International Standard 484/1

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

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

First edition — 1981-08-15

UDC 629.12.037.1 : 621.753.1 **Ref. No. ISO 484/1-1981 (E)**

Descriptors : shipbuilding, ship screw propellers, manufacturing, measurement, dimensions, tolerances, dimensional tolerances, form tolerances, classifications.

Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 484/1 was developed by Technical Committee ISO/TC 8, *Shipbuilding*, and was circulated to the member bodies in November 1979.

It has been approved by the member bodies of the following countries :

Australia	France	Korea, Rep. of
Austria	Germany, F.R.	Netherlands
Belgium	India	Norway
Brazil	Ireland	Romania
Chile	Italy	Spain
China	Japan	USSR
Czechoslovakia	Korea, Dem. Rep. of	

The member bodies of the following countries expressed disapproval of the document on technical grounds :

Poland
Sweden
United Kingdom

This International Standard cancels and replaces ISO Recommendation R 484-1966, of which it constitutes a technical revision.

Shipbuilding — Ship screw propellers — Manufacturing tolerances — Part 1 : Propellers of diameter greater than 2,50 m

0 Introduction

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

1 Scope

This International Standard defines manufacturing tolerances for ship screw propellers of a diameter greater than 2,50 m.

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

2 Field of application

This International Standard applies to monobloc, built-up and controllable pitch propellers.

3 References

ISO/R 468, *Surface roughness.*

ISO 484/2, *Shipbuilding — Ship screw propellers — Manufacturing tolerances — Part 2 : Propellers of diameters between* 0,80 m *and* 2,50 m *inclusive*.

ISO 3715, *Shipbuilding — Ship screw propellers — List of equivalent terms.*

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 by one of the methods described in 4.1.1 or 4.1.2[1].

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).

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 ST parallel to the propeller axis when defined in this way on the drawings).

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

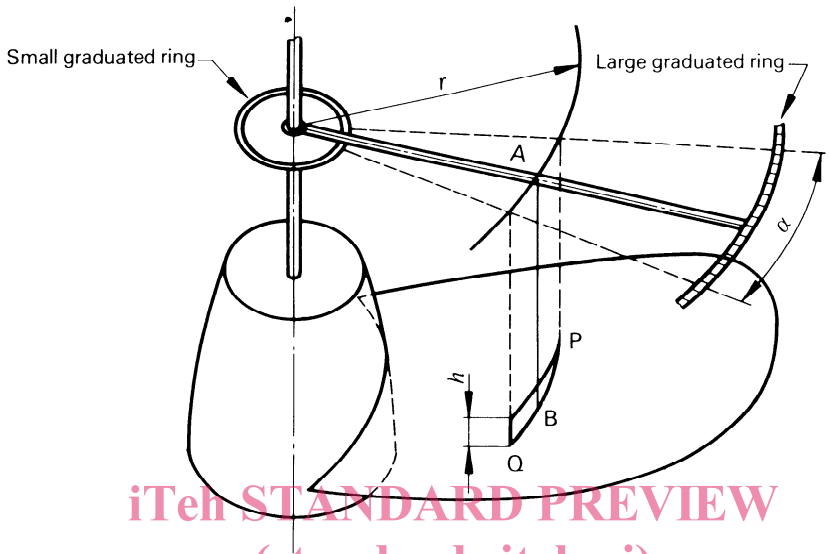


Figure 1

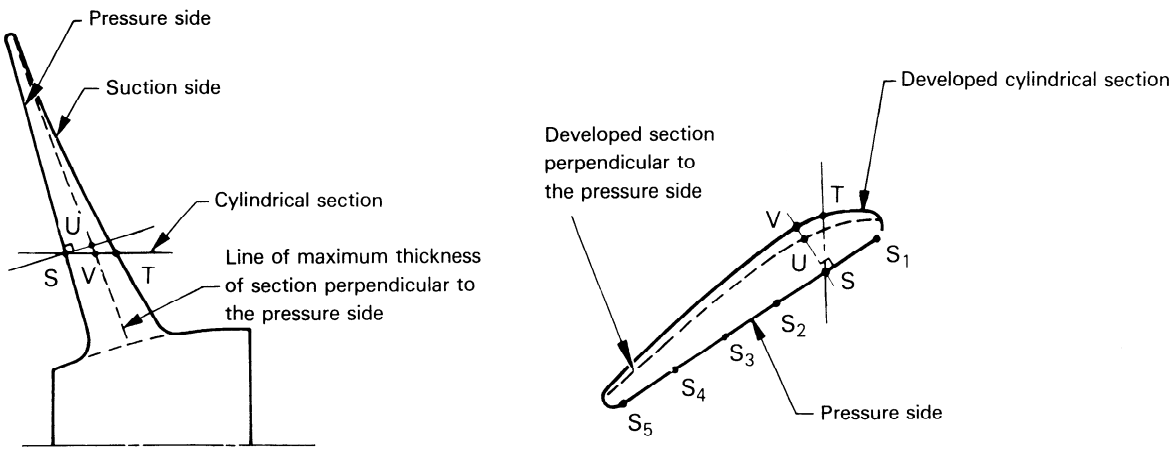


Figure 2

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

5.3 For checking the leading and trailing edges, use can be made of section templates. 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 at least 15 % of the length of the section with a minimum of 125 mm.

The leading and trailing edges shall be checked by templates for classes S and I (see table 1). For the other classes, checking may be required by special request at the time of ordering.

6 Accuracy classes

The accuracy class shall be selected by the customer; the indications in table 1 serve as guide in this choice.

Table 1

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

7 Tolerances on the pitch

Table 2

Designation of pitch	Class			
	S	I	II	III
a) Local pitch	± 1,5 %	± 2 %	± 3 %	—
b) Mean pitch of each radius of each blade	± 1 %	± 1,5 %	± 2 %	± 5 %
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 below. By agreement between the interested parties different radii may be measured.

Table 3

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 classes S and 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 line for the section in question from 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 but may be any other conveniently placed helical line.

7.6 The local pitch at a 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 $\frac{360}{\alpha}$. 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 extreme measuring points by $\frac{360}{\alpha}$.

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

7.9 The mean pitch for the screw propeller is defined as the arithmetic mean of the mean 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

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 be need to be reduced.

9 Tolerances on the thickness of the blade section

Table 5

Specification	Class			
	S	I	II	III
Plus tolerances With a minimum of	+ 2 % 2 mm	+ 2,5 % 2,5 mm	+ 4 % 4 mm	+ 6 % 6 mm
Minus tolerances With a minimum of	− 1 % − 1 mm	− 1,5 % − 1,5 mm	− 2 % − 2 mm	− 4 % − 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

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

To avoid discontinuity of form, the deviations resulting from consecutive measurements of local pitch and thickness shall not differ from each other by more than half the tolerance envelope (for example if the tolerance is + 2 % // − 2 %, the permitted difference of consecutive deviations is 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 lie between ± 3 %. See figure 3.)

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

The leading and trailing edges shall be checked by templates, or equivalent devices, to demonstrate their accuracy to the drawing to within the following tolerances of the face and the back :

— class S : ± 0,5 mm

— class I : ± 0,75 mm

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 a tolerance of 0,25 mm for class S and 0,35 mm for class I.

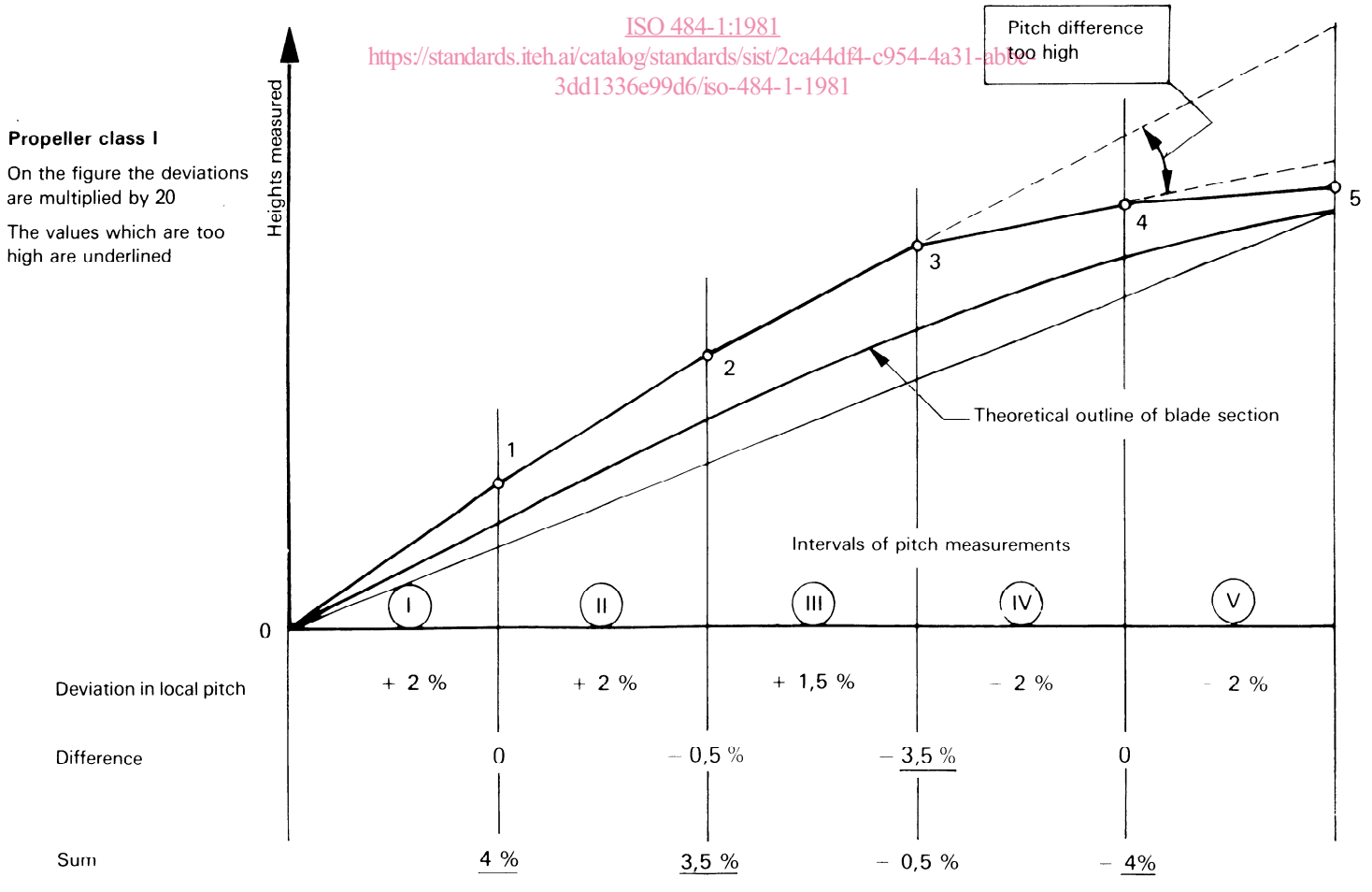


Figure 3

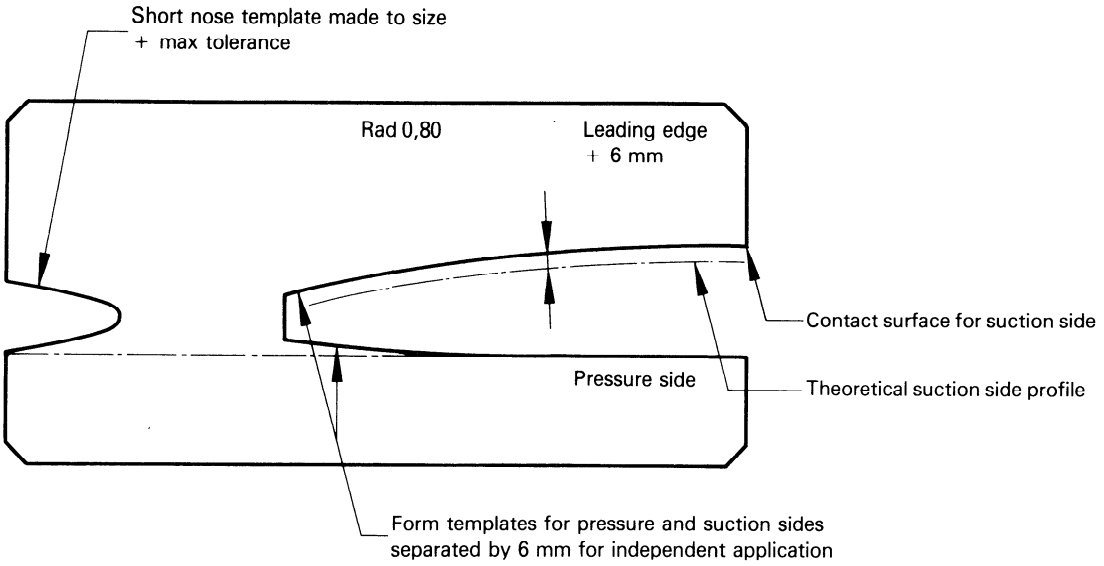


Figure 4

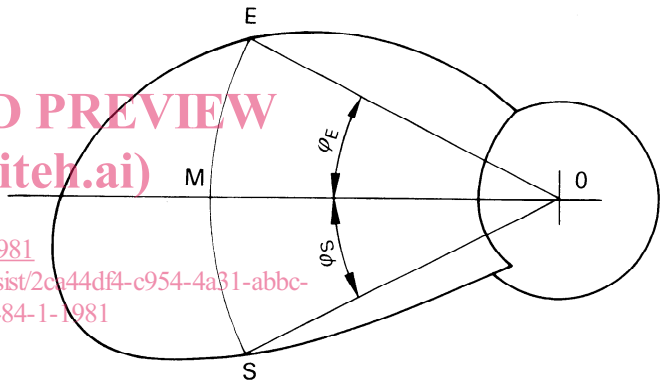
11 Tolerances on the length of the blade sections

Table 6

Specification	Class			
	S	I	II	III
Tolerance	± 1,5 %	± 2 %	± 3 %	± 5 %
With a minimum of	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 divided 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).



OM > 0,5 R

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

Figure 5

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

12.1 Marking of lines of reference

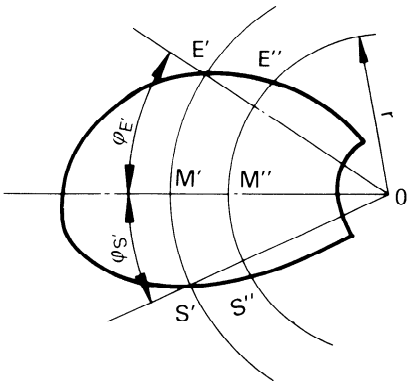
The reference line is positioned as a straight line on the drawing by location of the point M on the pressure side of the blade and a point O on the axis of the propeller.

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

It is in principle 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 $\varphi_{E'}/\varphi_{S'}$ equal to the ratio φ_E/φ_S as found on the drawings can be obtained at the considered radius (see figure 6).



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

Figure 6

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[1].

12.2 Tolerances on the contour of the leading edge

The tolerances 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 :

— for class S and I : ± 1°

— for class II and III : ± 2°

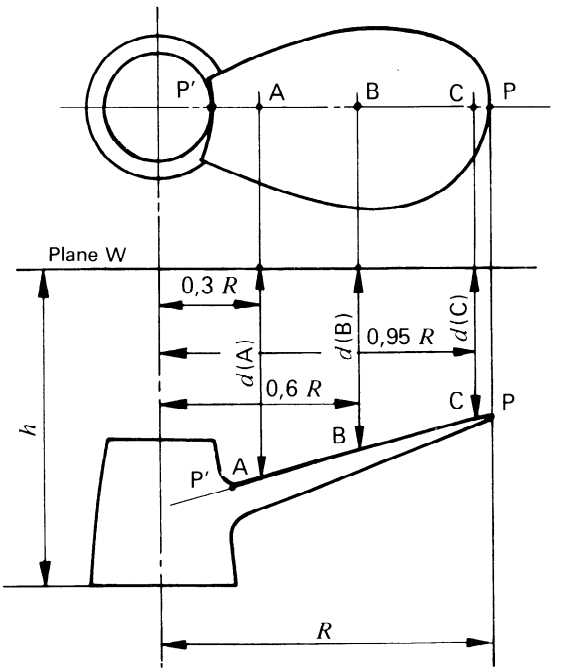


Figure 7

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). 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.

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

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 %

14 Surface finish

The surface texture of the blades, expressed as an arithmetic mean deviation, R_a, in micrometres, in accordance with ISO/R 468, shall have a roughness not greater than :

— 3 from the hub for propellers of class S;

— 6 from the radius 0,3 R for propellers of class I;

— 12 from the radius 0,4 R for propellers of class II;

— 25 from the radius 0,5 R for the propellers of class III.

15 Static balancing

15.1 When finished, all propellers shall be statically balanced.

The maximum permissible balancing mass p (in kilograms) at the tip of the propeller blade is defined by :

$$p = C\frac{m}{R\,n^2} \text{ or } Km, \text{ whichever is the smaller.}$$

where

m is the mass of propeller in kilograms;

1) For skew back definition see ISO 3715.

R is the radius of blade tip in metres;

n is the designed revolutions per minute of the propeller;

C and K are factors depending on class given in the following table :

Table 8

Class	S	I	II	III
C	15	25	40	75
K	0,0005	0,001	0,001	0,001

15.2 In the case of a controllable pitch or built-up propeller, the manufacturer shall satisfy the user that the assembled propeller will be in accordance with the requirements of this clause.

16 Measuring equipment

The maximum permissible inaccuracy of the measuring equipment shall not exceed half the tolerance on the dimension or quantity to be measured or, in the case of geometric measurements, 0,5 mm, whichever is the greater.