INTERNATIONAL STANDARD

ISO 19030-3

First edition
2016-11-15

Ships and marine technology — Measurement of changes in hull and propeller performance —

Part 3: Alternative methods

Navires et technologie maritime — Mesurage de la variation de performance de la coque et de l'hélice —

Partie 3: Méthodes alternatives

Reference number
ISO 19030-3:2016(E)

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 8, *Ships and marine technology*, Subcommittee SC 2, *Marine environment protection*.

A list of part of the ISO 19030 series can be found on the ISO website.

Introduction

Hull and propeller performance refers to the relationship between the condition of a ship's underwater hull and propeller and the power required to move the ship through water at a given speed. Measurements of changes in ship specific hull and propeller performance over time make it possible to indicate the impact of hull and propeller maintenance, repair and retrofit activities on the overall energy efficiency of the ship in question.

The aim of this document is to prescribe practical methods for measuring changes in ship specific hull and propeller performance and to define a set of relevant performance indicators for hull and propeller maintenance, repair, retrofit activities. The methods are not intended for comparing the performance of ships of different types and sizes (including sister ships) nor to be used in a regulatory framework.

This document consists of three parts.

— ISO 19030-1 outlines general principles for how to measure changes in hull and propeller performance and defines a set of performance indicators for hull and propeller maintenance, repair and retrofit activities.

— ISO 19030-2 defines the default method for measuring changes in hull and propeller performance and for calculating the performance indicators. It also provides guidance on the expected accuracy of each performance indicator.

— ISO 19030-3 outlines alternatives to the default method. Some will result in lower overall accuracy but increase applicability of the standard. Others may result in same or higher overall accuracy but includes elements which are not yet broadly used in commercial shipping.

The general principles outlined, and methods defined, in this document are based on measurement equipment, information, procedures and methodologies which are generally available and internationally recognized.

Ships and marine technology — Measurement of changes in hull and propeller performance —

Part 3: Alternative methods

1 Scope

This document outlines alternatives to the default method. Some will result in lower overall accuracy but increase applicability of the standard. Others can result in same or higher overall accuracy but includes elements which are not yet broadly used in commercial shipping.

The general principles outlined and performance indicators defined are applicable to all ship types driven by conventional fixed pitch propellers, where the objective is to compare the hull and propeller performance of the same ship to itself over time.

This document presents alternatives to measurement parameters (primary and then secondary) in Clause 4, then alternatives to measurement procedures (including alternative reference and evaluation periods) in Clause 5, describes the calculation of performance indicators in Clause 6, and finally the estimation of performance indicator accuracy in Clause 7. The structure used duplicates the structure of ISO 19030-2 to facilitate cross-reference between the two documents.

NOTE Support for additional configurations (e.g. variable pitch propellers) will, if justified, be included in later revisions of this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3046-1, *Reciprocating internal combustion engines — Performance — Part 1: Declarations of power, fuel and lubricating oil consumptions, and test methods — Additional requirements for engines for general use*

ISO 19030-1:2016, *Ships and marine technology — Measurement of changes in hull and propeller performance — Part 1: General principles*

ISO 19030-2:2016, *Ships and marine technology — Measurement of changes in hull and propeller performance — Part 2: Default method*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 19030-1 and ISO 19030-2 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

4 Measurement parameters and alternatives

4.1 General

This clause explores alternatives to the primary and secondary measurement parameters defined for the default method in ISO 19030-2. Whether using ISO 19030-2 or ISO 19030-3 (method alternatives), in all instances, any instruments, automated equipment and sensors used shall be installed, maintained and calibrated in accordance with the specification in ISO 19030-2:2016, 4.3.

4.2 Proxy for the primary measurement parameters

4.2.1 General

Hull and propeller performance as defined in ISO 19030-1:2016, 4.1 gives measurements of ship speed through water and of power delivered to the propeller as the two primary measurement parameters. ISO 19030-2:2016, Clause 4, defines minimum sensor requirements for these two parameters.

If the primary measurement parameters cannot be measured or the minimum sensor requirements cannot be met, proxies can be used to approximate the parameters. As compared with the default method, this will generally result in reduced accuracy. Table 1 summarises relevant proxies. 4.2 and 4.3 describe the proxies and estimate impact on accuracy. Speed data should be measured in m/s or converted from knots to m/s using the conversion factor 1 knot = 0,514 4 m/s.

Table 1 — Sensor proxies for the primary measurement parameters

Parameter	Proxy	Measurement approach	Unit
Speed through water	Speed Over Ground (SOG)	Calculate SOG from GPS/navigation system	(m/s)
Delivered power	Alternative methods for estimating of delivered power (other than ISO 19030-2:2016, Annex B and Annex C)	Alternatives to ISO 19030-2:2016, Annex B and Annex C approach	(kW)

4.2.2 Proxy for speed through water measurement (speed over ground measurement)

4.2.2.1 General

It is possible to approximate a ship's speed through water using speed over ground measurements. Speed over ground measurements are typically directly available as, or can be calculated based on information from, the GPS or navigation system. Using speed over ground as a proxy introduces an uncertainty due to the influence of currents. This uncertainty will affect all ships, but to varying extents depending on the area of operation and the ship's frequency of encountering current speeds with a similar magnitude to the ship's speed through the water (e.g. current speed greater than 10 % of the ship's speed through the water). The impact of the uncertainty associated with the use of this proxy is estimated and discussed in ISO 19030-1:2016, Annex A.

$$V_d = 100 \cdot \frac{v_m - v_e}{v_e} \quad (1)$$

where

V_d is the percentage speed loss;

v_m is the measured speed through water;

v_e is the expected speed through water.

When used as a proxy, speed over ground is a direct substitution for the measured speed (V_m) through water (in m/s) as defined in ISO 19030-2:2016, 5.4.7.2 and Formula (3) and in Formula (1).

4.2.2.2 Procedure for calculating the average speed over ground

The vessel's speed over ground is a key quantity for measuring the changes in hull and propeller performance. This data should be as accurate and precise as is practical.

When automatic recording systems for the vessel's speed over ground are not available, alternative methods to measure, calculate, and record the speed over ground are required.

When manual readings are required, the interval between measurements should be maintained as much as is practical.

When a calculation of distance travelled per period of time is used, it is important to consider how the distance travelled is measured and the method used shall be clearly documented. To ensure minimum uncertainty of the performance value, speed and draught shall be kept approximately constant over the period of time used to determine speed.

A clear procedure shall be documented to ensure that measurements and calculations are consistently performed.

4.2.3 Proxy for delivered power (Alternative methods for estimating delivered power other than ISO 19030-2:2016, Annex B and Annex C)

4.2.3.1 General

As one of the default methods for estimating delivered power, ISO 19030-2:2016, Annex B describes an approach for estimating delivered power from fuel consumption data, using mass or volumetric flow meters. This alternative considers situations where mass or volumetric flow meter data is not available.

This alternative method assumes a conventional propulsion system of a two-stroke main engine directly coupled to a propeller (no gearbox), and without a shaft generator (power take-off). The fuel consumption shall be measured for the main engine alone and shall not include consumption by auxiliaries, boilers or returns.

The average delivered power over each sample's period is calculated using Formula (2), which is the same as ISO 19030-2:2016, Formula (C.1):

$$P_B = f\left(M_{FOC} \times \frac{LCV}{42,7}\right) \quad (2)$$

where

M_{FOC} is the mass of consumed fuel oil by main engine (kg/h);

LCV is the lower calorific value of fuel oil (MJ/kg);

f is the SFOC reference curve.

In addition to the uncertainty inherent in any sensors, use of this proxy can introduce considerable additional uncertainty. This is mainly due to the influence of changes in fuel quality, the accuracy of the fuel mass measurement (see the section below for greater detail), and the influence of changes in SFOC over time on account of engine degradation, all of which it is difficult to control for. The impact of the uncertainty associated with the use of this proxy is estimated and discussed in ISO 19030-1:2016, Annex A.

4.2.3.2 Obtaining the mass of fuel consumed (M_{FOC}) and estimating the uncertainty in the quantification of mass of fuel consumed

When automated systems are not available to automatically measure fuel consumed, alternative methods can be considered. The choice of method will depend on the available equipment installed on the vessel.

When manual readings are required, either by physical sounding of tanks or by taking manual meter readings, the interval between measurements shall be maintained as much as is practical, with a frequency no less than daily, and with the effect of any time zone changes accounted for when calculating average parameters.

Any meters used for taking measurements shall be properly maintained, and their accuracy ensured with periodic testing and calibration.

When manually sounding tanks, it is important to consider the trim and list of the vessel. A consistent, documented process for taking accurate physical soundings of the tanks shall be used.

For both volumetric flow meters and sounding measurements, corrections shall be applied for temperature and density. This shall follow the correction procedure specified in ISO 19030-2:2016, Annex C.

Sources of uncertainty associated with obtaining measurements of the mass of fuel consumed by tank soundings and flow meters, respectively, include the following:

— measurement errors due to ship motions, trim and/or list, errors due to manual recording or calculation of total fuel consumed, errors due to the timings at which different tanks are sounded, errors due to the inclusion of waste (sludge) in measured fuel consumption, uncertainty in the dimensions of the tank and errors in the temperature and density measurement and correction calculation;

— measurement uncertainty of the flow meter and errors in the temperature and density measurement and correction calculation;

— error propagation due to calculating fuel consumption from differences of inflow and outflow of fuel.

4.2.3.3 Estimating the SFOC

If available, the SFOC curve used shall be based on actual shop tests of the specific engine in question covering all relevant engine output ranges and shall be corrected for environmental factors as per ISO 3046-1, and for a normal fuel of 42 700 kJ/kg.

If actual shop tests of the specific engine in question covering all relevant engine output ranges are not available, then the SFOC characteristic for a given engine type shall be obtained from the engine manufacturer.

4.3 Secondary measurement parameters and alternatives

4.3.1 General

For the isolation of comparable reference conditions and for the filtering and normalization procedures, both environmental factors and the ship's operational profile shall be measured. To this effect, ISO 19030-2:2016, 4.3 defines a number of secondary measurement parameters and minimum sensor requirements for each of these parameters.

If these parameters cannot be measured or the minimum sensor requirements cannot be met, proxies can be used to isolate comparable reference conditions and to enable filtering and normalization procedures.

In some cases, instead of adopting a proxy, one may have to modify the reference condition criterion (defined in ISO 19030-2:2016, 6.3.2) or modify the analysis procedure; any such modification shall be fully and transparently documented and justified.

Table 2 — Sensor proxies for normalization procedures and reference condition criterion

	Alternative measurement
Wind speed	Anemometer with lower accuracy than as specified in ISO 19030-2
Draught (fore and aft)	Observed directly or derived from observed draught (fore and aft) in port
Water depth	Calculated from electronic nautical charts and the ship track from (D)GPS
Rudder angle	None

4.3.2 Alternative measurement of wind speed

If measurements of the relative wind speed according to the sensor accuracy requirement specified in ISO 19030-2 are not available, lower accuracy sensors may be used instead. In all other respects, the procedure specified in ISO 19030-2 shall be followed.

When manual readings are required, the interval between measurements shall be maintained as much as is practical, with a frequency no less than daily and with the effect of any time zone changes accounted for. These recordings shall reflect representative wind conditions for the period in question.

4.3.3 Alternative measurement of static draught (fore and aft)

The vessel's draught at sea can be recorded from the loading computer. Input shall reflect the vessel's condition at the beginning of sea passage, or may be derived from observed draught and trim in port. When manual recording methods are used, the interval between measurements shall be maintained as much as is practical. If there is a significant change in displacement, then draught values shall be updated to reflect actual loading conditions.

Draught marks, when used, can be hard to read due to poor lighting, fading coatings, hull fouling, and conditions other than calm. A clear procedure shall be documented to ensure that personnel take accurate readings.

The impact of the uncertainty associated with the use of this proxy is estimated and discussed in ISO 19030-1:2016, Annex A.

4.3.4 Alternative measurement of water depth

In the event that automated logging of the water depth is not available, whenever the ship is operating in water depths less than 100 m, this data shall be obtained from electronic nautical charts and recorded alongside other secondary data.

5 Measurement procedures and alternatives

5.1 General

This clause discusses how measurement data is to be acquired, stored and prepared.

5.2 Data acquisition

ISO 19030-2:2016, 5.2, specifies that the following data shall be recorded simultaneously at a frequency of 1 signal every 15 s (0,07 Hz) or above and collected by a data acquisition system (e.g. a data logger). If

