INTERNATIONAL STANDARD

Shipbuilding — Ship screw propellers — Manufacturing tolerances —

Part 1:
Propellers of diameter greater than 2,50 m

Construction navale — Hélices de navires — Tolérances de fabrication —

Partie 1: Hélice de diamètre supérieur à 2,50 m

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Foreword

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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 WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 8, *Ships and marine technology*, Subcommittee SC 3, *Piping and machinery.*

This second edition cancels and replaces the first edition (ISO 484-1:1981), which has been technically revised.

ISO 484 consists of the following parts, under the general title *Shipbuilding — Ship screw propellers — Manufacturing tolerances*:

— *Part 1: Propellers of diameter greater than 2,50 m*

— *Part 2: Propellers of diameter between 0,80 m and 2,50 m inclusive*

Introduction

The propeller manufacturer is at liberty to use any equipment and method that enables the tolerances to be verified to the required accuracy.

Shipbuilding — Ship screw propellers — Manufacturing tolerances —

Part 1:
Propellers of diameter greater than 2,50 m

1 Scope

This part of ISO 484 defines manufacturing tolerances of ship screw propellers of a diameter greater than 2,50 m.

NOTE   Some deviations for the tolerance are permitted in certain cases subject to the discretion of the customer or of the designer and the customer.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1302, *Geometrical Product Specifications (GPS) — Indication of surface texture in technical product documentation*

3 Field of application

This part of ISO 484 applies to monobloc, built-up, and controllable pitch propellers.

4 Methods for measuring pitch

4.1 The principle of one method of measurement consists in setting out along a helicoidal line of radius, r, a certain length, PQ, corresponding to the desired angle, α, and in measuring the difference, h, in the heights of the points P and Q with respect to a reference plane (see Figure 1).

The length PQ shall be set out using one of the methods described in 4.1.1, 4.1.2, or 4.1.3.

NOTE   Other methods giving the required accuracy may be used if necessary.

4.1.1   Use of marking gauges

The length PQ shall be set out by means of marking gauges.

4.1.2   Method with a graduated ring

The length PQ shall be set out by means of angle, α, on a part of a graduated ring of suitable radius (see Figure 1).

4.1.3   Method using coordinate measuring machine

The height coordinates are taken at defined measuring points by means of coordinate measuring machine, and they are related to each other (determination of height differences needed for pitch

evaluation). Both cartesian coordinate system (x, y, z) and polar coordinate system (α, r, h) can be applied alternatively in order to define measuring points P and Q.

5 Methods for measuring the thickness of the section

5.1 The thickness of a cylindrical section at a point S shall be measured along direction SV (see Figure 2) on the plane tangent to the coaxial cylinder and perpendicular to the pitch line of the pressure side of the section (and only along direction SU perpendicular to the pressure side surface or direction S parallel to the propeller axis when defined in this way on the drawings).
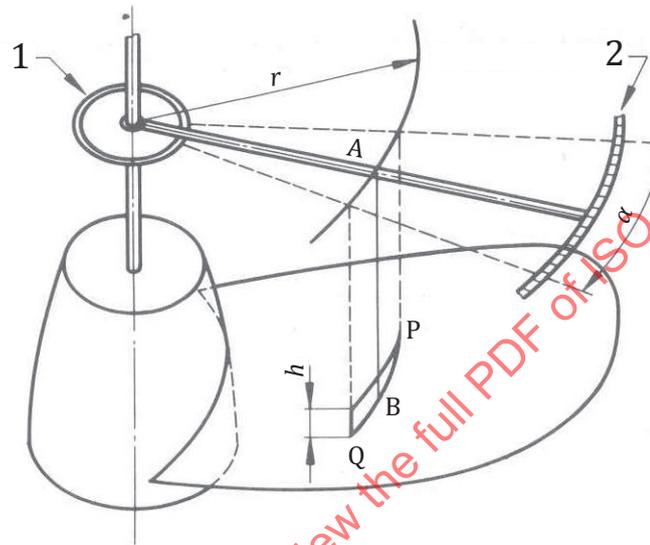
Key

1   small graduated ring
2   large graduated ring

Figure 1 — Pitch measurement
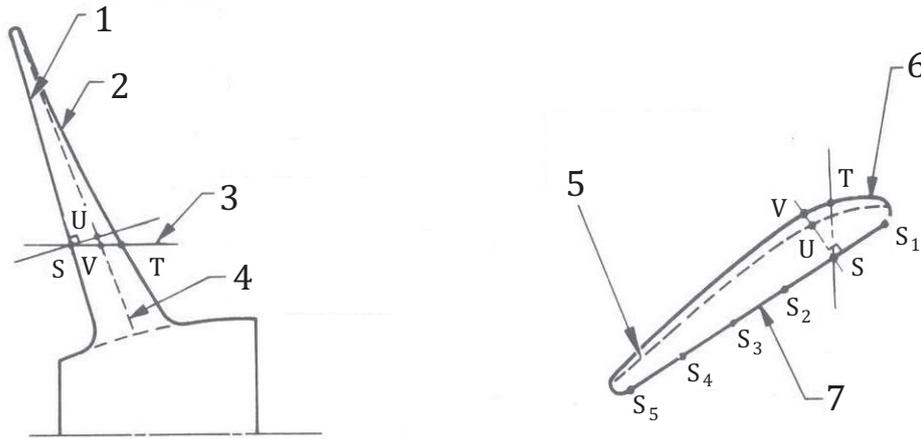
Key

1 pressure side
2 suction side
3 cylindrical section
4 line of maximum thickness of section perpendicular to the pressure side
5 developed section perpendicular to the pressure side
6 developed cylindrical section
7 pressure side

Figure 2 — Thickness measurement

5.2 The maximum thickness at each radius shall be determined by means of a pair of outside callipers or from the profile obtained by plotting the thickness at various points: S, S_1, S_2, S_3, etc.

6 Accuracy classes

The accuracy class shall be selected by the customer. The indications in Table 1 serve as guidance in this choice.

Table 1 — Accuracy of manufacturing

Class	Manufacturing accuracy
S	Very high accuracy
I	High accuracy
II	Medium accuracy
III	Wide tolerances

7 Tolerances on the pitch

Table 2 — Pitch tolerances

Designation of pitch	Class			
	S	I	II	III
a) Local pitch	±1,5 %	±2 %	±3 %	—
with a minimum of	±10 mm	±15 mm	±20 mm	
b) Mean pitch per radius of each blade	±1 %	±1,5 %	±2 %	±5 %
with a minimum of	±7,5 mm	±10 mm	±15 mm	±25 mm
c) Mean pitch per blade	±0,75 %	±1 %	±1,5 %	±4 %
d) Mean pitch for propeller	±0,5 %	±0,75 %	±1 %	±3 %
NOTE The tolerances of Table 2 are expressed as percentages of the design pitch corresponding to the radius for designations a) and b) and the mean design pitch for designations c) and d).				

7.1 Pitch shall be measured at least at the radii indicated in Table 3. By agreement between the interested parties, different radii may be measured.

Table 3 — Pitch measurement locations

Class	Radii
S and I	A section near the hub – 0,4 R – 0,5 R – 0,6 R – 0,7 R – 0,8 R – 0,9 R – 0,95 R
II	A section near the hub – 0,5 R – 0,6 R – 0,7 R – 0,8 R – 0,9 R
III	A section near the hub – 0,5 R – 0,7 R – 0,9 R

7.2 The measurement of local pitches for Class S and Class I is further controlled as described in Clause 10.

7.3 The tolerances on the local pitch and on the mean pitch of each radius of each blade given in Table 2, a) and b) are increased by 50 % for sections at 0,4 R or less.

7.4 Should the propeller manufacturer wish to compensate for an error on the pitch (inside or outside the tabulated tolerances) by means of an alteration in the propeller diameter, he may do so only with the customer's agreement.

7.5 The design pitch is the pitch of the reference line as defined below.

The design pitch line of a section is a helical reference for the section in question of which the section ordinates for the face and the back are given.

It could be a line joining the nose and tail of the section or any other conveniently placed helical line.

7.6 The local pitch at point B (Figure 1) is determined by measuring the difference in height between two points, P and Q, situated at equal distances from point B and on either side of the latter (BP = BQ) and by multiplying the difference in height by $\dfrac{360}{\alpha}$. This shall be compared with the local pitch as calculated from the face offsets for the same points.

The distance between any two points used for a local pitch measurement may range between 100 mm and 400 mm. One pitch measurement is to be near the leading edge, one near the trailing edge, and there shall be at least two other pitch measurements in between. As far as possible, the pitch measurements should be consecutive.

7.7 The pitch per radius and per blade is determined for each radius by multiplying the difference in height between the most distant measuring points at each radius by $\dfrac{360}{\alpha}$.

7.8 The average pitch per blade is defined as the arithmetic mean (average) of the measured pitches per radius for the blade in question.

7.9 The average pitch for the screw propeller is defined as the arithmetic mean of the average pitches per blade.

8 Tolerances on the extreme radius of the screw propeller

8.1 The tolerances in Table 4 are expressed as percentages of screw propeller radius.

Table 4 — Radius tolerance

Specification	Class			
	S	I	II	III
Tolerance	±0,2 %	±0,3 %	±0,4 %	±0,5 %

8.2 In the case of a ducted propeller, these tolerances may need to be reduced.

9 Tolerances on the thickness of the blade section

Table 5 — Blade thickness tolerance

Specification	Class			
	S	I	II	III
Plus tolerances	+2 %	+2,5 %	+4 %	+6 %
but not less than	2 mm	2,5 mm	4 mm	6 mm
Minus tolerances	−1 %	−1,5 %	−2 %	−4 %
but not less than	−1 mm	−1,5 mm	−2 mm	−4 mm

9.1 The thickness shall be measured at the same radii as those at which the pitch is measured.

9.2 The tolerances in Table 5 are expressed as percentages of the local thickness.

9.3 The maximum thicknesses indicated on the drawing shall not be less, after deduction of the minus tolerance, than the thicknesses required by the Classification Society concerned.

10 Checking and tolerances of the form of blade sections

10.1 These apply only to propellers of Class S and Class I and to the same radii as those at which the pitch is measured.

In case of CNC-machining of blade and edges, it can be agreed between the manufacturer and the user to abstain from any further checking of the form of blade sections.

10.2 To avoid undue deviation in overall camber, the algebraic sum of the percentage deviations resulting from any two consecutive measurements of local pitch shall not be in excess of 1,5 times the

allowable tolerance (for example, if the tolerance is ±2 %; the sum of consecutive deviations shall be within ±3 %, see Figure 3).

10.3 Alternatively, the satisfactory continuity of the cylindrical sections may be verified by the use of suitable flexible templates.

10.4 The leading and trailing edges shall be checked by templates, or equivalent devices, to demonstrate their accuracy to the drawing. These templates shall be calculated along a straight path or formed to the pitch and radius of the tested section. The length of these templates shall be about 20 % of the blade section length but not necessarily more than 300 mm.

**10.4.1** Single part templates shall fit within the following tolerances of the face and the back:

— Class S: ±0,5 mm;

— Class I: ±0,75 mm.

10.4.2 Alternatively, by agreement between the manufacturer and the user, the edges shall be checked by templates made in three parts for each edge (see Figure 4) a short nose template controlling the final edge detail and two fairing templates from the nose, one to the face and one to the back, each covering about 20 % of the blade length but not necessarily more than 300 mm. These templates shall fit with the following tolerance:

— Class S: 0,25 mm;

— Class I: 0,35 mm.

In case of large skew of the blades (skew angle more than 25°), LE templates (having a corresponding shape) may be attached perpendicular to the leading edge contour alternatively by agreement between the manufacturer and the user. This holds for the area from 0,7 R to the tip. The templates shall be attached at the cross points of blade outline and nominal test radii, and they shall overlap at least 2 test radii, at which pitch, thickness, etc. will be checked, but not necessarily more than 300 mm length.

The number of templates to be applied is the same as for the conventional procedure.
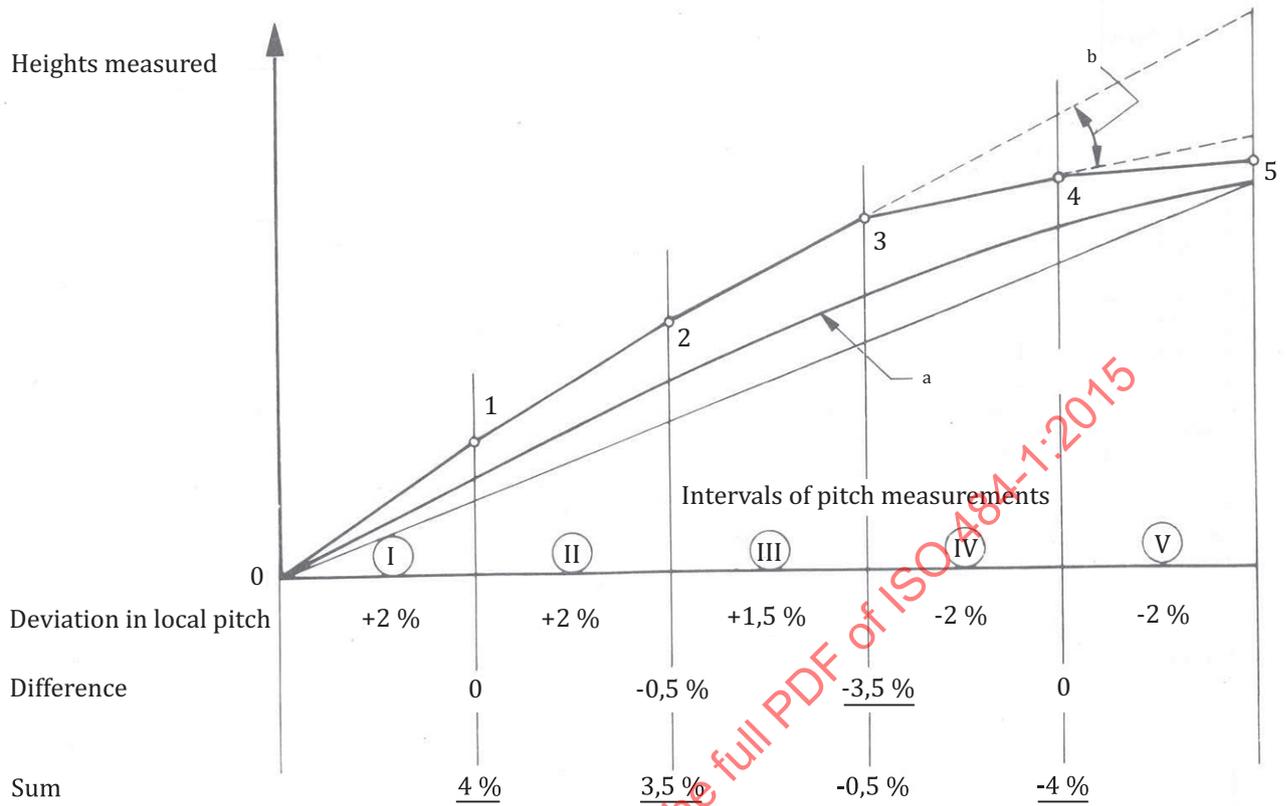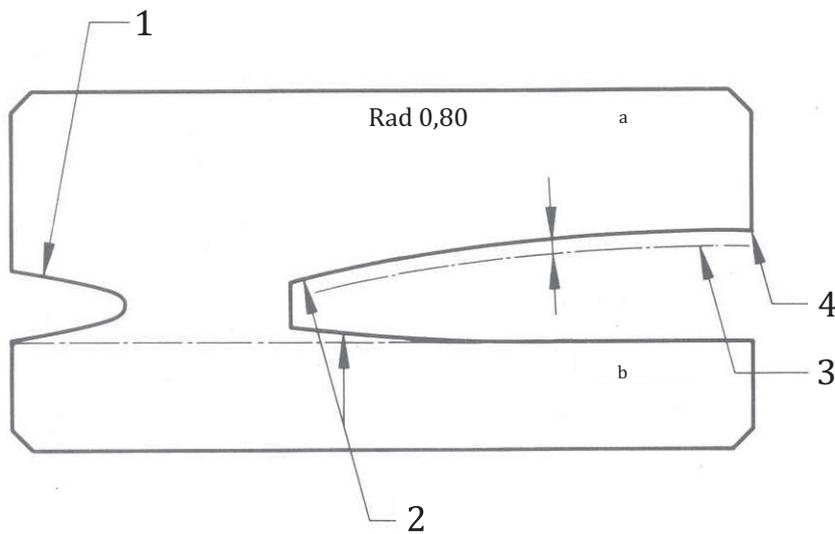
Key

a   Theoretical outline of blade section.

b   Pitch difference too high.

NOTE   On Figure 3, the deviations are multiplied by 20. The values which are too high are underlined.

Figure 3 — Measurement and verification of blade tolerances

Key

1 short nose template made to size + max tolerance

2 form templates for pressure and suction sides separated by 6 mm for independent application

3 theoretical suction side profile

4 contact surface for suction side

a Leading edge (+6 mm).

b Pressure side.

Figure 4 — Measurement using template

11 Tolerances on the length of the blade sections

Table 6 — Blade length tolerances

Specification	Class			
	S	I	II	III
Tolerance	±1,5 %	±2 %	±3 %	±5 %
But not less than	7 mm	10 mm	13 mm	15 mm

11.1 The tolerances in Table 6 are expressed as percentages of the values of the ratio: diameter by the number of blades (D/Z).

11.2 The lengths of the sections of each blade shall be measured at five radii at least (Example: $0,3\ R$ – $0,5\ R$ – $0,7\ R$ – $0,8\ R$ – $0,95\ R$).

12 Tolerances on the location of blades, reference lines, and blade contours

12.1 Marking of lines of reference

The reference line is positioned as a straight line on the drawing by location of the point M on the pressure side of the blade and point O on the axis of the propeller.

This point M shall be marked on a cylindrical section at a radius outside $0,5\ R$ and, if possible, near $0,7\ R$.

In principle, it is selected in such a way that the line OM cuts the largest possible number of blade sections.

The ratio between the angles φ_E (leading edge) and φ_S (trailing edge) is indicated on the drawings (see Figure 5).

Point M' on the manufactured propeller shall be determined in such a way that a ratio φ_E/φ_S as found on the drawings can be obtained at the considered radius (see Figure 6).
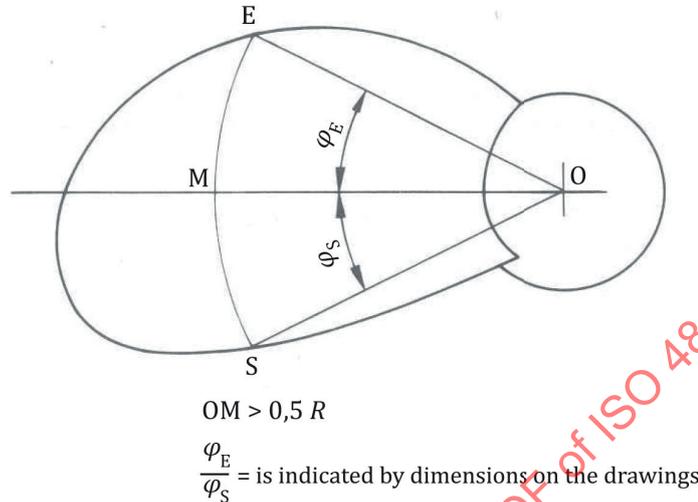

OM > 0,5 R

$\dfrac{\varphi_E}{\varphi_S}$ = is indicated by dimensions on the drawings

Figure 5 — Angles of blade leading and trailing edges

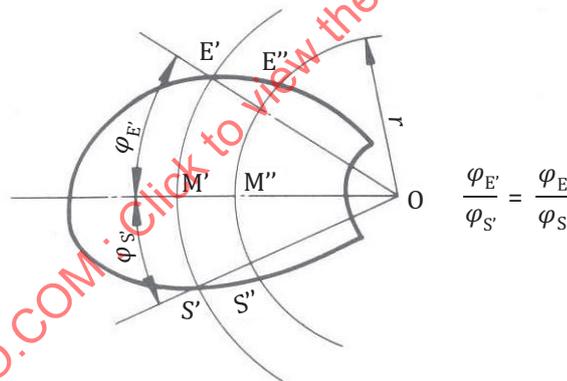$\dfrac{\varphi_{E'}}{\varphi_{S'}} = \dfrac{\varphi_E}{\varphi_S}$

Figure 6 — Lines of reference

The reference planes through points M' are used to check the shape of the leading edge and skew back, as well as the blade angular deviation.

NOTE   For skew back definition, see ISO 3715.

12.2 Tolerances on the contour of the leading edge

The tolerance shall be calculated on the radii according to Table 3 on the corresponding arcs and are valid for the arc lengths E''M'' (see Figure 6). They are given in percentages of D/Z in Table 6 (D = Diameter, Z = number of blades).

The tolerances for the distance E''M'' shall be double the values given in Table 6, provided that the contours of the blade edges are fair.

12.3 Tolerances on the angular deviation between two consecutive blades

The tolerances shall be given by the following:

— Class S and I: ±1°;

— Class II and III: ±2°.

13 Tolerances on rake, axial position, and relative axial position of consecutive blades

The rake is characterized by the position of the reference line PP' [see Figure 7, a)]. This is measured by the distance to a plane, W, perpendicular to the axis of rotation of the screw propeller at three points (at least). A, B, and C situated at 0,3 R or 0,4 R, 0,6 R or 0,7 R, 0,9 R or 0,95 R.

Alternatively, the centre line of blade sections shall be used as reference line PP' [see Figure 7, b)] for evaluation of rake in case of high-skewed propeller blades (skew angle >25°).

Table 7 gives the tolerances on these distances: d (A), d (B), and d (C) expressed as a percentage of the propeller diameter, D, to control the axial position of the blades. The same tolerances (and not double tolerances) are applicable to differences such as d (B) – d (C), for the same blade, to control the rake; and to differences such as d_1 (C) – d_2 (C), for two consecutive blades, to control the relative axial position.

Table 7 — Rake tolerances

Specification	Class			
	S	I	II	III
Deviation of plottings on each blade at points A, B, and C (situated at 0,3 R, 0,6 R, and 0,95 R) with respect to plane W perpendicular to the axis	±0,5 %	±1 %	±1,5 %	±3 %