CONTENTS

Trial Conditions

1. PURPOSE

The purpose of this procedure is to establish guidelines for the definition of acceptable limits for trial conditions needed to validate hydrodynamic design and/or satisfy contractual requirements.

2. SCOPE

This procedure applies to the documentation of trial conditions (environmental and ship) in which the full-scale Speed/Power trial are performed.

3. RESPONSIBILITIES

- The Trial Director is the duly authorized shipbuilder's representative responsible for the execution of all phases of the Speed/Power trials. When unforeseen problems, such as weather or technical difficulties require that the trial schedule or trial logistics be modified, the Trial Director shall make the final decision, subject to the concurrence of the ship's master and the owner's representative.
- The shipbuilder is responsible for the overall trial coordination between the ship's crew, trial personnel, and the owner representative. A pre-trial meeting between the trial team, owner and the ship's crew will be held to discuss the various trial events and to resolve any outstanding issues.
- The trial team is responsible for the following:
  a. Operate and maintain all required trial instrumentation and temporary cabling.
  b. Collect and record seawater temperature and specific gravity during trial, daily.

4. DEFINITIONS

None

5. PROCEDURE

1. Speed/Power trials require accurate position data and therefore will ideally be conducted at an instrumented tracking range located in a sheltered body of water. Lacking availability of an instrumented tracking range, the use of DGPS provides great latitude in choosing a trial site. Regardless of the instrumentation utilized for obtaining positional data, the operational area should be free from substantial small boat traffic.
2. If an instrumented tracking range is utilized, the ship's master will receive a formal briefing on tracking range procedures by the Trial Director prior to the conduct of the trials. During the briefing, specific trial runs will be reviewed. The trial team will provide an on-shore observer to monitor data collection by the tracking range facility. If DGPS is utilized, the Trial Director will brief the ship's master on specific trial runs and procedures.
3. Ship characteristics and environmental factors are carefully monitored and documented throughout the trials (see Table 1). Accurate quantification of these conditions is necessary because a ship's speed and powering characteristics are extremely sensitive to conditions such as ship and propeller condition, ship displacement, shallow water effects, sea state and wind velocity.

4. Speed/Power Trials are normally scheduled within 30 days of undocking to minimize the adverse effects of hull and propulsor fouling and provide a more "standard" condition for testing. In situations where the ship has become fouled after undocking, a hull cleaning, propeller polishing and hull and propeller roughness survey should be performed within 30 days of the Speed/Power trial date. Guidance may be found in Hull and Propulsor Survey Procedure 7.5-04-01-01.3. At a minimum, the ship's latest docking report and diver inspection should be provided to fulfill this requirement. Guidance may be found in Speed/Power Trial Ship Inspection Procedure 7.5-04-01-01.2.
5. Draft, trim and displacement of the trials must be obtained by averaging the ship draft mark readings. The ship should be brought into a condition that is as close as possible to the contract condition and/or the condition by which model tests have been carried out. This will allow for the correction of the displacement and trim with respect to the trials that were conducted and will be applicable to the suggestions outlined in the 23rd ITTC Speed and Powering Trials Specialist Committee final report.
   a. Draft, trim and displacement must be obtained at the beginning and at the end of the trial. This may be accomplished using a loading computer or by taking a second draft reading. The accuracy of the ship's draft marks and the method used to calculate draft and displacement underway will be compared in port by direct draft readings both port and starboard in conjunction with a liquid load calculation. The trial team will verify and document the results prior to the Speed/Power trials.
   b. Displacement must be derived from the hydrostatic curves by utilizing the draft data and the density of the water. When dealing with Froude numbers higher than 0.5 (e.g. a Fast Ferry with 100 m length and speed over 30 kn) intermediate ship loading conditions must be documented. This is better accomplished through tank soundings.
6. Environmental factors can significantly influence the data obtained during sea trials. Consequently, these factors must be monitored and documented to the greatest extent possible.
   a. High wind and sea states can force the use of excessive rudder to maintain heading, and thus cause excessive fluctuations in shaft torque, shaft speed and ship speed.
   b. Sea states of 3 or less and a true wind speed below Beaufort 6 (20 kn) are the desired conditions for sea trials. When working under the time constraints of a contract, corrections to the trials data can be made in accordance with the recommendations provided in the 23rd ITTC Speed and Powering Trials Specialist Committee final report for sea states less than or equal to 5. For sea states greater than 5, corrections to the trials data can be applied but are not considered reliable from a scientific standpoint.
   c. The local seawater temperature and specific gravity at the trial site are recorded to enable the calculation of ship's displacement.
   d. Air temperature and atmospheric pressure should be measured at the trial location using a calibrated thermometer and barometer.
   e. An acceptable minimum water depth for the trials where the data do not need to be cor-

rected for shallow water can be calculated using:

$h > 6.0(A_m)^{0.5}$ and $h > 0.5\ V^2$ (1)

Use the larger of the 2 values obtained from the two equations.

Other accepted formulae are:

1. SNAME 1973/21st ITTC Powering Performance Committee

   $d \geq 10TV/(L)^{0.5}$ (2)

   d = water depth, ft
   T = ´trial draft, ft
   V = speed, kn
   L = length between perpendiculars, ft

2. SNAME 1989 from Det Norske Veritas
   Nautical Safety- Additional Classes NAUT-A, NAUT-B AND NAUT-C, July 1986

   $h > 5.0(A_m)^{0.5}$ and $h > 0.4\ V^2$ (3)

   Use the larger of the 2 values obtained from the two equations.

   h = water depth, m
   A_m = midship section area, m^2
   V = ship speed, m/s

   or

   $h > 5\ (T)$ (4)

   T = Mean draft, m

3. 22nd ITTC Trials & Monitoring Specialist Committee/12th ITTC based on ship section and Froude Number.

   $h > 3.0(BT)^{0.5}$ and $h > 2.75\ V^2/g$ (5)

   Use the larger of the 2 values obtained from the two equations.

   h = depth in appropriate length units
   B = beam in appropriate length units
   T = draft in appropriate length units
   V = speed in system of units consistent with the above dimension
   g = acceleration due to gravity in units consistent with the above dimension

4. ISO/FDIS 15016:(E) based on Lackenby's Formula

$$\frac{\Delta V}{V} = 0.1242\left(\frac{A_m}{h^2} - 0.05\right) + 1 - \left(\tanh\left(\frac{gh}{V^2}\right)\right)^{0.5}$$

   for $h \leq (A_m/0.05)^{0.5}$ (6)
   $\frac{\Delta V}{V} \leq 0.02$

   h = water depth, m
   A_m = midship section area under water, m^2
   V = ship speed, m/s
   ΔV = speed loss due to shallow water effect, m/s
   g = acceleration due to gravity, m/s^2

f. Current speed and direction should be determined in the test area by prognostic analysis. When current speed is suspected to be varying and direction is unknown, the ship's global drift (also including wind effect) should be determined by a 360° turning test conducted at low ahead speed to magnify any environmental effect. Test runs should be conducted against and with global drift. It should be noted that this method of determining the direction of the trial runs is extremely important in the case of small ships whose performance is strongly effected by environmental conditions. For large ships, such as ULCCs, performance is not impacted as greatly by environmental conditions. If time is a critical factor, then the runs can be conducted into and against the waves; i.e., head and following seas, respectively. To ensure that tests are performed in comparable conditions, the data between reciprocal runs should be reviewed for consistency and/or anomalies. Individual speed runs conducted in the same conditions should be averaged with their reciprocal runs to take into account global drift.

6. REFERENCES

1. SNAME 1973/21st ITTC Powering Performance Committee Final Report
2. 22nd ITTC Trials & Monitoring Specialist Committee Final Report
3. Ships and marine technology – Guidelines for the assessment of speed and power performance analysis of speed trial data, Final Draft International Standard ISO/FDIS 15016: (E), ISO/TC 8/SC 9/WG 2 of 2001
4. 23rd ITTC Speed and Powering Trials Specialist Committee Final Report
5. Speed/Power Trial Ship Inspection Procedure 7.5-04-01-01.2
6. Hull and Propulsor Survey Procedure 7.5-04-01-01.3

7. RECORDS

1. Ship conditions – displacement, draft, propulsor and hull roughness
2. Environmental conditions – water depth, water temperature, wind direction and speed, sea state, specific gravity, air temperature, atmospheric pressure, current speed and direction

8. ATTACHMENTS

1. Table 1. Documented Ship and Trial Conditions Reported

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Description
Ship Hull Draft Trim Displacement and Load
Hull Condition Roughness of shell and bottom paint Height of welding beads Waviness of hull Size, number and position of zinc anodes Size, number and position of openings of sea water inlets and outlets Paint system
Hull Appendages and Rudder Geometry, deviations, roughness Type Rate of movement
Propeller(s) Geometry, deviations, roughness Pitch Direction of rotation Number of blades
Propeller Shaft(s) Geometry Material
Trial Site Water depth Water temperature Air temperature Sea State Specific gravity of water
Environmental Conditions Wind Waves Current Atmospheric pressure