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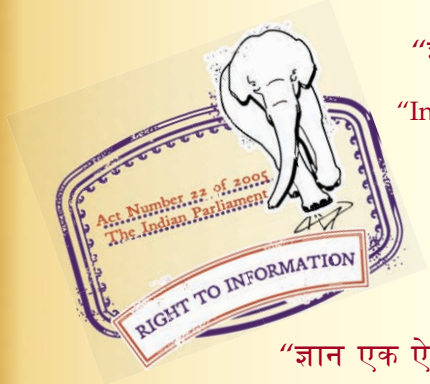
IS 11166 (1993): Permissible deviations on dimensions, surface roughness and mass of steel castings made with investment casting process [MTD 14: Foundry]



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IS 11166 : 1993
(Reaffirmed 1998)

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(पहला पुनरीक्षण)

Indian Standard

PERMISSIBLE DEVIATION ON DIMENSIONS, SURFACE ROUGHNESS AND MASS OF STEEL CASTINGS MADE WITH INVESTMENT CASTING PROCESS

(First Revision)

UDC 669·14-14 : 621·753·1

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

December 1993

Price Group 3

Steel Castings Sectional Committee, MTD 17

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Steel Castings Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This standard was first published in 1984. While reviewing the standard in the light of experience gained during these years the committee decided that the standard may be further revised. The present revision is mainly to incorporate the applicable machining allowances and permissible draft (taper), so as to make it comprehensive standard covering at a place all aspects affecting the dimensions of steel castings made with investment casting process. In addition to this permissible deviations for class 2 steel castings specified in this standard have been modified.

In the preparation of this standard, assistance has been derived from C S4-014470 — Limit variations of dimensions and forms of castings — issued by urad pronovmalizace a mereni, Czechoslovakia.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

PERMISSIBLE DEVIATION ON DIMENSIONS, SURFACE ROUGHNESS AND MASS OF STEEL CASTINGS MADE WITH INVESTMENT CASTING PROCESS

(First Revision)

1 SCOPE

1.1 This standard covers the permissible deviations on dimensions, surface roughness and mass of steel castings made with investment casting process. This standard provides for the following two classes of permissible deviations.

Class 1 — Involving a closer control over the process and in most cases, a higher cost of manufacture

Class 2 — Involving normal controls and in most cases a lower cost of manufacture

1.2 Normally on the engineering drawing, tolerances shall be specified on all important dimensions, on surface roughness at important areas and on mass of those castings where the mass is a relevant factor. The tolerances thus specified shall normally be in conformity with the values specified against Class 1 and Class 2.

1.3 With exceptionally close control or with certain additional operations, it may be possible to achieve a level of control closer than Class 1 also. The designer may call for such a closer level of tolerances on especially critical dimensions, but it is recommended that this be done in consultation with the manufacturer.

1.4 Unless otherwise specified on the drawing or in the enquiry and order, on the untoleranced dimensions, surface roughness and mass, the deviations mentioned against Class 2 shall apply.

2 TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Investment Casting (Lost Wax Process)

This is a casting process in which a consumable pattern of wax or thermoplastic or other material used. The pattern is invested in a refractory slurry to form a mould. After the mould is dried the pattern is melted or burnt out of the mould cavity.

2.2 Rough Casting

This is the final product of the investment foundry after the usual operations of gate removal, fettling, heat treatment, etc, but before any machining operation is carried out.

2.3 Dimensions

2.3.1 *Nominal Dimensions*

The dimension prescribed on the production drawing to which deviation is to be applied (*see* Annex A).

2.3.1.1 If the surfaces influencing this dimension are not provided with machining allowances, the nominal dimension of the final casting is the dimension specified in the drawing.

2.3.1.2 If the surface influencing this dimension are provided with machining allowance, then the nominal dimension on a casting is equal to the total of the dimension given in the machined component drawing and the relevant machining allowance.

2.3.2 *Overall Dimension*

The largest measurable dimension of the particular part of a casting in which the nominal dimension is located. The overall dimension is to be considered in a plane normal to the nominal dimension (*see* Annex A).

2.4 Permissible Deviations

2.4.1 A positive deviation is the difference between the maximum permissible dimension and nominal dimension.

2.4.2 A negative deviation is the difference between the minimum permissible dimension and the nominal dimension.

2.5 Machining Allowance

This is the stock of extra material, which is provided on the relevant surface of a raw casting, on removing which, in the process of machining, the casting would attain the finish machined dimensions shown in the drawing of machined component. Provision of a machining allowance, and the consequent machining, are necessary wherever the 'as cast' dimensional tolerances that are attainable are not close enough for a given application and require improvement by the process of machining. Machining is some times also done to enhance the 'as cast' surface finish or to alter the shape of a casting to suit a particular application.

2.6 Draft is the taper that is necessary to be provided in case of all vertical faces (faces perpendicular to the parting plane) in a pattern to facilitate its withdrawal from the die/mould.

3 PERMISSIBLE DEVIATION ON DIMENSIONS

3.1 Permissible deviations on the nominal dimensions of castings shall be as given in Tables 1 and 2 respectively for the particular class.

3.2 The total change in nominal dimensions due to change in geometrical shape or profile and other reasons should not exceed the deviation indicated in the respective classes.

Table 1 Permissible Deviations on Dimensions, Class 1

(*Clause* 3.1)

All dimensions in millimetres.

Nominal Dimensions of Rough Castings		Overall Dimensions							
Over	Up to	Up to 6	Over 6 Up to 10	Over 10 Up to 18	Over 18 Up to 30	Over 30 Up to 80	Over 80 Up to 180	Over 180 Up to 300	Over 300 Up to 500
	6	± 0·08	± 0·10	± 0·12	± 0·12	± 0·15	± 0·15	± 0·20	± 0·25
6	10	—	± 0·12	± 0·12	± 0·15	± 0·15	± 0·20	± 0·25	± 0·30
10	18	—	—	± 0·15	± 0·15	± 0·20	± 0·25	± 0·30	± 0·35
18	30	—	—	—	± 0·20	± 0·25	± 0·30	± 0·40	± 0·45
30	80	—	—	—	—	± 0·25	± 0·40	± 0·40	± 0·50
80	180	—	—	—	—	—	± 0·40	± 0·50	± 0·55
180	300	—	—	—	—	—	—	± 0·50	± 0·60
300	500	—	—	—	—	—	—	—	± 0·70

Table 2 Permissible Deviations on Dimensions, Class 2

(*Clause* 3.1)

All dimensions in millimetres.

Nominal Dimensions of Rough Casting		Overall Dimensions							
Over	Up to	Up to 6	Over 6 Up to 10	Over 10 Up to 18	Over 18 Up to 30	Over 30 Up to 80	Over 80 Up to 180	Over 180 Up to 300	Over 300 Up to 500
	6	± 0·10	± 0.12	± 0·15	± 0·20	± 0·25	± 0·25	± 0·30	± 0·35
6	10	—	± 0·12	± 0·15	± 0·25	± 0·25	± 0·30	± 0·35	± 0·45
10	18	—	—	± 0·20	± 0·30	± 0·35	± 0·35	± 0·40	± 0·55
18	30	—	—	—	± 0·30	± 0·40	± 0·45	± 0·50	± 0·65
30	80	—	—	—	—	± 0·45	± 0·55	± 0·60	± 0·75
80	180	—	—	—	—	—	± 0·60	± 0·70	± 0·90
180	300	—	—	—	—	—	—	± 1·00	± 1·15
300	500	—	—	—	—	—	—	—	± 2·00

4 PERMISSIBLE DEVIATIONS ON CENTRE-TO-CENTRE DISTANCE

Permissible deviations on centre-to-centre distance between holes, bosses, etc, shall be as given in Table 3.

Table 3 Permissible Deviations on Centre-to-Centre Distance Between Holes, Bosses, etc.

All dimensions in millimetres.

Nominal Dimensions		Permissible Deviation	
Over	Up to	Class 1	Class 2
	6	± 0·10	± 0·125
6	10	± 0·10	± 0·125
10	18	± 0·10	± 0·15
18	30	± 0·15	± 0·25
30	80	± 0·20	± 0·35
80	180	± 0·30	± 0·45
180	300	± 0·45	± 0·70
300	500	± 0·60	± 0·90

5 PERMISSIBLE DEVIATION ON MASS

5.1 Permissible deviations on mass of a casting shall be as given in Table 4.

Table 4 Permissible Deviation on Mass

Nominal Mass of Casting, g		Permissible Deviation, Percent	
Over	Up to	Class 1	Class 2
	50	± 4·0	± 5.0
50	200	± 3·0	± 4·0
200	500	± 2·0	± 2·5
500	1 000	± 1·5	± 2·0
1 000		± 1·0	± 1·5

5.2 The nominal mass of casting shall be deemed to be the average of the actual masses of a batch of castings, all of which have dimensions within the permissible deviations.

5.2.1 By prior agreement, the purchaser and the manufacturer may choose a different basis of defining the nominal mass and also what will constitute a batch of castings.

6 PERMISSIBLE DEVIATIONS ON ANGLES

Permissible deviations on specified angles shall be as follows:

Class 1	*Class* 2
± 1/2°*	± 1°

*Where the overall dimension governing the concerned faces or points is over 75 mm, the permissible deviation in Class 1 shall be ± 0·7° instead of ± 1/2°.

7 PERMISSIBLE DEVIATIONS ON SURFACE ROUGHNESS

7.1 Surface roughness determined in accordance with IS 3073 : 1979 shall not exceed the following limits:

Class 1	*Class* 2
(Ra μm)*	(Ra μm)*
3·0	6·0

*Raum = Arithmetical mean deviation from the line profile, in micrometres.

NOTE — Under Class 1, the actual surface roughness is generally likely to lie in the range of 1·6 to 3 μm.

8 MACHINING ALLOWANCE

8.1 The maximum permissible machining allowance per surface shall be as given in Table 5.

8.2 Even though the values given in Table 5 are the maximum as far as the manufacturing foundry is concerned, it is open to the purchaser to specify higher machining allowances, if he so desires, at the time of enquiry and the order.

Table 5 Permissible Machining Allowances

(*Clause* 8.1)

Nominal Dimension		Overall Dimensions (mm/face)						
Over	Up to	6	6-10	10-18	18-30	30-80	80-180	100-300
—	6	0.3	0·35	0·4	0.5	0·7	1·0	1·0
6	10	—	0·35	0.4	0.5	0·7	1·25	1·5
10	18	—	—	0·5	0·6	0·7	1·25	1·5
18	30	—	—	—	0·6	0·8	1·4	1·75
30	80	—	—	—	—	1.0	1·6	2·00
80	180	—	—	—	—	—	2·0	2.25
180	300	—	—	—	—	—	—	3·00

8.3 The interpretation of providing machining allowance and its relationship with casting tolerances are as illustrated in Fig. 1 A, 1B, 1C, and 1D. It is to be noted that a machining allowance specified in Table 5 is the nominal maximum amount that would survive inspite of there occurring the maximum permissible negative deviation in case of an external dimension (*see* Fig 1 a) or the maximum possible positive deviation in case of an internal dimensions (*see* Fig. 1 b). Hence a particular casting may have a total machining stock, for example, in case of an internal surface, equal to the machining allowance specified in Table 5 plus the maximum negative deviation permissible in accordance with Tables 1 and 2 (Class 1 and Class 2) as the case may be plus the permisible draft in accordance with Table 6. Thus when it is stated that a machining allowance given in Table 5 is the maximum, it means that it is the maximum value allowed over and above the corresponding applicable dimensional deviation as per Tables 1 or 2 plus the corresponding applicable draft as per Table 6.

8.3.1 If a surface requiring machining has a linkage or a reference with more than one point or surface, then greater distance shall be taken as nominal dimension for the purpose of deriving the applicable machining allowance.

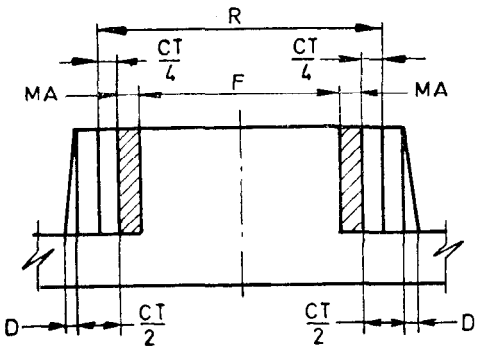
9 DRAFT

9.1 The maximum permissible draft per surface shall be as given in the Table 6.

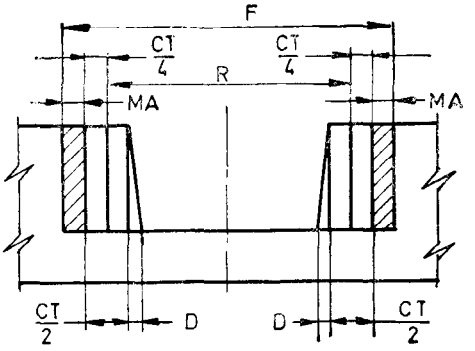
Table 6 Draft

(*Clauses* 8.3, 9.1 *and* 9.2)

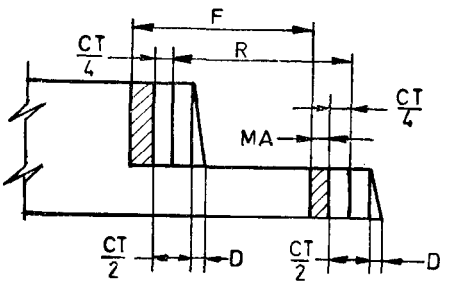
Height of Face mm		Draft in mm (*Max*)	
Over	Up to	Class 1	Class 2
—	25	0·1	0·2
25	50	0·2	0·4
50	80	0·35	0·7
80	120	0·5	1·0
120	180	0·75	1.5
180	250	1·0	1·75
250	350	1·50	2·0
350	500	1·75	2.5



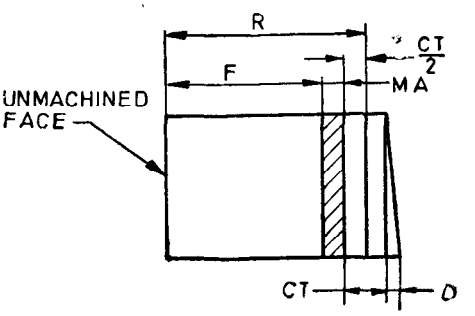
1A External Machining



1B Internal Machining



1C Machining of Step Dimension



1D Machining on One Side

FIG. 1 ILLUSTRATION OF MACHINING ALLOWANCE AND IT'S RELATIONSHIP WITH CASTING TOLERANCE AND DRAFT

NOTE

R = raw casting dimension.

F = finished dimension.

MA = machine allowance (*see* **2.5** and **8**).

CT = casting tolerance range as per Tables 1, 2 or 3.

D = draft (*See* **2.6** and **9**) (in this illustration '*D*' represents the + ve draft as referred to in **9.4.2**).

9.2 While it is theoretically possible to eliminate draft in all cases by suitably splitting the die or by any other means, these methods are often unfeasible, as they would substantially raise the cost of the die. Thus in case of some faces a certain degree of draft becomes unavoidable. The amount of such draft would vary depending upon not only the length of face but also upon such other factors like the depth to dia ratio in case of a hole whether the hole is through or blind, etc. While it would be logical from the foundry point of view to account for all these factors, it would not be reasonable to expect a purchaser of castings to be familiar with all such aspects and be uncertain of the amount of draft the casting bought by him, may actually have, depending on such factors. Hence to avoid confusion, and as measure of simplification the permissible extent of draft over a given length is based only on the class of accuracy. Table 6 for draft is drawn up accordingly.

9.3 The draft provided can be of any of the following 3 types — ± ve, + ve, − ve draft.

This differentiation is illustrated in Fig. 2A, 2B and 2C.

9.4 Tho following basis is ordinarily followed in chosing the type of draft.

9.4.1 ± *ve draft*

This type of draft is used when the design of a casting does not allow an increase or decrease of the nominal dimension more than 50% of the specified value of the draft, over and above the applicable dimensional deviation.

9.4.2 + *ve draft*

This type of draft is most commonly used and is applicable wherever the concerned face is machined or where it is not machined but the casting design and application do not permit an increase in the concerned nominal dimension in case of an external surface, and a decrease in case of an internal surface.

9.4.3 − *ve draft*

This type of draft is used where the concerned casting surface remains unmachined and the casting design and the application do not permit an increase in the concerned nominal dimension in case of an external surface, and a decrease in case of an internal surface.

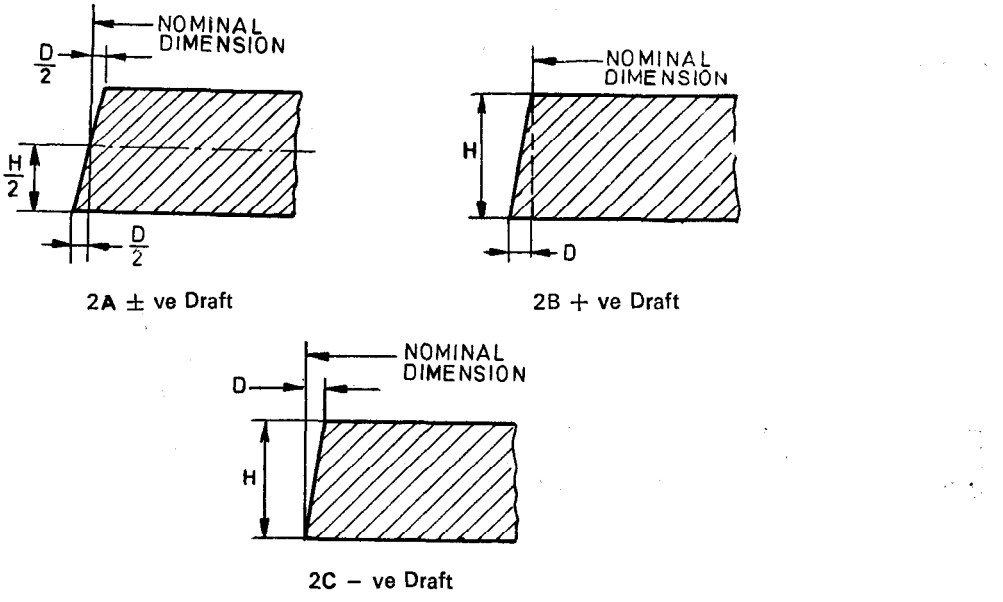


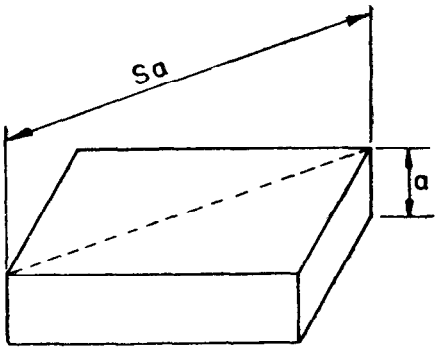
FIG. 2 ILLUSTRATION OF DIFFERENT TYPES OF DRAFT

ANNEX A

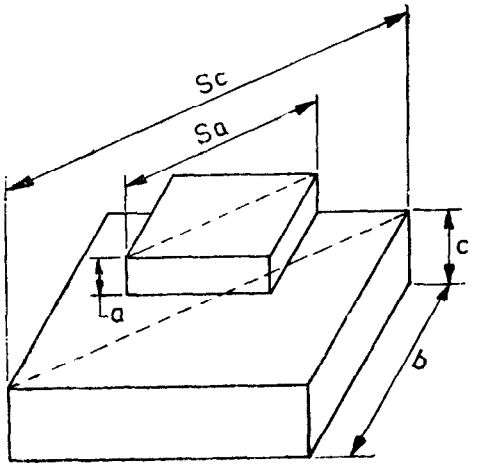
(*Clauses* 2.3.1 *and* 2.3.2)

TYPICAL ILLUSTRATIONS DEPICTING THE NOMINAL AND OVERALL DIMENSIONS

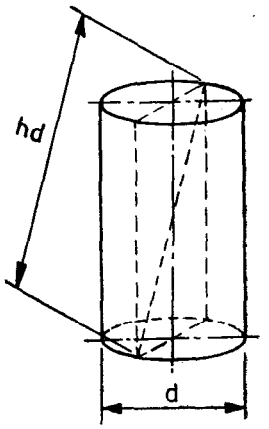
If the nominal dimension is '*a*' the Overall Dimension is '*Sa*' being the corresponding largest dimension



If the nominal dimension is '*a*' the overall dimension is '*Sa*'. For the nominal dimension '*c*' the overall dimension is '*Sc*'. For the Nominal dimension '*b*' the overall dimension is '*Sc*'



For the nominal dimension '*d*' the overall dimension is '*hd*'. For the nominal dimension '*hd*' the overall dimension is also '*hd*'



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Printed at Printwell Printers, Aligarh, India