3	1.37E-3	
CF0	1.45E-3	1.43E-3	1.41E-3	1.42E-3	1.40E-3	1.40E-3	1.41E-3	1.39E-3	
RF (kN)	12.47	16.05	18.34	16.33	20.34	22.07	19.70	23.19	
RT0 (kN)	8.73	11.42	13.15	11.63	14.69	16.02	14.19	16.88	
RAS (kN)	-0.17	-0.22	-0.25	-0.22	-0.27	-0.30	-0.27	-0.31	
Speed and power estimation results:									
	50%Up	50%Down	70%Up	70%Down	85%Up	85%Down	100%Up	100%Down	
Initial data:									
t	1900-01-00 01:11:32	1900-01-00 03:48:28	1900-01-00 06:52:19	1900-01-00 08:36:19	1900-01-00 10:51:50	1900-01-00 13:03:09	1900-01-00 15:11:04	1900-01-00 17:15:42	
vs (knot)	12.16	12.16	13.51	13.51	15.04	15.04	15.12	15.12	
PDM (kW)	10,600.83	10,707.92	15,047.27	14,962.37	18,226.35	18,213.62	21,260.82	21,411.34	
DeltaR (kN)	76.68	12.47	86.99	12.41	90.07	12.29	89.11	12.41	
DPM Load variation results:									
EtaD0	0.708	0.708	0.775	0.775	0.748	0.748	0.744	0.744	
Xip	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Xiv	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Xin	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Nm (rpm)	58.90	59.40	66.00	66.30	70.30	70.60	73.90	74.40	
PDC (kW)	9,923.32	10,597.78	14,267.69	14,851.12	17,295.29	18,086.59	20,329.76	21,281.66	
Nc (rpm)	58.90	59.40	66.00	66.30	70.30	70.60	73.90	74.40	
Iterative current correction results:									
vc' (knot)	-0.84	-0.52	0.18	0.83	0.07	-0.50	-0.99	-0.08	
Speed power curve coefficients	a	-93,726.95576	b	41,928.27001	p	3.0			

5. Application Results

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- **Purpose of application**
 - Validation of accuracy for ISO 2014
 - Comparison between 2002 version and 2014 version
- **Selection of container carriers**
 - More than 3 double runs for all sister ships
 - Including no correction ship carried out in very calm sea to consider correct answer
 - Using the normal options in speed trial analysis



- Some results doesn't converge to correct answer.
- Two method shows similar accuracy.
- There is possibility of arguments between builder and owner.

In view point of ship builders

- Why all results are different?
- The correction method is perfect to consider all added resistance?
- The speed performance depends on environmental condition and luck?
- Is it the best to wait until to meet very calm sea conditions on the sea?
- How explain the difference of speed performances between the sister ships to owners?
- How reduce the speed loss of non-compensation?

Exact Speed Trial
Analysis Method



No Worry

Fair Assessment

6. Conclusions

- i – STAP in developing based on ISO 15016(2014) is introduced. The program was developed user friendly using GUI.
- All reports are automatically produced when i-STAP is used.
- The revised ISO method was validated it's accuracy and compared with old ISO method. The accuracy of two methods is similar.
- But there is possibility of arguments for speed performance after sea trial between builder and owner because of inaccuracy of speed trial analysis method.
- For precise estimation of EEDI and EEOI, more improvements are necessary for correction method.

Thank you!

