

EEDI/IACS

- Overall Presentation
- EEDI Verification for Tank Test and Sea Trial
Ryuji Miyake
Class NK
- Verification of Tank Tests for EEDI
Dr. Fabian Kock
DNV GL

Energy Efficiency Design Index

$$\frac{\left(\prod_{j=1}^n f_j \right) \left(\sum_{i=1}^{n_{ME}} P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)} \right) + (P_{AE} \cdot C_{FAE} \cdot SFC_{FAE}^*) + \left(\prod_{j=1}^n f_j \cdot \sum_{i=1}^{n_{PTI}} P_{PTI(i)} - \sum_{i=1}^{n_{off}} f_{off(i)} \cdot P_{AEoff(i)} \right) C_{FAE} \cdot SFC_{FAE}}{f_i \cdot f_c \cdot f_j \cdot Capacity \cdot f_w \cdot V_{ref}} - \left(\sum_{i=1}^{n_{off}} f_{off(i)} \cdot P_{off(i)} \cdot C_{FME} \cdot SFC_{ME}^{**} \right)$$

Relevant for Towing Tanks

$$\frac{\left(\sum_{i=1}^{n_{ME}} P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)} \right)}{f_i \cdot f_c \cdot f_j \cdot Capacity \cdot f_w \cdot V_{ref}} +$$

P is the power of the main and auxiliary engines, measured in kW. The subscripts _{ME} and _{AE} refer to the main and auxiliary engine(s), respectively.

C_F is a non-dimensional conversion factor between fuel consumption measured in g and CO₂ emission also measured in g based on carbon content.

SFC is the certified specific fuel consumption, measured in g/kWh, of the engines. The subscripts _{ME(i)} and _{AE(i)} refer to the main and auxiliary engine(s), respectively.

V_{ref} is the ship speed, measured in nautical miles per hour (knöt), on deep water in the condition corresponding to the Capacity as defined in paragraphs 2.3.1 and 2.3.3



Joint Industrial Working Group

MEPC 68/INF.30.

2015 industry guidelines on calculation and verification of the Energy Efficiency Design Index (EEDI)



Verification of EEDI

PART III – VERIFICATION OF EEDI

13	Verification process	16
14	Documents to be submitted	16
15	Preliminary verification at the design stage.....	18
16	Final verification at sea trial	22
17	Verification of the EEDI in case of major conversion.....	24
1	Appendix 1. Review and witness points.....	26
2	Appendix 2. Sample of document to be submitted to the verifier	28
3	Appendix 3. Verifying the calibration of model test equipment.....	42
4	Appendix 4. Review and witnessing of model test procedures	48
5	Appendix 5. Sample report "preliminary verification of EEDI"	56
6	Appendix 6. Sample calculations of EEDI.....	57



Sample of document to be submitted to verifier

2.2 Preliminary verification of attained EEDI

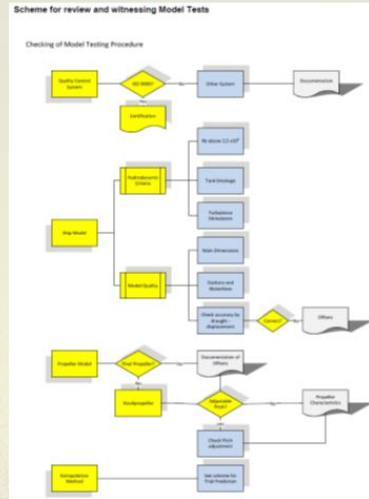
Parameter	Value	Reference
TOWING TANK TEST ORGANIZATION		
Identification of organization	TEST corp.	See section 6.
ISO Certification or previous experience?	Previous experience	
TOWING TANK TESTS		
Exemption of towing tank tests	No	
Process and methodology of estimation of the power curves		See section 7
Ship model information		See subparagraph 7.2.1
Propeller model information		See subparagraph 7.2.2
EEDI & sea trial loading conditions	EEDI: mean draft: 12.7 m Trim 0 Sea trial (ballast): mean draft: 5.8 m Trim 2.6 m by stern	

Sample of document to be submitted to verifier

Propeller open water diagram (model, ship)		See paragraph 7.4
Experience based parameters		See paragraph 7.3
Power curves at full scale		See section 3
Ship Reference speed	14.25 knots	
ELECTRIC POWER TABLE (as necessary, as defined in IMO EEDI Calculation Guidelines)	Significant difference from 2.5.6 of IMO EEDI Calculation Guidelines	See section 5
CALCULATION OF ATTAINED EEDI	5.06	See section 11
CALCULATION OF REQUIRED EEDI	5.27	See section 12
CALCULATION OF ATTAINED EEDI _{weather}	Not calculated	See section 13



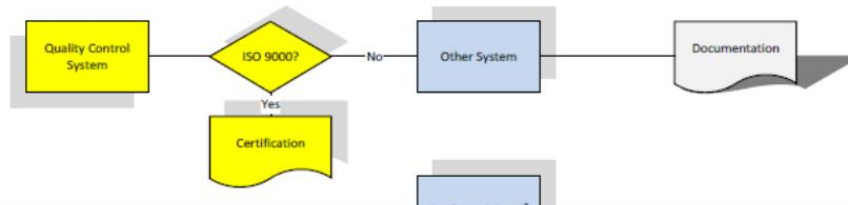
Scheme for review and witnessing Model Tanks



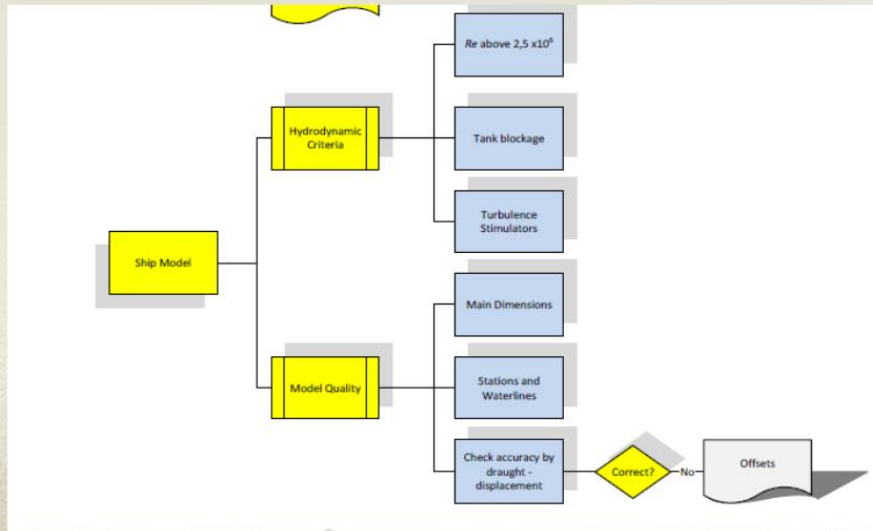
Scheme for review and witnessing Model Tanks

Scheme for review and witnessing Model Tests

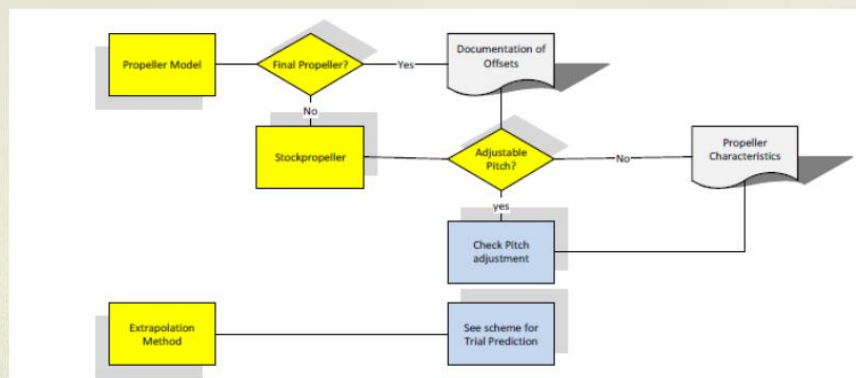
Checking of Model Testing Procedure



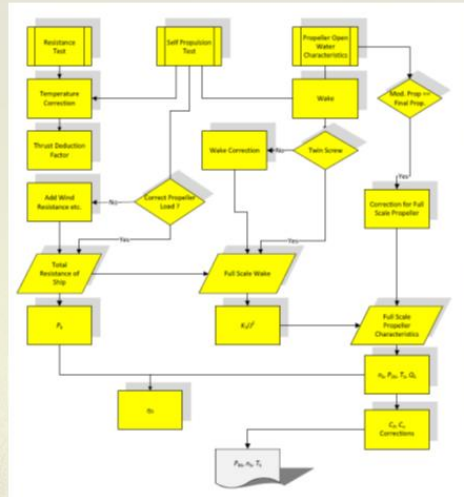
Scheme for review and witnessing Model Tanks



Scheme for review and witnessing Model Tanks



Scheme for Speed – Power Performance Prediction



Problems

- Some Classification Societies want to charge the model basins for acceptance testing for a certain period for EEDI. The intention is to not be present at the tests but rather to get the report only. This means that they want the model tanks to pay in order to enable these Classification Societies to save money and effort.
- As the Classification Societies do not accept each other's acceptance this could add up to high costs for the model tanks. The Classification Societies could save some effort if they would accept each other's reports.

Problems

- Some verifiers are not really qualified for the inspections.





ClassNK


Group discussion on EEDI/IACS
The 28th ITTC Full Conference
18th September 2017
Wuxi, China

EEDI Verification for tank test and sea trial







Ryuji Miyake
EEDI Department
Plan Approval Division
ClassNK

© Copyright by NIPPON KALJI KYOKAI

Process of EEDI Verification



$$EEDI (g / ton \cdot mile) = \frac{CO_2 \text{ Factor} \times SFC \times \text{Engine output}}{DWT \times \text{Ship speed}}$$

Promotion

↓

Contract

↓

Design

↓

Construction

↓

Sea trial

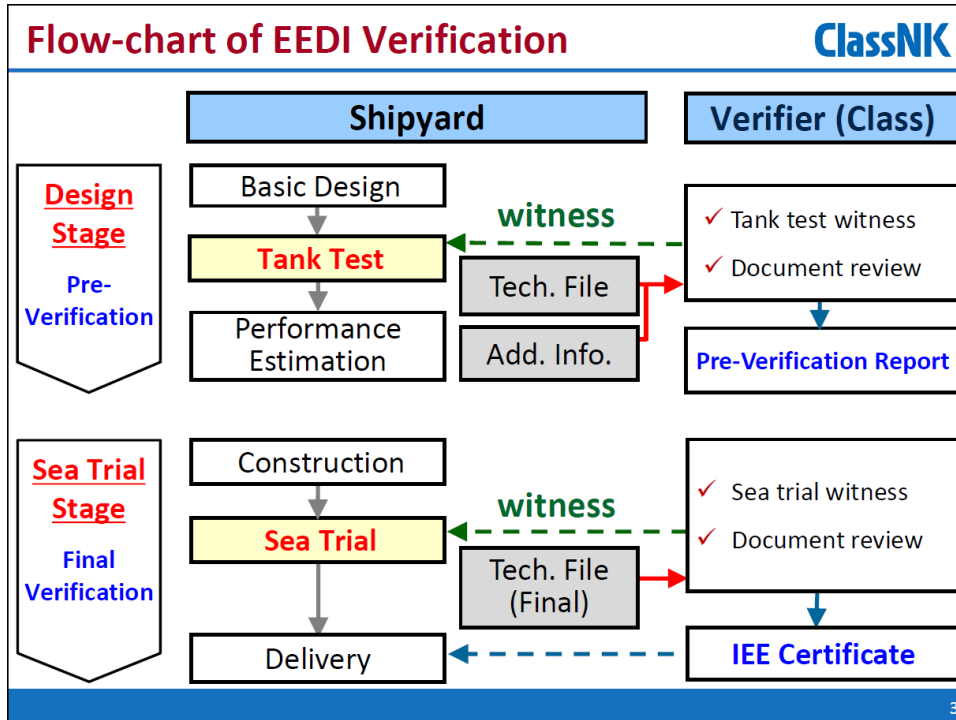
↓

Delivery

Preliminary verification
EEDI is calculated based on planned value at design stage.

Final verification
EEDI is finally determined based on measured values (Ship speed, DWT, SFC, etc.) after construction.

2



IMO Verification Guidelines of the EEDI ClassNK

MARPOL ANNEX VI

- Chapter 4 “Regulations on Energy Efficiency for ships”
 - EEDI (Energy Efficiency Design Index)
 - SEEMP (Ship Energy Efficiency Management Plan)
- Chapter 2 “Survey and Certification”

Chapter 2 Regulation 5.4

“Ships to which chapter 4 of this Annex applies shall also be subject to the surveys specified below, taking into account the guidelines adopted by the Organization”

 - Guidelines adopted by IMO:
 - 2014 Guidelines on survey and certification of the Energy Efficiency Design Index (hereafter referred to as “**IMO Verification Guidelines**”) (MEPC.1/Circ.855/Rev.1)

4

Guidelines etc. relating to EEDI Verification **ClassNK**

- IACS (International Association of Classification Societies) has formed a **“Joint Working Group on EEDI”** with other industries such as shipowners, shipbuilders, research institutes and ITTC etc. since 2011.
- The “Joint Working Group on EEDI” developed **“Industry Guidelines”** in order to provide details and examples for calculating attained EEDI as well as support the verifier in charge of conducting the survey and certification of EEDI in compliance with the relevant IMO Guidelines.
- IACS has adopted the Industry Guidelines as **“Procedural Requirements No.38”**. Thus, the Industry Guidelines are to be used as common procedures to be followed by all IACS members.
- In the EEDI calculation and verification, it is required to follow the procedures in the Industry Guidelines along with the relevant IMO Guidelines. In other words, **verification of the EEDI is performed in accordance with the Industry Guidelines as well as the IMO Verification Guidelines.**
- Both of the Guidelines refer to quality manuals and technical standards published by ISO and ITTC in order to compensate for the lack of the Guidelines.

5

Difficulty of verifying Speed-Power curve **ClassNK**

4.2.6/IMO Verification Guidelines

“For the estimation of the ship speed at the design stage much depends on each shipbuilder's experience, and it may not be practicable for any person/organization other than the shipbuilder to fully examine the technical aspects of experience-based parameters, such as the roughness coefficient and wake scaling coefficient. Therefore, the preliminary verification should focus on the calculation process of the attained EEDI to ensure that it is technically sound and reasonable and follows regulation 20 of MARPOL Annex VI and the EEDI Calculation Guidelines.

Note 1: A possible way forward for more robust verification is to establish a standard methodology of deriving the ship speed from the outcome of tank tests, by setting standard values for experience-based correction factors such as roughness coefficient and wake scaling coefficient. In this way, ship-by-ship performance comparisons could be made more objectively by excluding the possibility of arbitrary setting of experience-based parameters. If such standardization is sought, this would have an implication on how the ship speed adjustment based on sea trial results should be conducted, in accordance with paragraph 4.3.8 of these guidelines.

Note 2: A joint industry standard to support the method and role of the verifier is expected to be developed.”

Since the predicted Speed-Power curve much depends on the shipyard's experience, the verification of the EEDI focuses on the calculation process of the Speed-Power curve.

⇒ For the moment, the IMO Verification Guidelines don't require a unified procedure for predicting the Speed-Power curve in the verification.

6

Practice of shipyard regarding tank test process **ClassNK**

15.6 "Review and Witness"/Industry Guidelines

"Since detailed process of the towing tank tests depends on the practice of each submitter, sufficient information is to be included in the document submitted to the verifier to show that the principal scheme of the towing tank test process meets the requirements of the reference documents listed in Appendix 1 and Appendix 4."

The industry Guidelines accept the practice of shipyard regarding the tank test process, if the shipyard shows suitable technical justifications to the verifier.



It is not necessary for the tank tests to fully comply with the standards (ITTC Recommended Procedures) referred to in the Industry Guidelines.

7

EEDI Pre-verification at the design stage (1/4) **ClassNK**

2.3/IMO Verification Guidelines

- Tank test means;
 - Model towing tests
 - Model self-propulsion tests
 - Model propeller open water tests (POT)
- Numerical calculations are acceptable for;
 - Propeller open water characteristics (POC)
 - Complementary use of model tank tests for evaluation of the effect by hull features, etc. such as Energy Saving Device

Tank test may be omitted in the following cases.

- The results of tank test for sister ship are available.
- Required EEDI is not applicable. (i.e., only calculation is required)
- Sea trial is carried out under EEDI draught condition.
- Other cases based on suitable technical justifications

8



EEDI Pre-verification at the design stage (2/4) ClassNK

Witness and Review of the tank test for the pre-verification in accordance with the IMO Verification Guidelines and the Industry Guidelines

■ Confirmation items :

- Quality management system of tank test facility (ISO9001, ITTC quality system or equivalent)
- Hydrodynamic criteria of ship/propeller model (ITTC RP)
- Manufacturing accuracy of the ship/propeller model (ITTC RP)
- Calibration procedure of the measuring instruments (ITTC RP)
- Measurement accuracy (ITTC RP)
- Procedures of tank tests (ITTC RP or practice of the shipyard)
- Model-ship correlation (ITTC RP, Industry Guidelines or practice of the shipyard)
- Calculation process of Speed-Power curve (ITTC RP or practice of the shipyard)

9

EEDI Pre-verification at the design stage (3/4) ClassNK

4.2.5/IMO Verification Guidelines

“To ensure the quality of tank tests, the ITTC quality system should be taken into account. Model tank tests should be witnessed by the verifier.

Note: It would be desirable in the future that an organization conducting a tank test be authorized.”

For the moment, IMO has not authorized an organization to conduct the tank tests for the EEDI without witness of the verifier.



As a first step to approve the organization, it is necessary to discuss this issue in IMO. After that, IMO needs to develop and adopt Guidelines for approval of the organization.

⇒ It is much more likely that unified procedures for predicting the Speed-Power curve as well as the tank tests are strictly required in accordance with the IMO Guidelines.

10

EEDI Pre-verification at the design stage (4/4) **ClassNK**

15.6 “Review and Witness”/Industry Guidelines

“Prior to the start of the towing tank tests, the submitter is to submit a test plan to the verifier. The verifier reviews the test plan and agrees with the submitter which scheduled inspections will be performed with the verifier surveyor in attendance in order to perform the verifications listed in Appendix 1 concerning the towing tank tests.”

The Industry Guidelines don’t require the verifier surveyor to attend all of the tank tests for the EEDI as a practical treatment.



In accordance with the Industry Guidelines, ClassNK arranges a schedule for the witness with the shipyard based on the submitted test plan. After that, ClassNK normally attends **only the key tests, unless the shipyard desires us to attend all of the tests.**

11

EEDI Final verification at the sea trial **ClassNK**

ClassNK

Witness and Review of the sea trial for the final verification in accordance with the IMO Verification Guidelines and the Industry Guidelines

■ Confirmation items :

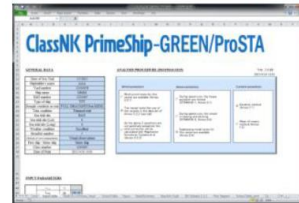
- Propulsion & power supply system, particulars of the engines and other items described in the EEDI Technical File
- Draught and trim (ISO15016 or ITTC RP)
- Ship speed, shaft power & RPM of Main Engine (ISO15016 or ITTC RP)
- Sea conditions (ISO15016 or ITTC RP)
- Speed correction to the effects of wind, wave, etc. (ISO15016 or ITTC RP)
- Ship reference speed V_{ref} corresponding to 75% MCR under EEDI loading condition (ISO15016 or ITTC RP)

12

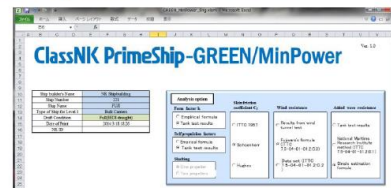


Technical services on EEDI provided by ClassNK **ClassNK**

- In order to support shipbuilders for the EEDI verification, ClassNK has provided “**PrimeShip-GREEN/ProSTA**” which can correct ship speed at sea trial based on the “ISO15016:2015” since 2015, as part of technical services on the EEDI.



- ClassNK has also provided “**PrimeShip-GREEN/MinPower**” which can easily assess the minimum propulsion power since 2014.



13

PrimeShip-GREEN/ProSTA

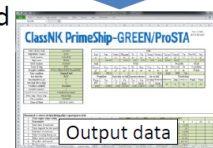
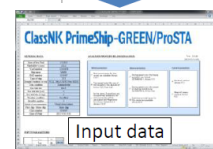
ClassNK

Software for **Progressive Speed Trial Analysis**

A software used for the speed correction for wind, current, wave, shallow water, displacement, water temperature and density at progressive speed trial in compliance with ISO 15016:2015

Key Features

- Speed-Power performance analysis of progressive speed trial in compliance with ISO 15016:2015
- Stand-alone software based on Microsoft Excel 2010
- Transparent and easy-to-understand output
- User-friendly interface
- Auto-generation of output results and figures for class approval
- Free to use



14

PrimeShip-GREEN/MinPower

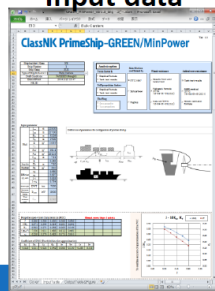
ClassNK

A software for assessment of minimum propulsion power in accordance with "Interim minimum propulsion power Guidelines"

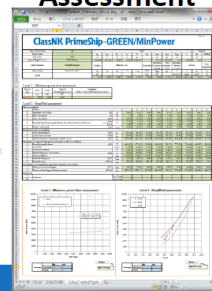
Key Features

- This software based on Microsoft Excel 2010
- User-friendly interface and easy to use
- Easy to assess the minimum propulsion power
- Easy to estimate the added resistance in waves used for the assessment using simple formula with the principal particulars
- Free to use

Input data



Assessment



15

ClassNK

THANK YOU

for your kind attention



16



MARITIME

VERIFICATION OF TANK TESTS FOR EEDI
ITTC MEETING WUXI 2017**Dr. Fabian Kock**
18 September 2017**TANK TEST FOR EEDI – MANDATORY SCOPE**

MODEL TEST HAVE TO BE WITNESSED BY THE VERIFIER (MEPC.254(67) 4.2.5)

- TESTS THAT HAVE TO BE WITNESSED (MEPC.254(67) 2.3)
 1. PROPELLER OPEN WATER TESTS
 2. RESISTANCE TEST
 3. SELF PROPULSION TEST

- DOCUMENTS THAT HAVE TO BE REVIEWED (MEPC.254(67) 4.)
 1. MODEL TANK TEST REPORT INCLUDING
 - DOCUMENTATION OF TESTS
 - PERFORMANCE PREDICTION
 - METHODS FOR PERFORMANCE PREDICTION



TANK TEST FOR EEDI – MANDATORY SCOPE

SURVEYOR

- TESTS THAT HAVE TO BE WITNESSED (MEPC.254(67) 2.3)
 1. PROPELLER OPEN WATER TESTS
 2. RESISTANCE TEST
 3. SELF PROPULSION TEST



APPROVAL ENGINEER

- DOCUMENTS THAT HAVE TO BE REVIEWED (MEPC.254(67) 4.2.7):
 1. MODEL TANK TEST REPORT INCLUDING
 - DOCUMENTATION OF TESTS
 - PERFORMANCE PREDICTION
 - METHODS FOR PERFORMANCE PREDICTION



TASKS OF SURVEYOR

- IS A QM SYSTEM IMPLEMENTED + PROPERLY IMPLEMENTED?
- ARE THE MODELS MANUFACTURED CORRECTLY?
- ARE THE TESTS CONDUCTED ACCORDING TO ITTC STANDARDS?
- ARE THE APPLIED SENSORS WORKING AND CALIBRATED?
- ARE THE RESULTS OF THE TESTS REASONABLE / HOW DOES THE INSTITUTE VERIFIES THAT?
- DOES THE INSTITUTE TAKE THE REQUIRED MEASURES TO ENSURE THAT THE MODEL IS CORRECTLY ADJUSTED?



- RECORD RAW DATA

(TO CHEK LATER IF THESE DATA ARE USED FOR FURTHER EEDI PREDICTION)

- RECORD DETAILS OF THE APPLIED MODELS

(TO CHECK IF THE FINAL SHIP IS WELL REPRESENTED BY THE MODEL)



TASKS OF SURVEYOR

GENERAL QM ISSUES

- IS A QM SYSTEM IMPLEMENTED + PROPERLY IMPLEMENTED?
- ARE THE MODELS MANUFACTURED CORRECTLY?
- ARE THE TESTS CONDUCTED ACCORDING TO ITTC STANDARDS?
- ARE THE APPLIED SENSORS WORKING AND CALIBRATED?
- ARE THE RESULTS OF THE TESTS REASONABLE / HOW DOES THE INSTITUTE VERIFIES THAT?
- DOES THE INSTITUTE TAKE THE REQUIRED MEASURES TO ENSURE THAT THE MODEL IS CORRECTLY ADJUSTED?

INDIVIDUAL TEST

- RECORD RAW DATA
(TO CHEK LATER IF THESE DATA ARE USED FOR FURTHER EEDI PREDICTION)
- RECORD DETAILS OF THE APPLIED MODELS
(TO CHECK IF THE FINAL SHIP IS WELL REPRESENTED BY THE MODEL)

TASKS OF THE APPROVAL ENGINEER

- IS THE SCOPE OF DOCUMENTATION SUFFICIENT?
 - PHOTOS
 - MODEL DETAILS
 - TEST CONDITIONS
 - DOCUMENTATION OF THE METHOD OF EXTRAPOLATION
- IS THE EXTRAPOLATION DONE ACCORDING TO ITTC STANDARDS?
- ARE DEVIATIONS TO THIS STANDARD TECHNICALLY PLAUSIBLE/SUFFICIENTLY REASONED?

- ARE THE RESULTS UNDERLYING THE REPORT FROM THE TEST THAT HAVE BEEN WITNESSED?



TASKS OF THE APPROVAL ENGINEER

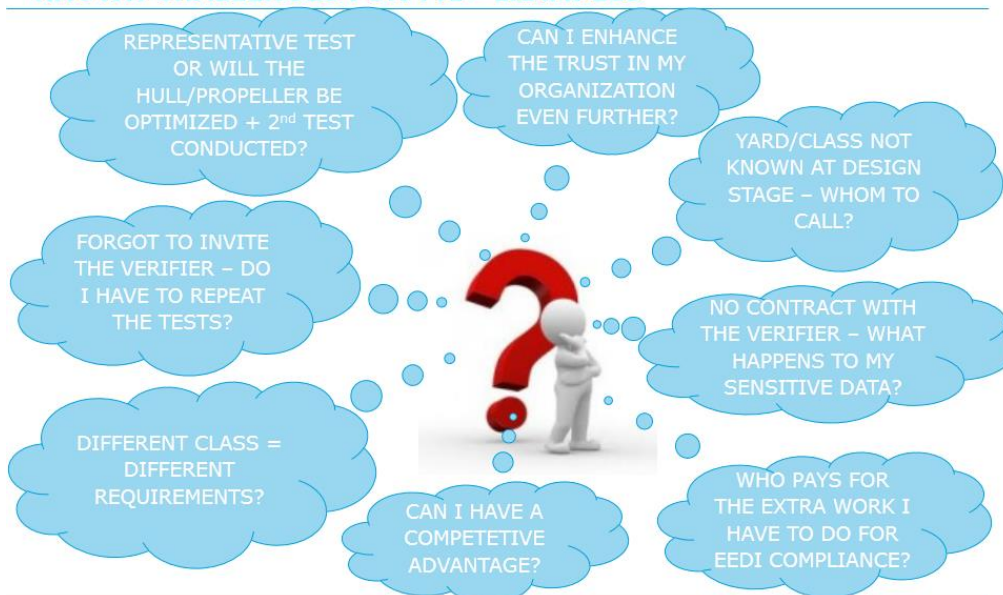
GENERAL QM ISSUES

- IS THE SCOPE OF DOCUMENTATION SUFFICIENT?
 - PHOTOS
 - MODEL DETAILS
 - TEST CONDITIONS
 - DOCUMENTATION OF THE METHOD OF EXTRAPOLATION
- IS THE EXTRAPOLATION DONE ACCORDING TO ITTC STANDARDS?
- ARE DEVIATIONS TO THIS STANDARD TECHNICALLY PLAUSIBLE/SUFFICIENTLY REASONED?

INDIVIDUAL TEST

- ARE THE RAW DATA FROM THE TEST THAT HAS BEEN WITNESSED?

KNOWN CHALLENGES FOR TTI - EXAMPLES





POTENTIAL SOLUTION – STEP 1: TTI IN THE LEAD

- CLEAR ALLOCATION OF COSTS ✓
- COST FOR EEDI VERIFICATION CAN BE CONSIDERED
- CLEAR CONTRACTUAL CONSTELLATION WITH CLASS
- COMPETITIVE ADVANTAGE WHEN HAVING A MORE EFFICIENT PROCESS

YARD/CLASS NOT KNOWN AT DESIGN STAGE – WHOM TO CALL?

NO CONTRACT WITH THE VERIFIER – WHAT HAPPENS TO MY SENSITIVE DATA?

WHO PAYS FOR THE EXTRA WORK I HAVE TO DO FOR EEDI COMPLIANCE?

CAN I HAVE A COMPETITIVE ADVANTAGE?

- YARD NEEDS TO ACCEPT "ADDITIONAL" COSTS ✗

POTENTIAL SOLUTION – STEP 2: CERTIFICATION OF TTI

REPRESENTATIVE TEST OR WILL THE HULL/PROPELLER BE OPTIMIZED + 2nd TEST CONDUCTED?

FORGOTT TO INVITE THE VERIFIER – DO I HAVE TO REPEAT THE TESTS?

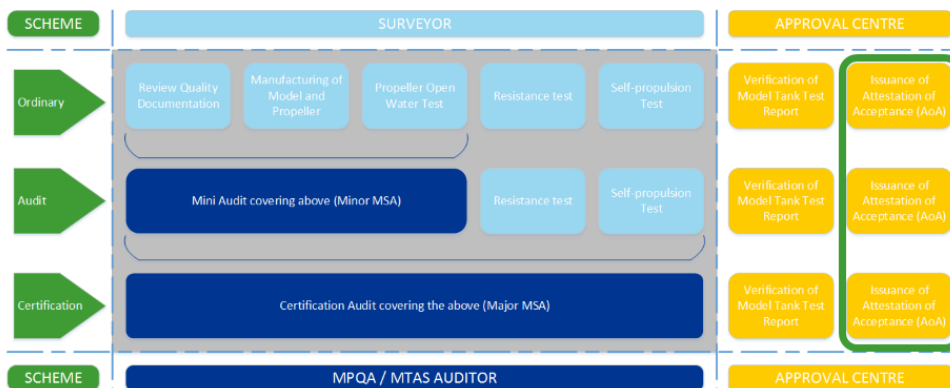
DIFFERENT CLASS = DIFFERENT REQUIREMENTS?

- MORE DEDICATED + CHEAPER THAN ISO 9001 ✓
- ENHANCED TRUST
- FULL FLEXIBILITY IN CONDUCTION OF TESTS
- CLEAR COOPERATION WITH SELECTED CLASS
- MINIMUM COSTS FOR INDIVIDUAL TESTS

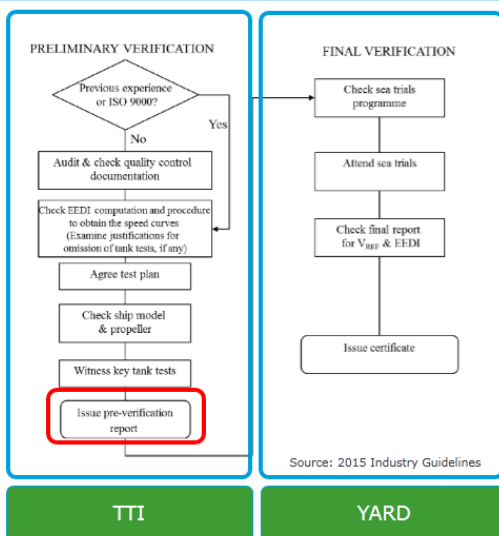
- COSTS FOR CERTIFICATION? ✗
- DOCUMENTATION

CAN I ENHANCE THE TRUST IN MY ORGANIZATION EVEN FURTHER?

DNVGL APPROACH – FULL FLEXIBILITY



DNVGL APPROACH – LEGAL FRAMEWORK



MEPC.254(67) 4.2.5:

Note: It would be desirable in the future that an organization conducting a tank test be authorized.



KEY BENEFIT TTI IN LEAD + CERTIFICATION

- MORE FLEXIBILITY
- SINGLE POINT OF CONTACT
- TRUST
- COST EFFICIENCY



ACCEPTED:

- Panama
- Germany
- USA
- Belize
- Barbados
- Bahamas
- St. Kitts and Nevis

PENDING:

- Liberia
- Hong Kong

谢谢!

Dr. Fabian Kock
Head of Section Safety&Systems, Shanghai

Fabian.kock@dnvgl.com

+86 13916578652

www.dnvgl.com

SAFER, SMARTER, GREENER

EEDI contractual situation

