INTERNATIONAL STANDARD

ISO 20083-2

First edition
2019-06

Ships and marine technology — Determination of the shaft power of ship propulsion systems by measuring the shaft distorsion —

Part 2:
Optical reflection method

Reference number
ISO 20083-2:2019(E)

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Foreword

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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).

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For an explanation of the voluntary nature of standards, 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 2, *Marine environment protection*.

A list of all parts in the ISO 20083 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Selecting the optimum rating of a ship's main engine is important for ship owners, because it greatly affects the expenses of operations, maintenance and management as well as the ship's construction cost.

Measuring the output of the ship's main engine is important for confirming the ship efficiency, as well as for assessing the possible deterioration of the propulsion equipment or the accumulation of fouling on the hull over time. There are many methods of measuring an engine's output: (1) measuring the distortion of the shaft, (2) determining the fuel consumption, and (3) observing engine indicators such as cylinder pressure gauges.

Among these methods, ISO 20083 addresses the shaft distortion measurement with a shaft power meter, a method commonly used as the principal measurement of engine power output.

The purposes of shaft power measurement are:

— to provide a measurement of the ship's main engine output,

— to provide information regarding the ship's most efficient speed,

— to select optimum engine operational characteristics,

— to estimate maintenance and repair costs, and

— to monitor heavy propeller running.

Ships and marine technology — Determination of the shaft power of ship propulsion systems by measuring the shaft distorsion —

Part 2: **Optical reflection method**

1 Scope

This document specifies a procedure to determine the shaft power of engine ships, by measuring the shaft distortion using an optical reflection type device. It gives the principles of the measurement, the components of the device and the calculation method. It also describes the factors for determining the measuring accuracy, including the calibration procedure, and specifies the on-board documentation for the device.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

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

3.1
shaft
propeller shaft or intermediate shaft that transmits the engine power to the propeller, and on which the shaft power meter is installed

3.2
shaft torque
Q
turning moment transmitted to the shaft that is generated by the engine to rotate the propeller

Note 1 to entry: It is expressed in newton meters.

3.3
shaft power
P_S
power transmitted to the shaft that is generated by the engine to rotate the propeller

Note 1 to entry: It is expressed in kilowatts.

4 Principles of the measurement

The shaft power meter is a device that measures the shaft revolution and the torsional deformation of the shaft caused by the shaft torque. The shaft power, P_s [kW], is calculated using Formula (1):

$$P_s = \frac{2 \cdot \pi \cdot N \cdot Q}{60} \times \frac{1}{1\,000} \quad (1)$$

where

N is the rate of shaft revolutions per minute [min^{-1}];

Q is the shaft torque [Nm].

The shaft torque, Q [Nm], is calculated from the torsional deformation angle rate at unit length of the shaft using Formula (2):

$$Q = \frac{G \cdot I_p \cdot \theta'}{1\,000} \quad (2)$$

where

G is the G-modulus [N/mm^2];

I_p is the polar moment of inertia [mm^4];

θ' is the shaft torsional deformation angle rate at unit length [1/mm].

The polar moment of inertia, I_p [mm^4], is calculated using Formula (3):

$$I_p = \frac{\pi}{32}\left(D_o{}^4 - D_i{}^4\right) \quad (3)$$

where

D_o is the outer diameter of the shaft [mm];

D_i is the inner diameter of the hollow shaft [mm].

The shaft torsional deformation angle rate at unit length, Θ' [1/mm], is calculated using Formula (4):

$$\theta' = \frac{\theta}{l} \quad (4)$$

where

θ is the shaft torsional deformation angle [rad] as shown in Figure 1;

l is the length between the shaft rings [mm].

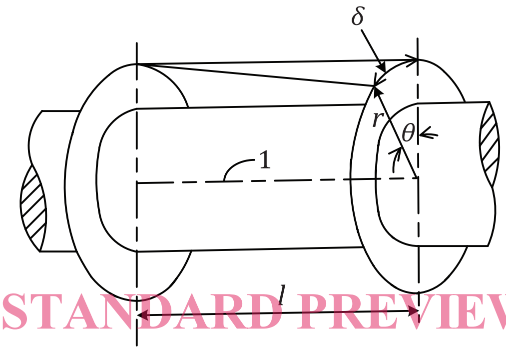
The torsional deformation angle, θ [rad], can be calculated from the displacement of the detecting point measured by the torsion meter as given in Formula (5):

$$\theta = \frac{\delta}{r} \tag{5}$$

where

δ is the displacement of the detecting point [mm];

r is the distance of the detecting point from the shaft center line [mm].



Key

1 center line of the shaft

θ shaft torsional deformation angle [rad]

l length between rings [mm]

δ displacement of the detecting point [mm]

r distance of the detecting point from the shaft center line [mm]

Figure 1 — Torsional deformation angle of a shaft

The optical reflection type device measures the displacement by torsional deformation of the shaft (δ) using a light source, a reflecting mirror, and a charge coupled device (CCD) sensor as shown in Figure 2. The image of the light source, which is made by the concave mirror, moves twice as the real displacement of the mirror (δ). The image of the light source is then magnified about 5 to 10 times by the magnifying lens set before the CCD sensor. As a result, the total magnifying rate of the displacement at the CCD sensor is around 10 to 20 times.

The total magnifying rate and the calibration factor, which relates the real displacement value and CCD's count number, are determined by the calibration process as shown in Clause 7.

