BS EN 10243-1:1999
Incorporating Corrigendum No. 1

Steel die forgings — Tolerances on dimensions —

Part 1: Drop and vertical press forgings

The European Standard EN 10243-1:1999 has the status of a British Standard

ICS 77.140.85

British Standards

National foreword

This British Standard is the English language version of EN 10243-1:1999, incorporating Corrigendum March 2005. Together with BS EN 10243-2, it supersedes BS 4114:1967 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ISE/31, Wrought steels, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

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English version

Steel die forgings — Tolerances on dimensions — Part 1: Drop and vertical press forgings

Pièces forgées par estampage en acier — Tolérances dimensionnelles — Partie 1: Pièces exécutées à chaud sur marteaux-pilons ou presses verticales

Gesenkschmiedeteile aus Stahl — Maßtoleranzen — Teil 1: Warm hergestellt in Hämmern und Senkrecht-Pressen

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Ref. No. EN 10243-1:1999 E

Foreword

This European Standard has been prepared by Technical Committee ECISS/TC 28, Steel forgings, the Secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2000, and conflicting national standards shall be withdrawn at the latest by March 2000.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association. This European Standard is considered to be a supporting standard to those application and product standards which in themselves support an essential safety requirement of a New Approach Directive and which make reference to this European Standard.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Contents

1 Scope

1.1 This European Standard specifies the dimensional tolerances for steel drop and vertical press forgings made under hammers and presses.

The first part of this European Standard applies to hot forgings in the delivery condition, made in carbon and alloy steels. The tolerances specified apply to forgings not exceeding 250 kg in mass or 2 500 mm maximum dimension. Tolerances for heavier or larger forgings shall be agreed at the time of enquiry and order.

This European Standard does not apply to upset forgings made on horizontal forging machines (see EN 10243-2).

1.2 The tolerances shown in this European Standard cover both forgings to normal requirements and forgings to a closer range of tolerances. These two grades of tolerances are identified as follows:

— forging grade F with tolerances providing an adequate standard of accuracy for the majority of applications and capable of being complied with by commonly used forging equipment and production methods;

— forging grade E providing closer tolerances to assist in acommodating those instances in which the normal manufacturing standards are inadequate.

While grade E (close) tolerances may be applied to all dimensions on one forging, it is more economical to apply them only to those specific dimensions on which closer tolerances are essential. This grade should not be specified unless the additional forging cost entailed can be justified by a consequent saving in overall cost.

The tables showing dimensional tolerances are based on the R20 series of preferred numbers (see ISO 3).

Annex A gives for information some examples of the application of these tolerances for different types of closed die forgings.

1.3 Any occasional instances may necessitate the use of tolerances wider than those indicated, e.g. specially complicated designs and steels having particularly difficult forging characteristics. In such cases these standard tolerances can form only a basis on which to agree modifications appropriate to the particular circumstances.

1.4 This European Standard does not include ranges of special tolerances closer than grade E. Such requirements usually necessitate supplementary operations, e.g. hot or cold coining or special processes such as warm or cold forging.

Considerations of this nature, whilst frequently encountered, are highly individual, and vary widely. They are best dealt with by consultation at the design stage and shall be agreed between the purchaser and the supplier. This approach will ensure that optimum use is made of the forging process in fulfilling the purchaser's special requirements at the lowest additional cost.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

ISO 3, *Preferred numbers — Series of preferred numbers.*

ISO 8015, *Technical drawings — Fundamental tolerancing principle.*

3 Symbols

The symbols used in this European Standard are as follows:

l = length dimension;

b = width dimension;

h = height dimension;

a	= thickness dimension;
d	= diameter;
r	= radius;
p	= step dimension;
u	= height of burr;
v	= width of burr;
t	= theoretical length;
e	= special thickness across die line;
m	= mass (weight);
π	= circle factor;
ρ	= density;
S	= shape complexity factor (see **4.4**);
M	= category of steel (see **4.3**);
x and *y*	= shearing deformation.

4 Information required in determining tolerances

To determine the tolerances applicable to a given forging in accordance with Table 1, Table 2, Table 3, Table 4, Table 5 and Table 6, the following information is required in addition to the dimensions of the forging:

— mass of forging;
— shape of die line;
— category of steel used;
— shape complexity factor;
— type of dimension.

4.1 Mass of forging

The forging mass is calculated.

4.2 Shape of die line

The shape of die line is determined as being within one of the following categories:

— either straight or symmetrically cranked;
— or asymmetrically cranked (see Figure 1 for example).

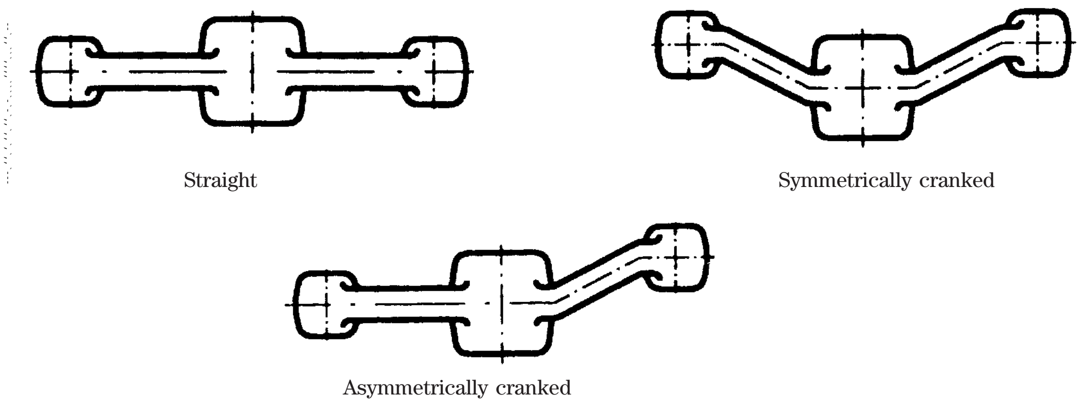


Figure 1 — Die lines

4.3 Category of steel used

The type of steel symbol used takes account of the fact that steels of high carbon and high alloy content are more difficult to deform and cause higher die wear than do steels with lower carbon content and lower alloying elements.

The category of steel used is determined as being within one of the following:

— group M1: Steel with carbon content not more than 0,65 % and total of specified alloying elements (Mn, Ni, Cr, Mo, V, W) not more than 5 % by mass;

— group M2: Steel with carbon content above 0,65 % or total of specified alloying elements (Mn, Ni, Cr, Mo, V, W) above 5 % by mass.

To determine the category in which a steel belongs, the maximum permitted content of the elements in the steel specification shall be the values used.

4.4 Shape complexity factor

The shape complexity factor takes account of the fact that in forging thin sections and branched components, as compared to components having simple compact shapes, larger dimensional variations occur which are attributable to different rates of shrinkage, higher shaping forces and higher rates of die wear. Examples are shown of circular and non-circular forgings (see Figure 2 and Figure 3).

The shape complexity factor of a forging is the ratio of the mass of the forging to the mass[1)] of the enveloping shape necessary to accommodate the maximum dimensions of the forging:

$$S = \frac{m_{\text{forging}}}{m_{\text{enveloping shape}}}$$

The enveloping shape of a circular forging is the circumscribing cylinder, the mass of which is calculated from the formula (see Figure 2):

$$m_{\text{enveloping shape}} = \frac{\pi d^2}{4} h\rho$$

where

d = diameter;

ρ = density (7,85 g/cm^3);

h = height or length of cylinder.

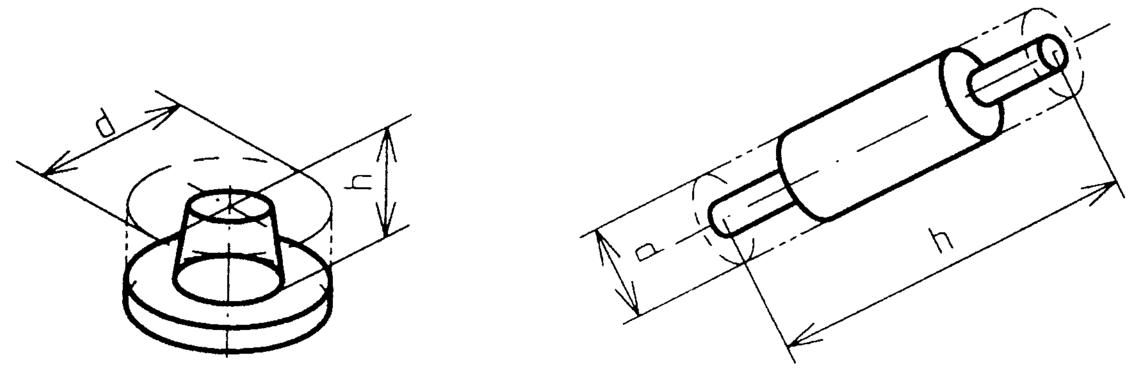


Figure 2 — Enveloping shapes of circular forgings

For a non-circular forging the enveloping shape is constituted by the smallest rectangular block that will encompass the forging (see Figure 3):

$$m_{\text{enveloping shape}} = lbhp$$

1) If desired, the shape complexity factor may be calculated as the ratio of the volume of the forging to the volume of the enveloping shape.

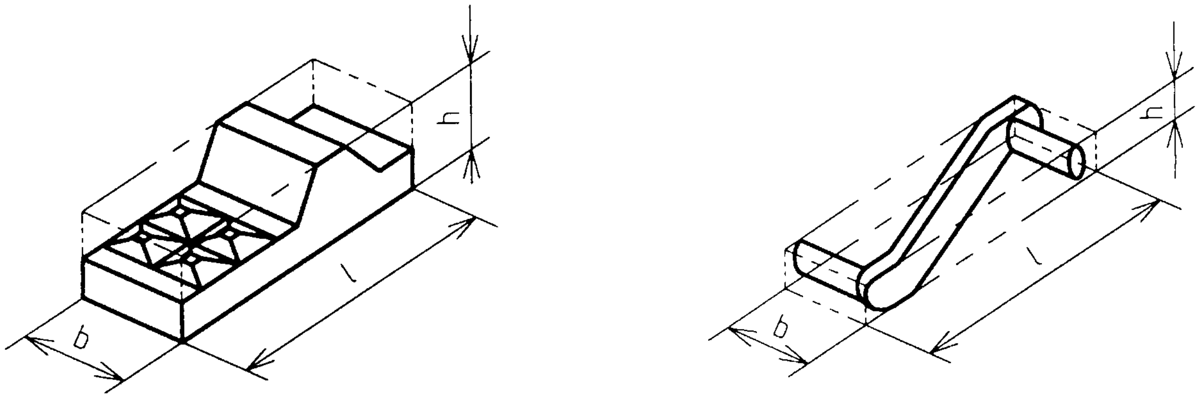


Figure 3 — Enveloping shapes of non-circular forgings

The resulting shape complexity factor is determined as falling within one of the following categories:

S4: Up to and including 0,16;

S3: Above 0,16 up to and including 0,32;

S2: Above 0,32 up to and including 0,63;

S1: Above 0,63 up to and including 1.

EXCEPTION: In determining the shape complexity factor for thin disks or flanges there is an exception to the above procedure when the expression *e*/*d* does not exceed 0,20, where *d* is the diameter and *e* is the corresponding thickness of the disk or flange (see Figure 4).

In such cases the factor S4 is used; the weight to be taken into consideration is only that of a cylinder having diameter *d* and height *e*. This special procedure is not applied if larger tolerances will result from use of the normal procedure as shown in **4.4**.

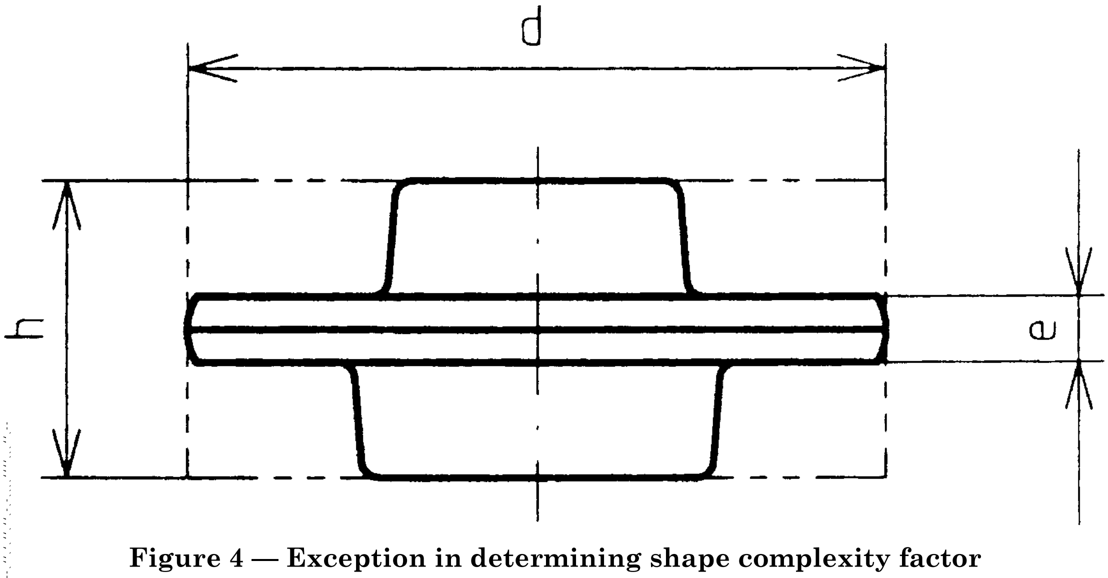


Figure 4 — Exception in determining shape complexity factor

4.5 Types of dimension

Four major types of dimension are identified (see Figure 5) and the relationship to the forging direction and die line is as follows:

Dimension	Forging direction	Die line
Length	⊥	One side
Width	⊥	
Height	//	
Thickness	//	Across

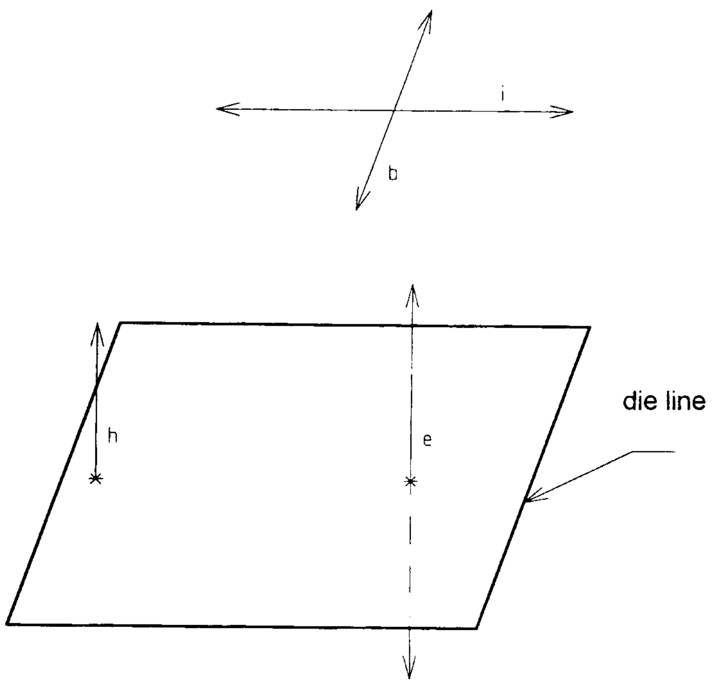


Figure 5 — Relationship between types of dimensions and die line

5 Categories of tolerances

5.1 Scope of categories

The tolerances are related to the different kinds of dimension. They are classified into four groups; accordingly each of them is displayed in the table.

5.1.1 ***First group of tolerances (Table 1 and Table 2)***

Tolerances for:

— length, width and height;
— mismatch;
— residual flash (and trimmed flat);
— pierced hole.

5.1.2 ***Second group of tolerances (Table 3 and Table 4)***

Tolerances for:

— thickness;
— ejector marks.

5.1.3 ***Third group of tolerances (Table 5)***

Tolerances for:

— straightness and flatness;

— centre-to-centre dimensions.

5.1.4 ***Other categories of tolerances***

Tolerances for:

— fillet and edge radii (Table 6);

— burr (Table 6);

— surface;

— draft angle surfaces;

— eccentricity for deep holes;

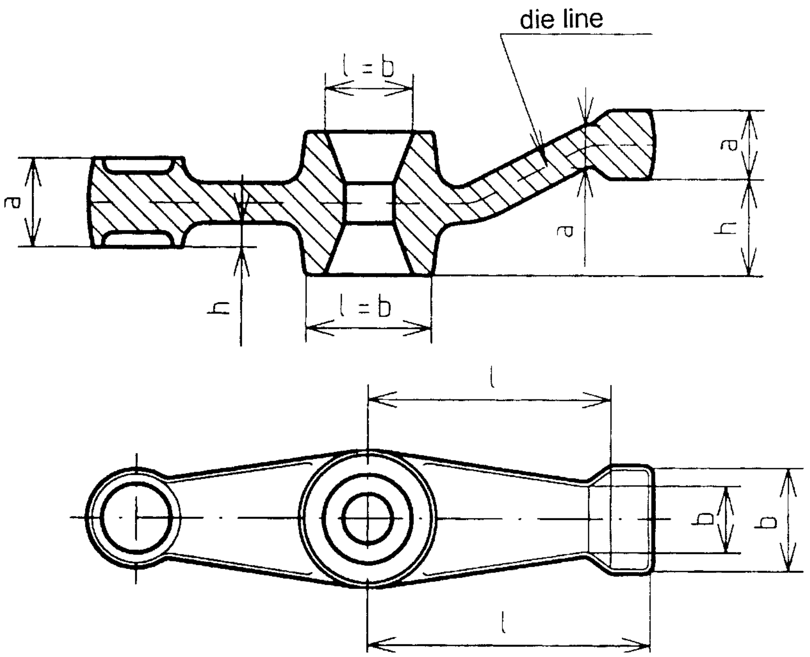
— unforged stock;

— deformation of sheared ends (Table 6).

5.2 Definition of categories

5.2.1 ***First group of tolerances (Table 1 and Table 2)***

5.2.1.1 *Length, width and height tolerances* (see Figure 6)



l dimensions of length in one die;

b dimensions of width in one die;

h dimensions of height in one die;

a dimensions of thickness across die line.

Figure 6 — Type of dimensions

Except for certain centre-to-centre dimensions (see **5.2.3.2**), length, width and height tolerances relate to all dimensions of length, width and height (including diameters) on one side of the die line. All variations, including those due to die wear and shrinkage, are included in the length, width and height tolerances. Length and width tolerances are to be applied in directions parallel to the main die line, or as nearly so as practical considerations will permit.

Length, width and height tolerances comprise the following:

— tolerances on dimensions to external and internal forged surfaces;

— tolerances on dimensions from an axis to a single surface.

Length, width and height tolerances are shown in Table 1 and Table 2 as applied to dimensions between external surfaces (see Figure 7), i.e. with a dispersion of +2/3, –1/3 for all length and width tolerances and also all height tolerances unless the more restrictive step height tolerances are required.

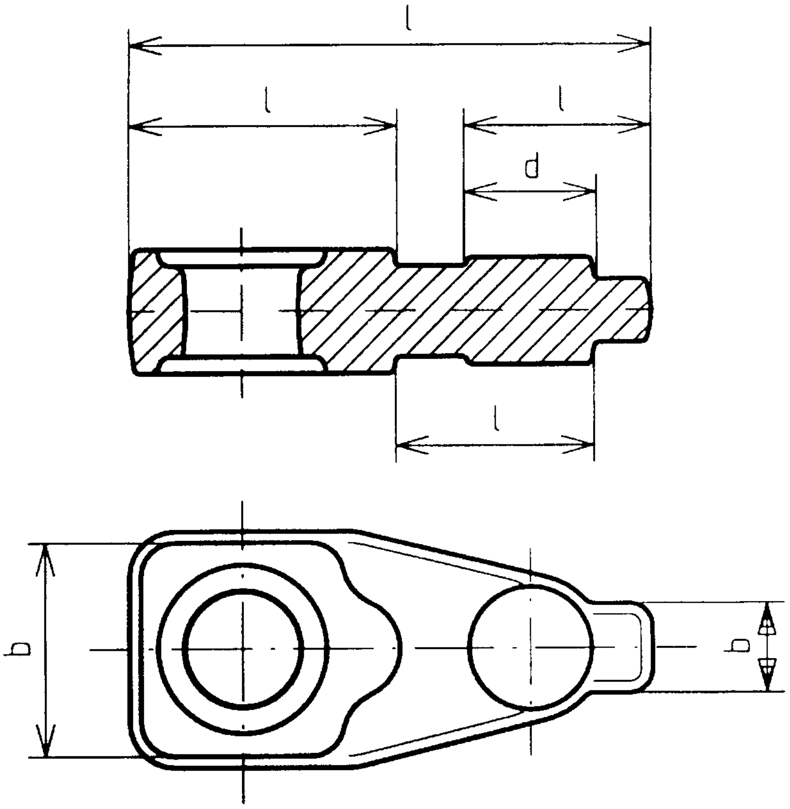


Figure 7 — Length and width dimensions between external surfaces

For dimensions between internal surfaces (see Figure 8), the signs should be reversed so that the tolerance dispersion is +1/3, –2/3.

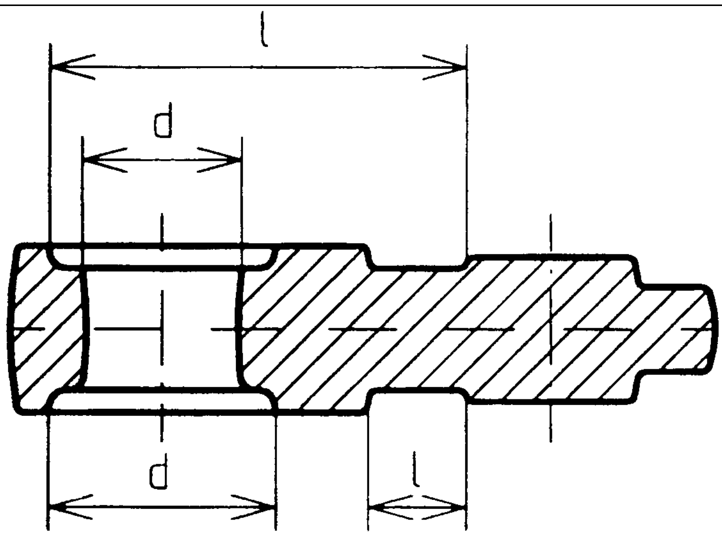


Figure 8 — Length and width dimensions between internal surfaces

When applying length, width and height tolerances to a forging, the tolerances for the greatest dimension of length (i.e. the overall length) should be applied, wherever possible, to all dimensions of length and similarly for dimensions of width and dimensions of height. This should be done to obviate unnecessary minor variations between tolerances, thus facilitating drawing preparation and simplifying inspection procedures. In those instances where the variation is of importance (e.g. where there is a large difference in dimensions of length), individual tolerances may be applied from Table 1 and Table 2 to those dimensions where this is considered necessary. The application of such tolerances should be kept to a minimum and, in these instances, the tolerances shall be indicated clearly against the appropriate dimension(s) on the forging drawing.

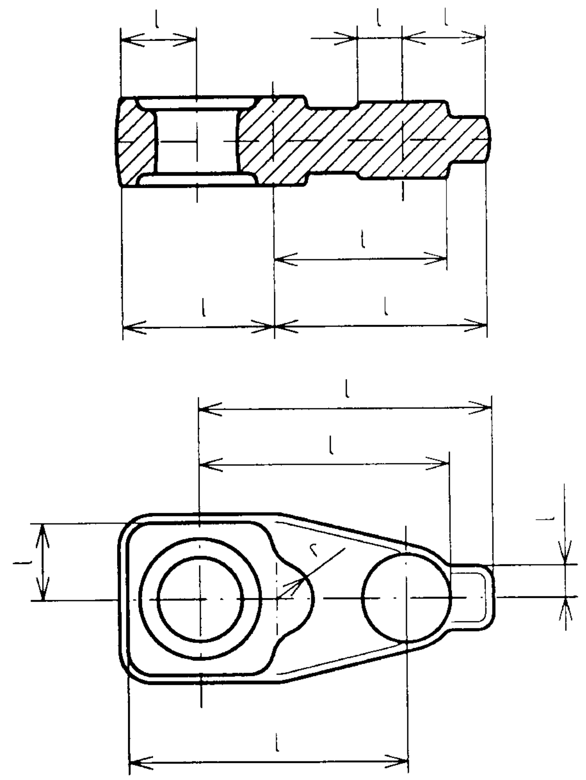


Figure 9 — Length and width dimensions from a centre to a surface

For dimensions from a centre to a surface (see Figure 9) and for dimensions on steps within one die, the tolerances for the greatest length, width and height shall apply wherever possible. Where more restrictive tolerances are required, they shall be indicated against the appropriate dimension on the drawing and shall be +1/3, –1/3 of the total tolerances shown in Table 1 and Table 2.

5.2.1.2 *Mismatch tolerances*

Mismatch tolerances indicate the permissible extent of misalignment between any point on one side of the parting line and the corresponding point on the opposite side, in directions parallel to the main die line. Mismatch tolerances depend on the forging mass and on the shape of die line. They shall be taken from Table 1 and Table 2.

Mismatch tolerances are applied independently of any other tolerances.

Measurement: In measuring mismatch, accuracy depends upon making due allowance for surplus metal caused by uneven die wear. For that reason measurements should be made at areas of the forging least affected by die wear.

Formula for calculating mismatch: With reference to Figure 10, mismatch at any position relative to the length or width of a forging may be calculated as follows:

$$\text{Mismatch} = \frac{l_2 - l_1}{2} \text{ or } \frac{b_2 - b_1}{2}$$

where

l_1 or b_1 lesser projected length or width dimension, measured parallel to the main die line of the dies;

l_2 or b_2 corresponding greater projected length or width dimension, measured parallel to the main die line.

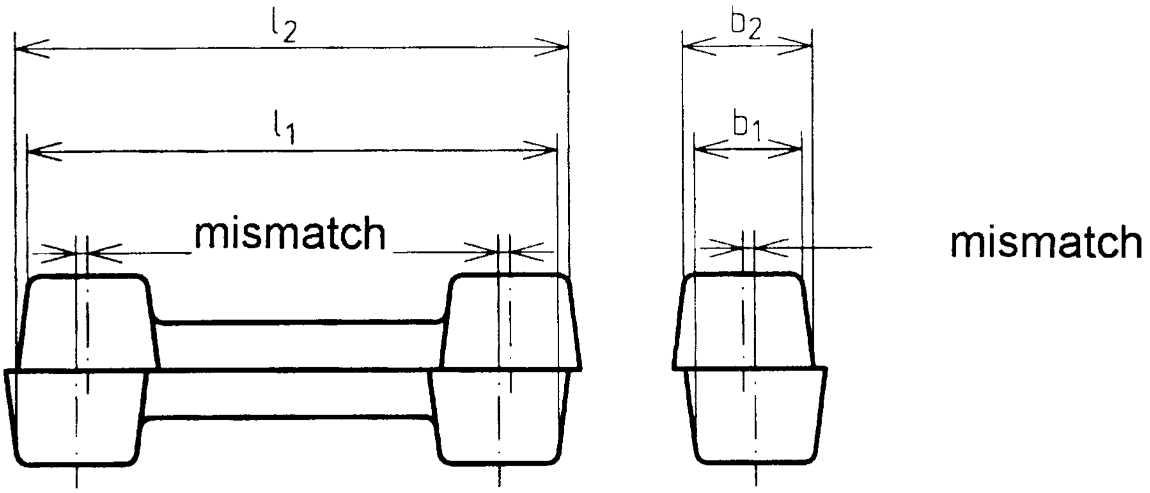


Figure 10 — Mismatch

5.2.1.3 *Residual flash (and trimmed flat) tolerances*

Variations in trimming may produce either a residual flash or trimmed flat. The positive (residual flash) and negative (trimmed flash) values permitted are given in Table 1 and Table 2. The residual flash is measured from the body of the forging to the trimmed edge of the flash, as indicated in Figure 11. The position of the trimmed flat is measured relative to the theoretical point at which the draft angles meet (see Figure 12).

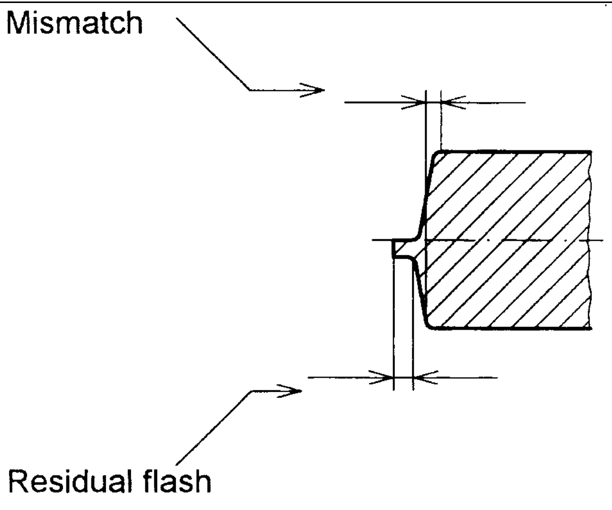


Figure 11 — Residual flash

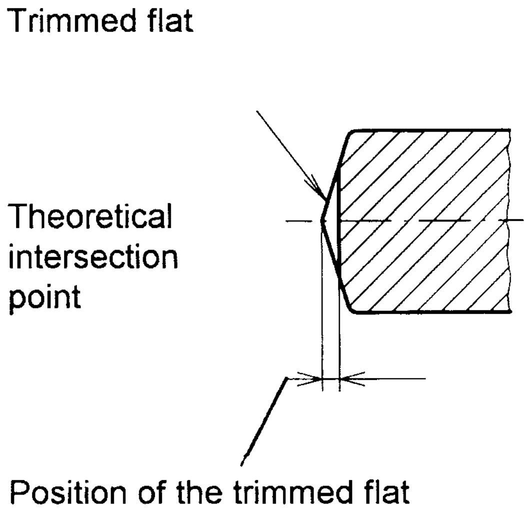


Figure 12 — Trimmed flat

Residual flash and trimmed flat tolerances are applied independently of, and in addition to, any other tolerances.

5.2.1.4 *Pierced hole tolerances*

Tolerances for dimensions of pierced holes shall be taken from Table 1 or Table 2, but the positive and negative dispersions shall be reversed. Normally the tolerances for the greatest dimension of length (or diameter) of the forging will be applied but, if more restrictive tolerances are required, those for the specific dimension of the pierced hole may be used. In the latter case the tolerances shall be indicated against the appropriate dimension on the forging drawing.

5.2.2 ***Second group of tolerances (Tables 3 and 4)***

5.2.2.1 *Thickness tolerances* (see Figure 6)

Thickness tolerances govern permissible variations in any dimension which crosses the die line. All variations in thickness, due to die-closure, die-wear and shrinkage are included in the thickness tolerances.

The characteristics of the forging process require that, for any given forging, all tolerances for thickness dimensions are uniform. The tolerances are determined from Table 3 and Table 4 in accordance with the greatest thickness dimension of the forging.

Where more restrictive tolerances are required for application to individual dimensions of thickness, supplementary operations are involved. Such special tolerances should be negotiated between the purchaser and the supplier in accordance with **1.4**.

EXCEPTION: In the case of a forging having a flange from which projects:

a) a deep hub, the height of which is more than 1,5 times its diameter; or

b) a non-circular projection, the height of which is more than 1,5 times its enveloping diameter, all thickness tolerances except that of the overall thickness shall be calculated as if the height of the hub or projection had been equal only to 1,5 times its diameter (or enveloping diameter) and not to the greatest thickness dimension (see Figure 13).

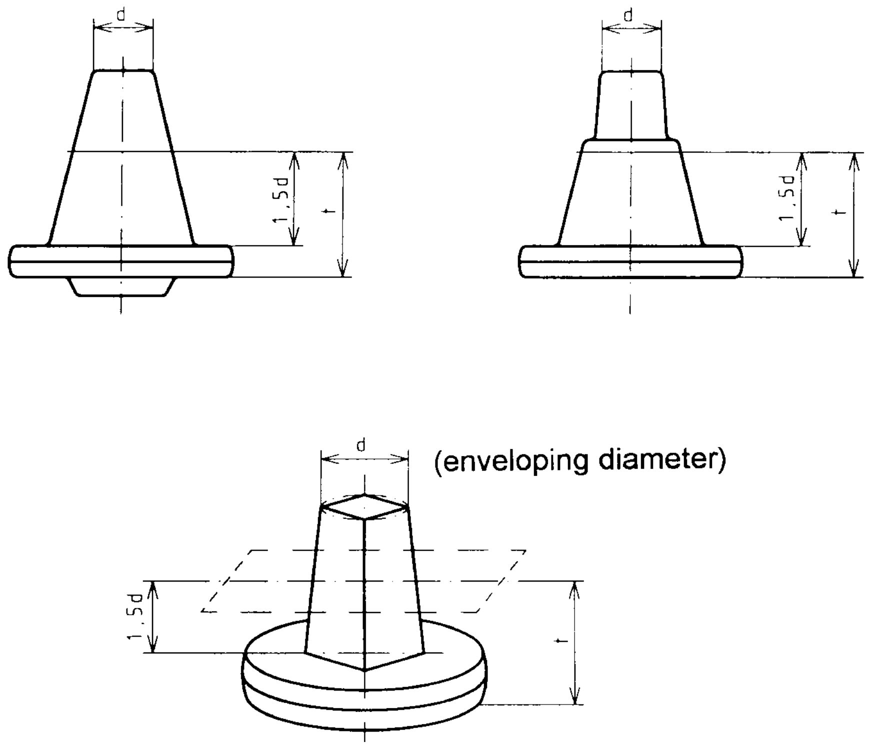


Figure 13 — Application of thickness tolerances to deep hubs

Base all thickness tolerances except those for overall thickness on dimension *t* shown above. In both cases, the permissible deviations shall be mentioned besides the relative measurements in the drawings of the forgings.

5.2.2.2 *Ejector mark tolerances*

When forging dies incorporate ejectors, an allowance is required for the marks made on the forgings. These marks may be either sunken or raised. The total tolerances permitted are shown in Table 3 and Table 4.

The height or the depth of an ejector mark, relative to the surrounding surface, shall not exceed one-half of the total tolerance permitted, unless stated otherwise on the agreed forging drawing.

The nominal diameter and the location of ejector marks will be indicated to the purchaser on the forging drawing before the commencement of production.

Ejector mark tolerances are applied independently of, and in addition to, any other tolerances.

5.2.3 ***Third group of tolerances (Table 5)***

5.2.3.1 *Straightness and flatness tolerances*

Straightness tolerances relate to deviations of centre lines from the specified contour (see Figure 14).

Flatness tolerances relate to deviations of surfaces from the specified contour.

Straightness and flatness tolerances are to be found from Table 5 according to the greatest length or greatest width dimension of the forging.

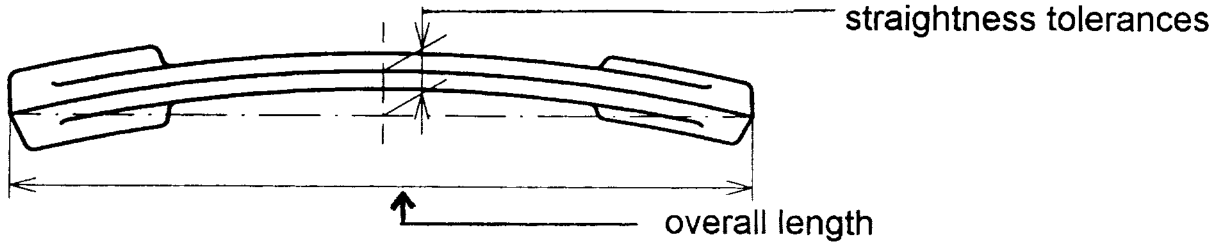


Figure 14 — Application of straightness tolerances

When straightness tolerances or flatness tolerances are required, this shall be indicated on the agreed forging drawing.

Straightness and flatness tolerances are applied independently of, and in addition to, any other tolerances.

5.2.3.2 *Tolerances for centre-to-centre dimensions*

The tolerances for centre-to-centre dimensions, up to and including 1 250 mm, shall be taken from Table 5 and shall be indicated against the appropriate dimension on the agreed forging drawing. When no tolerance is indicated against the dimension concerned, the tolerance for the maximum length (or width) of the forging shall be applied (from Table 1 or Table 2), but the dispersion will be plus and minus one-half of the total tolerance, and not as shown in the tables. For centre-to-centre dimensions greater than 1 250 mm length, tolerances from Table 1 or Table 2, with equal plus or minus dispersions, shall be applied. The centre-to-centre tolerances provided in this standard apply only when a straight line joining the two centres occurs within the profile of the forging (see Figure 15).

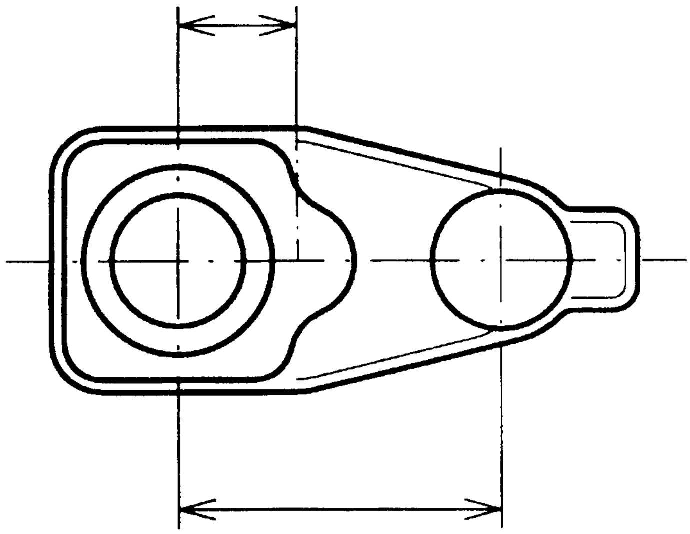


Figure 15 — Dimensions to which centre-to-centre tolerances are applicable

In other instances (see Figure 16) centre-to-centre tolerances, if required either by the purchaser or the supplier, shall be negotiated before the commencement of production.

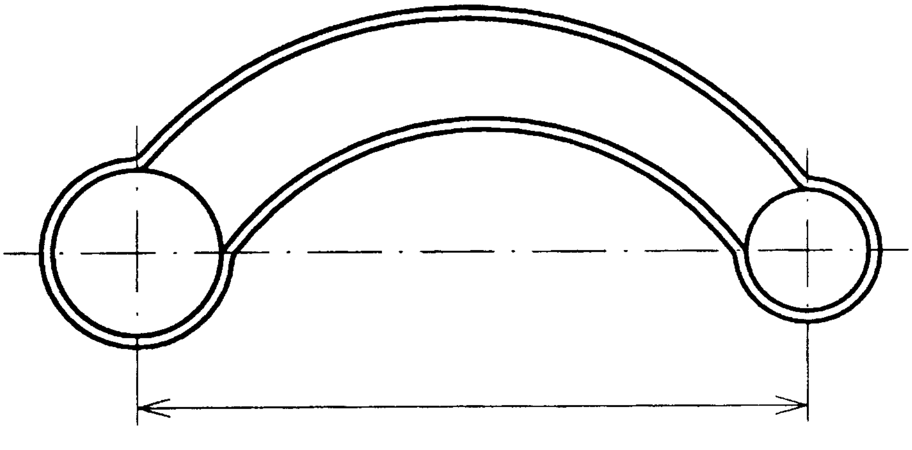


Figure 16 — Dimensions to which centre-to-centre tolerances are not applicable (other than by negotiation)

Centre-to-centre tolerances shall be applied independently of, and in addition to, any other tolerances.

5.2.4 ***Other categories of tolerances***

5.2.4.1 *Fillet and edge radii tolerances* (*Table 6*)

Sharp edges and fillets on forgings are undesirable features and all fillets and edge radii should, therefore, be as generous as design requirements permit. Tolerances for fillet radii and edge radii are shown in Table 6 and examples of such radii are shown in Figure 17.

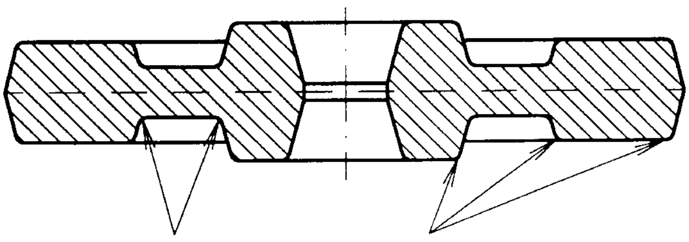


Figure 17 — Fillet and edge radii

The minus tolerances do not apply to edge radii up to and including 3 mm when such radii are affected by subsequent removal of draft by trimming or punching. In such cases the minus tolerance is modified to allow for the formation of a square corner.

Tolerances for fillet and edge radii shown in Table 6 are applicable to both grade E and grade F.

5.2.4.2 *Burr tolerances* (*Table 6*)

An allowance is made for the burr or drag formed, during trimming or punching, on the edges of certain forgings; for example, when an edge is close to the die line. Tolerances for the maximum permissible extent of burr relative to such edges are based on the weight of the forging, in accordance with Table 6 and are applied unless the purchaser specifies otherwise. The location of burrs shall be indicated to the purchaser on the forging drawing for approval before the commencement of production.

Burr tolerances are applied independently of, and in addition to, any other tolerances.

5.2.4.3 *Surface tolerances*

Surface tolerances relate to depth of scale pits and depth of surface dressing. They apply within the limits stated below unless the purchaser specifies otherwise.

On forged surfaces which are to be machined subsequently, scale pits and surface dressing shall be permitted, but the maximum depth shall be such that at least one-half of the nominal machining allowance remains. Dimensional checks regarding depth of scale pits or any other point in question should be made in relation to the machining locations.

On forged surfaces which are not machined subsequently, scale pits and surface dressing shall be permitted to a depth equal to one-third of the total value of the thickness tolerance.

5.2.4.4 *Tolerances on draft angle surfaces*

It is normal practice to apply the tolerances for a nominal dimension of length or width, shown on the agreed forging drawing, to any corresponding dimension required between points on the adjacent draft angle surfaces. Many instances of heavy die wear occur in which these tolerances are inadequate. The supplier will draw the attention of the purchaser to such instances and it will be necessary to negotiate greater tolerances on the draft angle surfaces to meet these circumstances. Such special tolerances shall be agreed between the supplier and the purchaser before the commencement of production.

5.2.4.5 *Eccentricity tolerances for deep holes*

For a hole, the depth of which is greater than the greatest diameter, an eccentricity tolerance of 0,5 % of hole depth shall be applied, but this value shall be doubled (1,0 %) if measured as a total indicator reading. Instances occur in which this tolerance is inadequate. In such cases, special tolerances shall be negotiated with the purchaser before the commencement of production.

Eccentricity tolerances for deep holes shall be applied in addition to the normal tolerances for mismatch (see Figure 18).

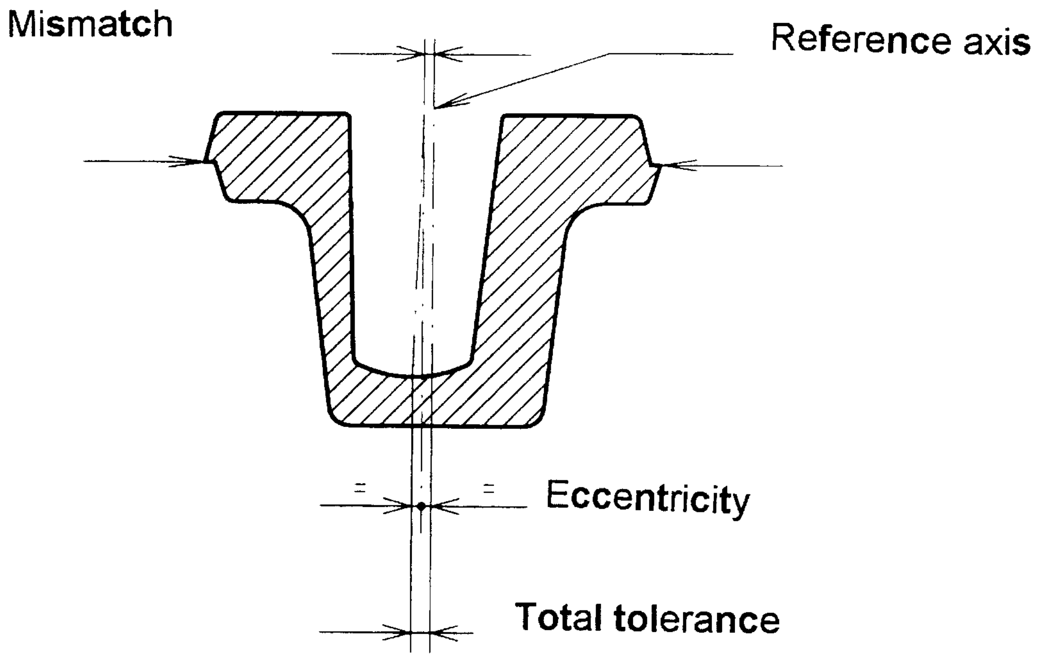


Figure 18 — Eccentricity tolerance for deep holes

5.2.4.6 *Tolerances for unforged stock* (*Table 1*)

Unforged stock is that part of a forging which has not been intentionally deformed by the forging process.

When a forging incorporates a length of unforged stock, local deviations from the actual bar stock diameter or section are allowed adjacent to the forged portion.

The permissible increase or decrease in original actual diameter or section of bar stock adjoining such forged portions is the same as the tolerance applicable to the adjoining forged portion on dimensions at right angles to the longitudinal axis of the unforged stock.

Instances occur in which the negative tolerances for such local deviations cannot be permitted on unforged stock where it is not subsequently machined. In such cases it can be arranged by negotiation between the purchaser and the supplier that the entire tolerance is shown as a positive one.

The permissible length of local deviation from the bar stock diameter or section adjoining a forged portion shall be up to 1,5 times the bar stock diameter or largest cross-sectional dimension, but with a maximum value of 100 mm (see Figure 19).

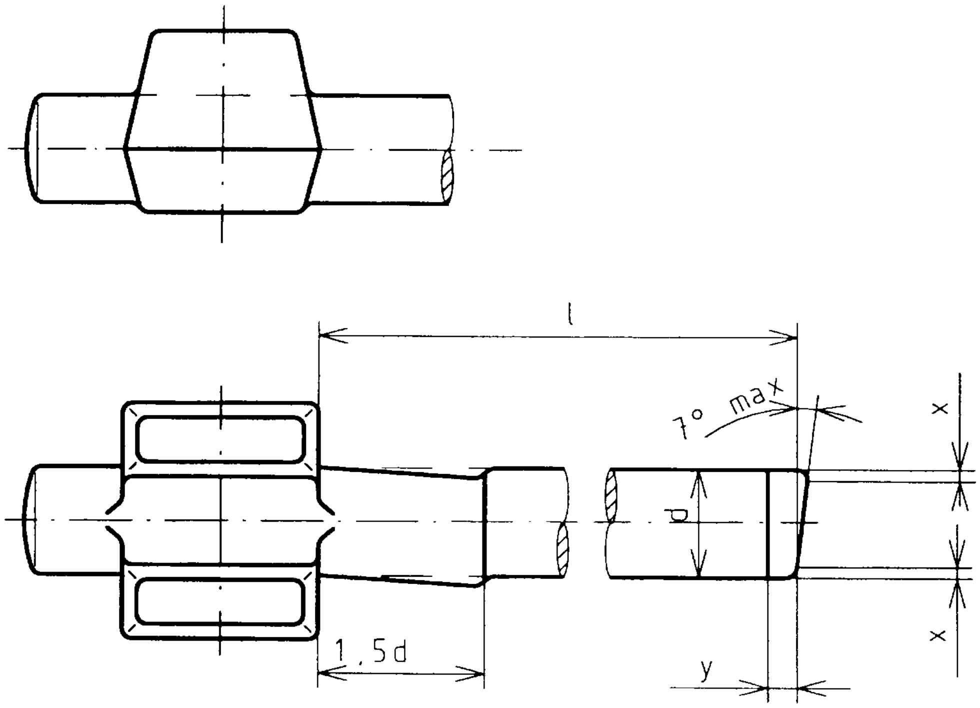


Figure 19 — Tolerances for unforged stock and sheared ends

When a forging is produced at the extremity of a portion of unforged stock, the length tolerance from any inner face of the forged portion to that extremity shall be determined from Table 1 employing the category of steel used M1 and shape complexity factor S1. Only tolerances to grade F shall be applied. The weight of the total length in question shall be calculated as if of unforged stock, irrespective of whether this is the case or not.

5.2.4.7 *Tolerances for deformation of sheared ends*

An allowance is made for distortion occurring at the end of the unforged stem of a forging due to shearing. Tolerances for the maximum permissible extent of such distortion are based on the nominal diameter of the unforged stock in accordance with Table 6 and Figure 19.

When tolerances for sheared ends are required, this will be indicated to the purchaser on the forging drawing before the commencement of production.

Tolerances for sheared ends are applied independently of, and in addition to, any other tolerances.

5.3 Deviations of form

The tolerances for lengths, widths, heights, and thicknesses cover not only the differences of dimensions, but also the deviations of form, which are:

— out of round;

— deviations form cylindricity;

— deviations from parallelism;

— other deviations from specified contour.

These deviations are not to exceed the limits given by the tolerances. In extreme cases they can cover the whole field of tolerances unless otherwise agreed between the supplier and the purchaser.

Deviations of straightness or flatness as given in Table 5 are not included in the above-mentioned faults of form. Also, the deviations of form do not include scale pits and depth of surface dressing (see **5.2.4.3**) nor any roughness of surface.

Where restrictions in deviations of form have been agreed, these will be to ISO 8015 and noted on the drawing.

6 Use of tables

6.1 Table 1 and Table 2 — Tolerances for length, width and height, residual flash (and trimmed flat), and mismatch

Normal tolerances to grade F are shown in Table 1 and close tolerances to grade E are shown in Table 2.

The same method applies for the use of all tables according to the grade of tolerances required.

To determine length, width and height tolerances, reference is first made to the appropriate category in the mass column. The horizontal line is then followed to the right. If the category of steel used is M1, the same horizontal line is followed further to the right. If the category of steel used is M2, the heavy diagonal line is followed downward to the point of intersection with the vertical line M2 and the horizontal line thus met is followed to the right (i.e. if the category is M2 the horizontal line used is moved two places downward). A similar procedure is followed for the factor of shape complexity so that downward displacement of the horizontal line used is nil, one place, two places and three places for factors S1, S2, S3 and S4 respectively. By further movement to the right, the correct tolerance is found under the appropriate vertical column heading for the dimension concerned (wherever possible the greatest dimension of length, width or height (see **5.2.1.1**). (See also Figure 20.)

EXAMPLE OF APPLICATION:

Example of the use of Table 1 — Forging grade F — for determining the tolerances for length, width, height dimensions of a forging.

Data required:

Maximum length:	77,95 mm
Maximum width:	50,7 mm
Maximum thickness:	23,0 mm
Maximum height:	18,75 mm
Density:	7,85 g/mm^3
Mass of forging:	200 g
Mass of enveloping body (7,795 × 5,07 × 2,755 × 7,85):	861 g
Shape complexity factor (see **4.4**) (200:861 = 0,232):	S3
Type of steel used:	C 45
Category of steel used (see **4.3**) (C = 0,50 < 0,65 % by mass and total MnCrMoNi = 1,43 < 5 % by mass):	M1

From Table 1 the tolerances (see Figure 20) are found to be:

length $^{+1,1}_{-0,5}$ mm;
width $^{+1,1}_{-0,5}$ mm;
height $^{+0,9}_{-0,5}$ mm.

Permissible tolerances based on the greatest dimensions are usually obtained from the appropriate table and apply to all the length, width and height dimensions.

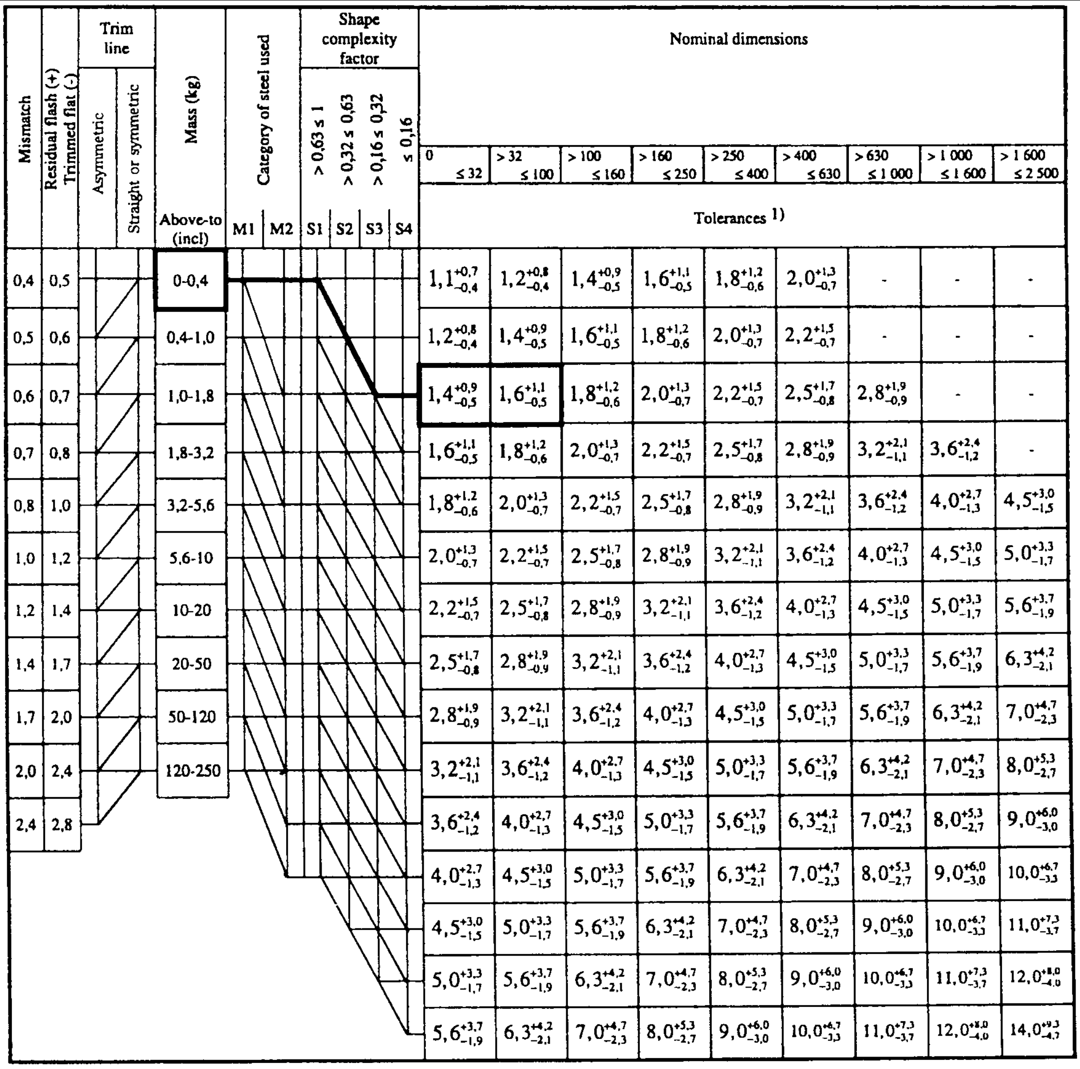


Figure 20 — Use of tables

To determine tolerances for residual flash (and trimmed flat) and for mismatch from Table 1 and Table 2, it is again necessary to commence at the appropriate category in the mass column, but then to move horizontally to the left in the table. According to whether the die line is straight, symmetrically cranked or asymmetrically cranked the correct tolerances for residual flash (and trimmed flat) and for mismatch are read from the appropriate columns (see also Figure 20).

6.2 Table 3 and Table 4 — Tolerances for thickness and ejector marks

Normal tolerances to grade F are shown in Table 3 and close tolerances to grade E are shown in Table 4.

Tolerances for thickness, based on the greatest dimension of thickness, are obtained from the appropriate table for the grade required by the same method as that described above for length, width and height tolerances in Table 1 and Table 2.

Tolerances for ejector marks are obtained by referring to the appropriate category in the weight column and moving horizontally one column to the left.

6.3 Table 5 — Tolerances for straightness, flatness and tolerances for centre-to-centre dimensions

Tolerances for straightness and flatness are obtained from the upper part of Table 5 by referring to the appropriate horizontal line for grade F or grade E, whichever is required, and by reading the tolerance under the vertical column heading for the dimension concerned.

Tolerances for centre-to-centre dimensions are obtained as indicated in **5.2.3.2**.

6.4 Table 6 — Tolerances for fillet and edge radii; tolerances for burrs; tolerances for sheared ends

Tolerances for fillet and edge radii are shown as percentages of the dimension concerned and are obtained by reference to the upper part of Table 6. Reference is made to the appropriate dimension in the left-hand column "*r*"; the positive and negative components of the tolerance are shown on the right as percentages of the nominal radius.

Tolerances for burrs are shown in the middle part of Table 6. Reference is first made to the appropriate category in the weight column and the tolerances are read off from the vertical columns headed "*u*" and "*v*".

Tolerances for sheared ends are shown in the lower part of Table 6.

7 Design procedure

7.1 Information required by the forger

In order to assist the forger to utilize his experience to best effect, both in designing his dies and tools and in establishing forging inspection procedures, it is in the purchaser's interest to supply the following information:

— a finished machined drawing;

— details and dimensions of machining locations (prior notice should be given of any subsequent changes in these location points);

— any other relevant information on machining operations and function of the component.

7.2 Preparation of forging drawing

It is recommended that the forger should prepare the forging drawing, which should then be submitted to the purchaser for approval and, if necessary, for joint consultation.

In instances where the purchaser wishes to prepare his own fully dimensioned forging drawing, it is still necessary that the drawing of the finished machined component and the other information referred to above should be made available to the forger.

7.3 Indication of dimensions on forging drawing

It is imperative to note that, with the exception concerning draft angle surfaces referred to in **5.2.4.4**, the tolerances indicated in this European Standard shall be applied only to those dimensions specifically indicated on the agreed forging drawing.

For this reason the method of indicating dimensions on the forging drawing has a vital bearing on the dimensional control of the forging.

Tolerances for dimensions not shown on the forging drawing cannot be taken from this European Standard but can be determined, if required, only by calculation based on the dimensions and tolerances which are already shown on the agreed forging drawing.

7.4 Indication of tolerances on forgoing drawings

All forging drawings should be endorsed "tolerances conform to EN 10243-1" unless otherwise indicated.

As diameter dimensions have no specific orientation the following rules apply:

— a diameter is to be treated as a width dimension when the die line is in the same plane as the diameter under consideration;

— a diameter is to be treated as a thickness dimension when the diameter is perpendicular to the die line.

For correct endorsement of forging drawings it is recommended to follow the presentation of tolerances at the foot of the drawing as given in Annex A, e.g. example 4: rocker arm.

Any tolerances which are only applicable to specific dimensions shall be indicated on the drawing against the particular dimension concerned.

Ejector mark tolerances and burr tolerances should be shown on the drawing against the specific locations.

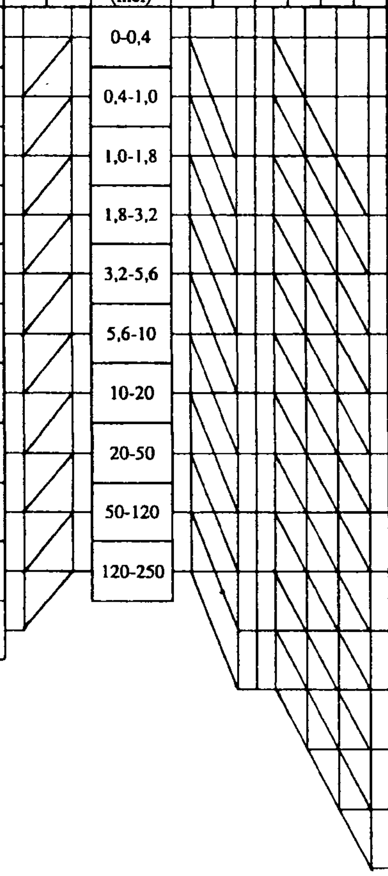
Any special tolerances agreed between the purchaser and the forger shall be indicated clearly on the forging drawing and will, wherever possible, be entered against the specific dimensions concerned.

7.5 Importance of forging drawing

The drawing of the forged part which has been accepted by the purchaser is the only valid document for inspection of the forged part. This drawing is also the only valid document for tolerances on parts of the forging remaining unmachined.

Table 1 — Drop and press forgings — Forging grade F — Tolerances for length, width, height, mismatch, residual flash and trimmed flash

Dimensions in millimetres



Mismatch	Residual flash (+) Trimmed flat (-)	Trim line: Asymmetric	Trim line: Straight or symmetric	Mass (kg) Above-to (incl)	Category of steel used: M1	M2	Shape complexity factor: > 0,63 ≤ 1 S1	> 0,32 ≤ 0,63 S2	> 0,16 ≤ 0,32 S3	≤ 0,16 S4	Nominal dimensions: 0 ≤ 32	> 32 ≤ 100	> 100 ≤ 160	> 160 ≤ 250	> 250 ≤ 400	> 400 ≤ 630	> 630 ≤ 1 000	> 1 000 ≤ 1 600	> 1 600 ≤ 2 500
											Tolerances 1)								
0,4	0,5			0-0,4							$1,1^{+0,7}_{-0,4}$	$1,2^{+0,8}_{-0,4}$	$1,4^{+0,9}_{-0,5}$	$1,6^{+1,1}_{-0,5}$	$1,8^{+1,2}_{-0,6}$	$2,0^{+1,3}_{-0,7}$	-	-	-
0,5	0,6			0,4-1,0							$1,2^{+0,8}_{-0,4}$	$1,4^{+0,9}_{-0,5}$	$1,6^{+1,1}_{-0,5}$	$1,8^{+1,2}_{-0,6}$	$2,0^{+1,3}_{-0,7}$	$2,2^{+1,5}_{-0,7}$	-	-	-
0,6	0,7			1,0-1,8							$1,4^{+0,9}_{-0,5}$	$1,6^{+1,1}_{-0,5}$	$1,8^{+1,2}_{-0,6}$	$2,0^{+1,3}_{-0,7}$	$2,2^{+1,5}_{-0,7}$	$2,5^{+1,7}_{-0,8}$	$2,8^{+1,9}_{-0,9}$	-	-
0,7	0,8			1,8-3,2							$1,6^{+1,1}_{-0,5}$	$1,8^{+1,2}_{-0,6}$	$2,0^{+1,3}_{-0,7}$	$2,2^{+1,5}_{-0,7}$	$2,5^{+1,7}_{-0,8}$	$2,8^{+1,9}_{-0,9}$	$3,2^{+2,1}_{-1,1}$	$3,6^{+2,4}_{-1,2}$	-
0,8	1,0			3,2-5,6							$1,8^{+1,2}_{-0,6}$	$2,0^{+1,3}_{-0,7}$	$2,2^{+1,5}_{-0,7}$	$2,5^{+1,7}_{-0,8}$	$2,8^{+1,9}_{-0,9}$	$3,2^{+2,1}_{-1,1}$	$3,6^{+2,4}_{-1,2}$	$4,0^{+2,7}_{-1,3}$	$4,5^{+3,0}_{-1,5}$
1,0	1,2			5,6-10							$2,0^{+1,3}_{-0,7}$	$2,2^{+1,5}_{-0,7}$	$2,5^{+1,7}_{-0,8}$	$2,8^{+1,9}_{-0,9}$	$3,2^{+2,1}_{-1,1}$	$3,6^{+2,4}_{-1,2}$	$4,0^{+2,7}_{-1,3}$	$4,5^{+3,0}_{-1,5}$	$5,0^{+3,3}_{-1,7}$
1,2	1,4			10-20							$2,2^{+1,5}_{-0,7}$	$2,5^{+1,7}_{-0,8}$	$2,8^{+1,9}_{-0,9}$	$3,2^{+2,1}_{-1,1}$	$3,6^{+2,4}_{-1,2}$	$4,0^{+2,7}_{-1,3}$	$4,5^{+3,0}_{-1,5}$	$5,0^{+3,3}_{-1,7}$	$5,6^{+3,7}_{-1,9}$
1,4	1,7			20-50							$2,5^{+1,7}_{-0,8}$	$2,8^{+1,9}_{-0,9}$	$3,2^{+2,1}_{-1,1}$	$3,6^{+2,4}_{-1,2}$	$4,0^{+2,7}_{-1,3}$	$4,5^{+3,0}_{-1,5}$	$5,0^{+3,3}_{-1,7}$	$5,6^{+3,7}_{-1,9}$	$6,3^{+4,2}_{-2,1}$
1,7	2,0			50-120							$2,8^{+1,9}_{-0,9}$	$3,2^{+2,1}_{-1,1}$	$3,6^{+2,4}_{-1,2}$	$4,0^{+2,7}_{-1,3}$	$4,5^{+3,0}_{-1,5}$	$5,0^{+3,3}_{-1,7}$	$5,6^{+3,7}_{-1,9}$	$6,3^{+4,2}_{-2,1}$	$7,0^{+4,7}_{-2,3}$
2,0	2,4			120-250							$3,2^{+2,1}_{-1,1}$	$3,6^{+2,4}_{-1,2}$	$4,0^{+2,7}_{-1,3}$	$4,5^{+3,0}_{-1,5}$	$5,0^{+3,3}_{-1,7}$	$5,6^{+3,7}_{-1,9}$	$6,3^{+4,2}_{-2,1}$	$7,0^{+4,7}_{-2,3}$	$8,0^{+5,3}_{-2,7}$
2,4	2,8										$3,6^{+2,4}_{-1,2}$	$4,0^{+2,7}_{-1,3}$	$4,5^{+3,0}_{-1,5}$	$5,0^{+3,3}_{-1,7}$	$5,6^{+3,7}_{-1,9}$	$6,3^{+4,2}_{-2,1}$	$7,0^{+4,7}_{-2,3}$	$8,0^{+5,3}_{-2,7}$	$9,0^{+6,0}_{-3,0}$
											$4,0^{+2,7}_{-1,3}$	$4,5^{+3,0}_{-1,5}$	$5,0^{+3,3}_{-1,7}$	$5,6^{+3,7}_{-1,9}$	$6,3^{+4,2}_{-2,1}$	$7,0^{+4,7}_{-2,3}$	$8,0^{+5,3}_{-2,7}$	$9,0^{+6,0}_{-3,0}$	$10,0^{+6,7}_{-3,3}$
											$4,5^{+3,0}_{-1,5}$	$5,0^{+3,3}_{-1,7}$	$5,6^{+3,7}_{-1,9}$	$6,3^{+4,2}_{-2,1}$	$7,0^{+4,7}_{-2,3}$	$8,0^{+5,3}_{-2,7}$	$9,0^{+6,0}_{-3,0}$	$10,0^{+6,7}_{-3,3}$	$11,0^{+7,3}_{-3,7}$
											$5,0^{+3,3}_{-1,7}$	$5,6^{+3,7}_{-1,9}$	$6,3^{+4,2}_{-2,1}$	$7,0^{+4,7}_{-2,3}$	$8,0^{+5,3}_{-2,7}$	$9,0^{+6,0}_{-3,0}$	$10,0^{+6,7}_{-3,3}$	$11,0^{+7,3}_{-3,7}$	$12,0^{+8,0}_{-4,0}$
											$5,6^{+3,7}_{-1,9}$	$6,3^{+4,2}_{-2,1}$	$7,0^{+4,7}_{-2,3}$	$8,0^{+5,3}_{-2,7}$	$9,0^{+6,0}_{-3,0}$	$10,0^{+6,7}_{-3,3}$	$11,0^{+7,3}_{-3,7}$	$12,0^{+8,0}_{-4,0}$	$14,0^{+9,3}_{-4,7}$

1) Tolerances are 2/3 and 1/3 (rounded values). Minus and plus signs, given in the table above, are applicable to external dimensions. For internal dimensions reverse the values. For centre-to-centre, tolerances are ± 1/2 (see **5.2.3.2**).

Table 2 — Drop and press forgings — Forging grade E — Tolerances for length, width and height

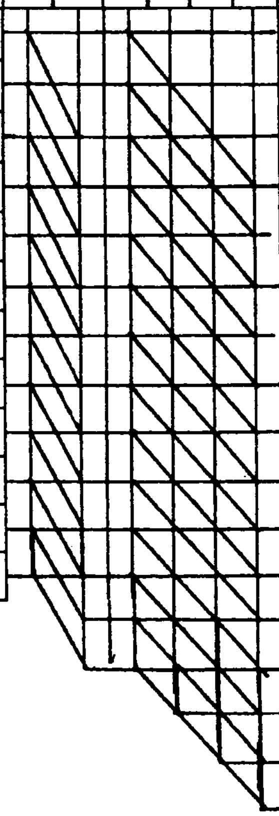
Dimensions in millimetres

Mismatch	Residual flash (+) Trimmed flat (-)	Trim line: Asymmetric	Trim line: Straight or symmetric	Mass (kg) Above-to (incl)	Category of steel used M1	Category of steel used M2	Shape complexity factor S1 > 0,63 ≤ 1	S2 > 0,32 ≤ 0,63	S3 > 0,16 ≤ 0,32	S4 ≤ 0,16	Nominal dimension 0 ≤ 32	> 32 ≤ 100	> 100 ≤ 160	> 160 ≤ 250	> 250 ≤ 400	> 400 ≤ 630	> 630 ≤ 1 000	> 1 000 ≤ 1 600	> 1 600 ≤ 2 500
											Tolerances 1)								
0,3	0,3			0-0,4							$0,7^{+0,5}_{-0,2}$	$0,8^{+0,5}_{-0,3}$	$0,9^{+0,6}_{-0,3}$	$1,0^{+0,7}_{-0,3}$	$1,1^{+0,7}_{-0,4}$	-	-	-	-
0,3	0,4			0,4-1,0							$0,8^{+0,5}_{-0,3}$	$0,9^{+0,6}_{-0,3}$	$1,0^{+0,7}_{-0,3}$	$1,1^{+0,7}_{-0,4}$	$1,2^{+0,8}_{-0,4}$	$1,4^{+0,9}_{-0,5}$	-	-	-
0,4	0,4			1,0-1,8							$0,9^{+0,6}_{-0,3}$	$1,0^{+0,7}_{-0,3}$	$1,1^{+0,7}_{-0,4}$	$1,2^{+0,8}_{-0,4}$	$1,4^{+0,9}_{-0,5}$	$1,6^{+1,1}_{-0,5}$	$1,8^{+1,2}_{-0,6}$	-	-
0,4	0,5			1,8-3,2							$1,0^{+0,7}_{-0,3}$	$1,1^{+0,7}_{-0,4}$	$1,2^{+0,8}_{-0,4}$	$1,4^{+0,9}_{-0,5}$	$1,6^{+1,1}_{-0,5}$	$1,8^{+1,2}_{-0,6}$	$2,0^{+1,3}_{-0,7}$	$2,2^{+1,5}_{-0,7}$	-
0,5	0,6			3,2-5,6							$1,1^{+0,7}_{-0,4}$	$1,2^{+0,8}_{-0,4}$	$1,4^{+0,9}_{-0,5}$	$1,6^{+1,1}_{-0,5}$	$1,8^{+1,2}_{-0,6}$	$2,0^{+1,3}_{-0,7}$	$2,2^{+1,5}_{-0,7}$	$2,5^{+1,7}_{-0,8}$	$2,8^{+1,9}_{-0,9}$
0,6	0,7			5,6-10							$1,2^{+0,8}_{-0,4}$	$1,4^{+0,9}_{-0,5}$	$1,6^{+1,1}_{-0,5}$	$1,8^{+1,2}_{-0,6}$	$2,0^{+1,3}_{-0,7}$	$2,2^{+1,5}_{-0,7}$	$2,5^{+1,7}_{-0,8}$	$2,8^{+1,9}_{-0,9}$	$3,2^{+2,1}_{-1,1}$
0,7	0,8			10-20							$1,4^{+0,9}_{-0,5}$	$1,6^{+1,1}_{-0,5}$	$1,8^{+1,2}_{-0,6}$	$2,0^{+1,3}_{-0,7}$	$2,2^{+1,5}_{-0,7}$	$2,5^{+1,7}_{-0,8}$	$2,8^{+1,9}_{-0,9}$	$3,2^{+2,1}_{-1,1}$	$3,6^{+2,4}_{-1,2}$
0,8	1,0			20-50							$1,6^{+1,1}_{-0,5}$	$1,8^{+1,2}_{-0,6}$	$2,0^{+1,3}_{-0,7}$	$2,2^{+1,5}_{-0,7}$	$2,5^{+1,7}_{-0,8}$	$2,8^{+1,9}_{-0,9}$	$3,2^{+2,1}_{-1,1}$	$3,6^{+2,4}_{-1,2}$	$4,0^{+2,7}_{-1,3}$
1,0	1,2			50-120							$1,8^{+1,2}_{-0,6}$	$2,0^{+1,3}_{-0,7}$	$2,2^{+1,5}_{-0,7}$	$2,5^{+1,7}_{-0,8}$	$2,8^{+1,9}_{-0,9}$	$3,2^{+2,1}_{-1,1}$	$3,6^{+2,4}_{-1,2}$	$4,0^{+2,7}_{-1,3}$	$4,5^{+3,0}_{-1,5}$
1,2	1,4			120-250							$2,0^{+1,3}_{-0,7}$	$2,2^{+1,5}_{-0,7}$	$2,5^{+1,7}_{-0,8}$	$2,8^{+1,9}_{-0,9}$	$3,2^{+2,1}_{-1,1}$	$3,6^{+2,4}_{-1,2}$	$4,0^{+2,7}_{-1,3}$	$4,5^{+3,0}_{-1,5}$	$5,0^{+3,3}_{-1,7}$
1,4	1,7										$2,2^{+1,5}_{-0,7}$	$2,5^{+1,7}_{-0,8}$	$2,8^{+1,9}_{-0,9}$	$3,2^{+2,1}_{-1,1}$	$3,6^{+2,4}_{-1,2}$	$4,0^{+2,7}_{-1,3}$	$4,5^{+3,0}_{-1,5}$	$5,0^{+3,3}_{-1,7}$	$5,6^{+3,7}_{-1,9}$
											$2,5^{+1,7}_{-0,8}$	$2,8^{+1,9}_{-0,9}$	$3,2^{+2,1}_{-1,1}$	$3,6^{+2,4}_{-1,2}$	$4,0^{+2,7}_{-1,3}$	$4,5^{+3,0}_{-1,5}$	$5,0^{+3,3}_{-1,7}$	$5,6^{+3,7}_{-1,9}$	$6,3^{+4,2}_{-2,1}$
											$2,8^{+1,9}_{-0,9}$	$3,2^{+2,1}_{-1,1}$	$3,6^{+2,4}_{-1,2}$	$4,0^{+2,7}_{-1,3}$	$4,5^{+3,0}_{-1,5}$	$5,0^{+3,3}_{-1,7}$	$5,6^{+3,7}_{-1,9}$	$6,3^{+4,2}_{-2,1}$	$7,0^{+4,7}_{-2,3}$
											$3,2^{+2,1}_{-1,1}$	$3,6^{+2,4}_{-1,2}$	$4,0^{+2,7}_{-1,3}$	$4,5^{+3,0}_{-1,5}$	$5,0^{+3,3}_{-1,7}$	$5,6^{+3,7}_{-1,9}$	$6,3^{+4,2}_{-2,1}$	$7,0^{+4,7}_{-2,3}$	$8,0^{+5,3}_{-2,7}$
											$3,6^{+2,4}_{-1,2}$	$4,0^{+2,7}_{-1,3}$	$4,5^{+3,0}_{-1,5}$	$5,0^{+3,3}_{-1,7}$	$5,6^{+3,7}_{-1,9}$	$6,3^{+4,2}_{-2,1}$	$7,0^{+4,7}_{-2,3}$	$8,0^{+5,3}_{-2,7}$	$9,0^{+6,0}_{-3,0}$

1) Tolerances are 2/3 and 1/3 (rounded values). Minus and plus signs, given in the table above, are applicable to external dimensions. For internal dimensions reverse the values. For centre-to-centre, tolerances are ± 1/2 (see **5.2.3.2**).

Table 3 — Drop and press forgings — Forging grade F — Tolerances for thickness and ejector marks

Dimensions in millimetres



Maximum permissible tolerances 1)	Mass (kg)	Category of steel used		Shape complexity factor				Nominal dimensions						
	Above-to (incl)	M1	M2	S1 > 0,63 ≤ 1	S2 > 0,32 ≤ 0,63	S3 > 0,16 ≤ 0,32	S4 ≤ 0,16	0 ≤ 16	> 16 ≤ 40	> 40 ≤ 63	> 63 ≤ 100	> 100 ≤ 160	> 160 ≤ 250	> 250
								Tolerances 2)						
1,0	0-0,4							$1,0^{+0,7}_{-0,3}$	$1,1^{+0,7}_{-0,4}$	$1,2^{+0,8}_{-0,4}$	$1,4^{+0,9}_{-0,5}$	$1,6^{+1,1}_{-0,5}$	$1,8^{+1,2}_{-0,6}$	$2,0^{+1,3}_{-0,7}$
1,2	0,4-1,2							$1,1^{+0,7}_{-0,4}$	$1,2^{+0,8}_{-0,4}$	$1,4^{+0,9}_{-0,5}$	$1,6^{+1,1}_{-0,5}$	$1,8^{+1,2}_{-0,6}$	$2,0^{+1,3}_{-0,7}$	$2,2^{+1,5}_{-0,7}$
1,6	1,2-2,5							$1,2^{+0,8}_{-0,4}$	$1,4^{+0,9}_{-0,5}$	$1,6^{+1,1}_{-0,5}$	$1,8^{+1,2}_{-0,6}$	$2,0^{+1,3}_{-0,7}$	$2,2^{+1,5}_{-0,7}$	$2,5^{+1,7}_{-0,8}$
2,0	2,5-5							$1,4^{+0,9}_{-0,5}$	$1,6^{+1,1}_{-0,5}$	$1,8^{+1,2}_{-0,6}$	$2,0^{+1,3}_{-0,7}$	$2,2^{+1,5}_{-0,7}$	$2,5^{+1,7}_{-0,8}$	$2,8^{+1,9}_{-0,9}$
2,4	5-8							$1,6^{+1,1}_{-0,5}$	$1,8^{+1,2}_{-0,6}$	$2,0^{+1,3}_{-0,7}$	$2,2^{+1,5}_{-0,7}$	$2,5^{+1,7}_{-0,8}$	$2,8^{+1,9}_{-0,9}$	$3,2^{+2,1}_{-1,1}$
3,2	8-12							$1,8^{+1,2}_{-0,6}$	$2,0^{+1,3}_{-0,7}$	$2,2^{+1,5}_{-0,7}$	$2,5^{+1,7}_{-0,8}$	$2,8^{+1,9}_{-0,9}$	$3,2^{+2,1}_{-1,1}$	$3,6^{+2,4}_{-1,2}$
4,0	12-20							$2,0^{+1,3}_{-0,7}$	$2,2^{+1,5}_{-0,7}$	$2,5^{+1,7}_{-0,8}$	$2,8^{+1,9}_{-0,9}$	$3,2^{+2,1}_{-1,1}$	$3,6^{+2,4}_{-1,2}$	$4,0^{+2,7}_{-1,3}$
5,0	20-36							$2,2^{+1,5}_{-0,7}$	$2,5^{+1,7}_{-0,8}$	$2,8^{+1,9}_{-0,9}$	$3,2^{+2,1}_{-1,1}$	$3,6^{+2,4}_{-1,2}$	$4,0^{+2,7}_{-1,3}$	$4,5^{+3,0}_{-1,5}$
6,4	36-63							$2,5^{+1,7}_{-0,8}$	$2,8^{+1,9}_{-0,9}$	$3,2^{+2,1}_{-1,1}$	$3,6^{+2,4}_{-1,2}$	$4,0^{+2,7}_{-1,3}$	$4,5^{+3,0}_{-1,5}$	$5,0^{+3,3}_{-1,7}$
8,0	63-110							$2,8^{+1,9}_{-0,9}$	$3,2^{+2,1}_{-1,1}$	$3,6^{+2,4}_{-1,2}$	$4,0^{+2,7}_{-1,3}$	$4,5^{+3,0}_{-1,5}$	$5,0^{+3,3}_{-1,7}$	$5,6^{+3,7}_{-1,9}$
10,0	110-200							$3,2^{+2,1}_{-1,1}$	$3,6^{+2,4}_{-1,2}$	$4,0^{+2,7}_{-1,3}$	$4,5^{+3,0}_{-1,5}$	$5,0^{+3,3}_{-1,7}$	$5,6^{+3,7}_{-1,9}$	$6,3^{+4,2}_{-2,1}$
12,6	200-250							$3,6^{+2,4}_{-1,2}$	$4,0^{+2,7}_{-1,3}$	$4,5^{+3,0}_{-1,5}$	$5,0^{+3,3}_{-1,7}$	$5,6^{+3,7}_{-1,9}$	$6,3^{+4,2}_{-2,1}$	$7,0^{+4,7}_{-2,3}$
								$4,0^{+2,7}_{-1,3}$	$4,5^{+3,0}_{-1,5}$	$5,0^{+3,3}_{-1,7}$	$5,6^{+3,7}_{-1,9}$	$6,3^{+4,2}_{-2,1}$	$7,0^{+4,7}_{-2,3}$	$8,0^{+5,3}_{-2,7}$
								$4,5^{+3,0}_{-1,5}$	$5,0^{+3,3}_{-1,7}$	$5,6^{+3,7}_{-1,9}$	$6,3^{+4,2}_{-2,1}$	$7,0^{+4,7}_{-2,3}$	$8,0^{+5,3}_{-2,7}$	$9,0^{+6,0}_{-3,0}$
								$5,0^{+3,3}_{-1,7}$	$5,6^{+3,7}_{-1,9}$	$6,3^{+4,2}_{-2,1}$	$7,0^{+4,7}_{-2,3}$	$8,0^{+5,3}_{-2,7}$	$9,0^{+6,0}_{-3,0}$	$10,0^{+6,7}_{-3,3}$
								$5,6^{+3,7}_{-1,9}$	$6,3^{+4,2}_{-2,1}$	$7,0^{+4,7}_{-2,3}$	$8,0^{+5,3}_{-2,7}$	$9,0^{+6,0}_{-3,0}$	$10,0^{+6,7}_{-3,3}$	$11,0^{+7,3}_{-3,7}$
								$6,3^{+4,2}_{-2,1}$	$7,0^{+4,7}_{-2,3}$	$8,0^{+5,3}_{-2,7}$	$9,0^{+6,0}_{-3,0}$	$10,0^{+6,7}_{-3,3}$	$11,0^{+7,3}_{-3,7}$	$12,0^{+8,0}_{-4,0}$

1) See **5.2.2.2**.

2) Tolerances are 2/3 and 1/3 (rounded values).

Table 4 — Drop and press forgings — Forging grade E — Tolerances for thickness and ejector marks

Dimensions in millimetres

Maximum permissible tolerances 1)	Mass (kg) Above-to (incl)	Category of steel used M1	M2	Shape complexity factor > 0,63 ≤ 1 S1	> 0,32 ≤ 0,63 S2	> 0,16 ≤ 0,32 S3	≤ 0,16 S4	Nominal dimensions 0 ≤ 16	> 16 ≤ 40	> 40 ≤ 63	> 63 ≤ 100	> 100 ≤ 160	> 160 ≤ 250	> 250
								Tolerances 2)						
1,0	0-0,4							$0,6^{+0,4}_{-0,2}$	$0,7^{+0,5}_{-0,2}$	$0,8^{+0,5}_{-0,3}$	$0,9^{+0,6}_{-0,3}$	$1,0^{+0,7}_{-0,3}$	$1,1^{+0,7}_{-0,4}$	$1,2^{+0,8}_{-0,4}$
1,2	0,4-1,2							$0,7^{+0,5}_{-0,2}$	$0,8^{+0,5}_{-0,3}$	$0,9^{+0,6}_{-0,3}$	$1,0^{+0,7}_{-0,3}$	$1,1^{+0,7}_{-0,4}$	$1,2^{+0,8}_{-0,4}$	$1,4^{+0,9}_{-0,5}$
1,6	1,2-2,5							$0,8^{+0,5}_{-0,3}$	$0,9^{+0,6}_{-0,3}$	$1,0^{+0,7}_{-0,3}$	$1,1^{+0,7}_{-0,4}$	$1,2^{+0,8}_{-0,4}$	$1,4^{+0,9}_{-0,5}$	$1,6^{+1,1}_{-0,5}$
2,0	2,5-5							$0,9^{+0,6}_{-0,3}$	$1,0^{+0,7}_{-0,3}$	$1,1^{+0,7}_{-0,4}$	$1,2^{+0,8}_{-0,4}$	$1,4^{+0,9}_{-0,5}$	$1,6^{+1,1}_{-0,5}$	$1,8^{+1,2}_{-0,6}$
2,4	5-8							$1,0^{+0,7}_{-0,3}$	$1,1^{+0,7}_{-0,4}$	$1,2^{+0,8}_{-0,4}$	$1,4^{+0,9}_{-0,5}$	$1,6^{+1,1}_{-0,5}$	$1,8^{+1,2}_{-0,6}$	$2,0^{+1,3}_{-0,7}$
3,2	8-12							$1,1^{+0,7}_{-0,4}$	$1,2^{+0,8}_{-0,4}$	$1,4^{+0,9}_{-0,5}$	$1,6^{+1,1}_{-0,5}$	$1,8^{+1,2}_{-0,6}$	$2,0^{+1,3}_{-0,7}$	$2,2^{+1,5}_{-0,7}$
4,0	12-20							$1,2^{+0,8}_{-0,4}$	$1,4^{+0,9}_{-0,5}$	$1,6^{+1,1}_{-0,5}$	$1,8^{+1,2}_{-0,6}$	$2,0^{+1,3}_{-0,7}$	$2,2^{+1,5}_{-0,7}$	$2,5^{+1,7}_{-0,8}$
5,0	20-36							$1,4^{+0,9}_{-0,5}$	$1,6^{+1,1}_{-0,5}$	$1,8^{+1,2}_{-0,6}$	$2,0^{+1,3}_{-0,7}$	$2,2^{+1,5}_{-0,7}$	$2,5^{+1,7}_{-0,8}$	$2,8^{+1,9}_{-0,9}$
6,4	36-63							$1,6^{+1,1}_{-0,5}$	$1,8^{+1,2}_{-0,6}$	$2,0^{+1,3}_{-0,7}$	$2,2^{+1,5}_{-0,7}$	$2,5^{+1,7}_{-0,8}$	$2,8^{+1,9}_{-0,9}$	$3,2^{+2,1}_{-1,1}$
8,0	63-110							$1,8^{+1,2}_{-0,6}$	$2,0^{+1,3}_{-0,7}$	$2,2^{+1,5}_{-0,7}$	$2,5^{+1,7}_{-0,8}$	$2,8^{+1,9}_{-0,9}$	$3,2^{+2,1}_{-1,1}$	$3,6^{+2,4}_{-1,2}$
10,0	110-200							$2,0^{+1,3}_{-0,7}$	$2,2^{+1,5}_{-0,7}$	$2,5^{+1,7}_{-0,8}$	$2,8^{+1,9}_{-0,9}$	$3,2^{+2,1}_{-1,1}$	$3,6^{+2,4}_{-1,2}$	$4,0^{+2,7}_{-1,3}$
12,6	200-250							$2,2^{+1,5}_{-0,7}$	$2,5^{+1,7}_{-0,8}$	$2,8^{+1,9}_{-0,9}$	$3,2^{+2,1}_{-1,1}$	$3,6^{+2,4}_{-1,2}$	$4,0^{+2,7}_{-1,3}$	$4,5^{+3,0}_{-1,5}$
								$2,5^{+1,7}_{-0,8}$	$2,8^{+1,9}_{-0,9}$	$3,2^{+2,1}_{-1,1}$	$3,6^{+2,4}_{-1,2}$	$4,0^{+2,7}_{-1,3}$	$4,5^{+3,0}_{-1,5}$	$5,0^{+3,3}_{-1,7}$
								$2,8^{+1,9}_{-0,9}$	$3,2^{+2,1}_{-1,1}$	$3,6^{+2,4}_{-1,2}$	$4,0^{+2,7}_{-1,3}$	$4,5^{+3,0}_{-1,5}$	$5,0^{+3,3}_{-1,7}$	$5,6^{+3,7}_{-1,9}$
								$3,2^{+2,1}_{-1,1}$	$3,6^{+2,4}_{-1,2}$	$4,0^{+2,7}_{-1,3}$	$4,5^{+3,0}_{-1,5}$	$5,0^{+3,3}_{-1,7}$	$5,6^{+3,7}_{-1,9}$	$6,3^{+4,2}_{-2,1}$
								$3,6^{+2,4}_{-1,2}$	$4,0^{+2,7}_{-1,3}$	$4,5^{+3,0}_{-1,5}$	$5,0^{+3,3}_{-1,7}$	$5,6^{+3,7}_{-1,9}$	$6,3^{+4,2}_{-2,1}$	$7,0^{+4,7}_{-2,3}$
								$4,0^{+2,7}_{-1,3}$	$4,5^{+3,0}_{-1,5}$	$5,0^{+3,3}_{-1,7}$	$5,6^{+3,7}_{-1,9}$	$6,3^{+4,2}_{-2,1}$	$7,0^{+4,7}_{-2,3}$	$8,0^{+5,3}_{-2,7}$

1) See **5.2.2.2**.

2) Tolerances are 2/3 and 1/3 (rounded values).

Table 5 — Drop and press forgings — Tolerances for straightness, flatness and centre-to-centre dimensions

Dimensions in millimetres

Range tolerances for straightness and flatness

Length above-to (included)		Nominal dimensions														
		0 100	100 125	125 160	160 200	200 250	250 315	315 400	400 500	500 630	630 800	800 1 000	1 000 1 250	1 250 1 600	1 600 2 000	2 000 2 500
		Tolerances														
Grade	F	0,6	0,7	0,8	0,9	1,0	1,1	1,2	1,4	1,6	1,8	2,0	2,2	2,5	2,8	3,2
	E	0,4	0,5	0,5	0,6	0,6	0,7	0,8	0,9	1,0	1,1	1,2	1,4	1,6	1,8	2,0

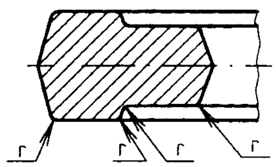
Range of tolerances for centre-to-centre dimensions

Length above-to (included)		Nominal dimensions										
		0 100	100 160	160 200	200 250	250 315	315 400	400 500	500 630	630 800	800 1 000	1 000 1 250
		Tolerances										
Grade	F	0,6 ± 0,3	0,8 ± 0,4	1,0 ± 0,5	1,2 ± 0,6	1,6 ± 0,8	2,0 ± 1,0	2,4 ± 1,2	3,2 ± 1,6	4,0 ± 2,0	5,0 ± 2,5	6,4 ± 3,2
	E	0,5 ± 0,25	0,6 ± 0,3	0,8 ± 0,4	1,0 ± 0,5	1,2 ± 0,6	1,6 ± 0,8	2,0 ± 1,0	2,4 ± 1,2	3,2 ± 1,6	4,0 ± 2,0	5,0 ± 2,5

Table 6 — Drop and press forgings — Tolerances for fillet, edge radii, burrs and sheared ends

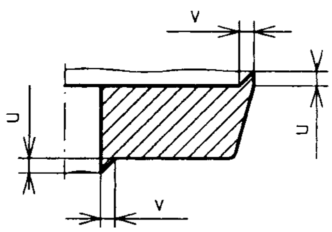
Fillet and edge radii tolerances

r (mm)	+	−
$r \leq 10$	50 %	25 %
$10 < r \leq 32$	40 %	20 %
$32 < r \leq 100$	32 %	15 %
$r > 100$	25 %	10 %



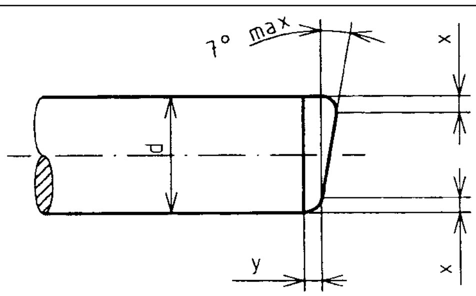
Burr tolerances

Mass (kg) above-to (included)	*u* mm	*v* mm
$m \leq 1$	1	0,5
$1 < m \leq 6$	1,6	0,8
$6 < m \leq 40$	2,5	1,2
$40 < m \leq 250$	4	2



Tolerances for deformations of sheared ends

Nominal diameter of the unforged stock	Tolerances *x*	Tolerances *y*
≤ 36	0,07 *d*	*d*
> 36	0,05 *d*	0,7 *d*



Annex A (informative) Examples of application

A.0 Content

General remarks concerning the examples:

Example 1 Gear
Example 2 Crankshaft
Example 3 Stub axle
Example 4 Rocker arm

A.1 General remarks concerning the examples

This annex illustrates the procedure for obtaining the dimensional tolerances for typical forged components. The tolerance grade and tolerances given on the drawings are examples only and should not be regarded as either mandatory, recommended or minimum requirements since in practice the tolerances will depend on both the capability of the forging equipment and the requirements of the purchaser.

As a general rule grade F tolerances result in a cheaper forged component. The cost of the forged part can be higher if grade E tolerances are selected, but the need for subsequent machining operations can often be reduced.

Reference dimensions included in the examples are given in brackets. These are dimensions which would lead to over definition geometrically, or contradictions when given a tolerance. They are not used for check measurements on the actual forging, but for tool construction when forging dimensions are not measurable.

Where any special tolerances are applicable they are indicated in the example by a small solid black circle alongside the tolerance.

A.2 Example 1: Gear

Material C 35 E according to EN 10083-1.

A.2.1 *General*

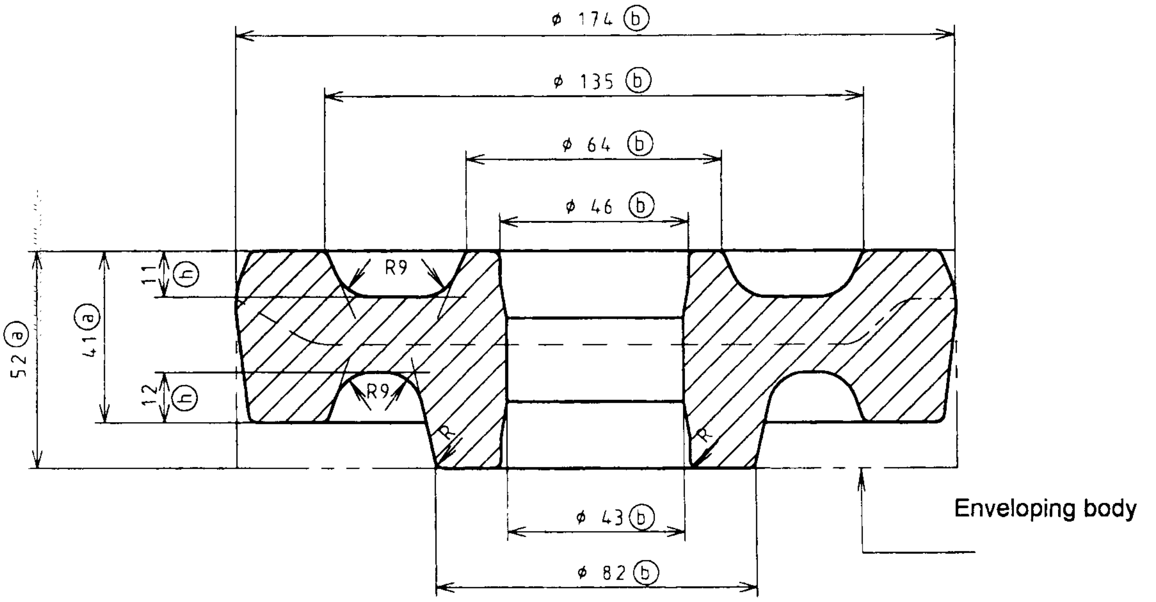
The gear is manufactured by drop or press forging. Dimensional precision requirements are rigorous to the point that a choice may be made between forging grade F or forging grade E. To avoid extra expense, it is essential that all the dimensions be admitted into forging grade F.

A.2.2 *Information necessary for determining the tolerances*

Maximum diameter:	174 mm
Maximum height:	41 mm
Maximum thickness:	52 mm
Mass of the gear (calculated):	5,35 kg
Mass of the enveloping body (cylinder with diameter of 174 mm and length of 52 mm) (calculated):	9,70 kg
Shape complexity factor at 5.35:9,70 = 0,55 (see **4.4**):	Group S2
Category of steel for C 35 E with content C = 0,40 % by mass < 0,65 % by mass and Mn = 0,80 % by mass < 5 % by mass (see **4.3**):	Group M1
Die line:	Symmetrically cranked

A.2.3 *Determining the tolerances from the tables according to EN 10243-1*

Dimensions	Permissible variations (mm) at	
	forging grade F	forging grade E
Diameter (width) dimensions	Table 1: $^{+1,9}_{-0,9}$	Table 2: $^{+1,2}_{-0,6}$
Height dimensions	Table 1: $^{+1,5}_{-0,7}$	Table 2: $^{+0,9}_{-0,5}$
Thickness dimensions	Table 3: $^{+1,5}_{-0,7}$	Table 4: $^{+0,9}_{-0,5}$
Mismatch	Table 1: 0,8	Table 2: 0,5
Residual flash/depth of chamfer	Table 1: 1,0	Table 2: 0,6



Key

b = Width dimensions

h = Height dimensions

a = Thickness dimensions

EXAMPLE 1: Gear

Tolerances and permissible variations according to EN 10243-1				
Forging mass	**Mass of enveloping body**	**Shape complexity factor**	**Category of steel**	**Forging grade**
5,35 kg	9,70 kg	Group S2	Group M1	F

Type of dimension	**Tolerances and permissible variations**	**Type of dimension**		**Tolerances and permissible variations**
Length dimensions[a]	—	Trimming burr	Height	—
	—		Width	—
Width/diameter dimensions[a]	$^{+1,9}_{-0,9}$	Die line fin	Height	—
			Width	—
Height dimensions[a]	$^{+1,5}_{-0,7}$	Special tolerances		No
Thickness/diameter dimensions	$^{+1,5}_{-0,7}$	Fillets and edge radii according to Table 6		
Mismatch[b]	0,8	Depth of surface imperfections according to **5.2.4.3**		
Residual flash (+), depth of chamfer (–)[b]	1,0			
Straightness and flatness[b]	—			

[a] For internal dimensions, interchange numerical values for + and – variations.

[b] Additional to other tolerances.

A.3 Example 2: Crankshaft

Material 28Mn6 according to EN 10083-1.

A.3.1 *General*

The crankshaft is generally forged in presses. The crankshaft in this example is to be located from its centre for machining purposes and therefore all length dimensions are indicated as starting from the centre.

A.3.2 *Information necessary for determining the tolerances*

Maximum length:	431 mm
Maximum width:	150 mm
Maximum height:	65 mm
Maximum thickness:	130 mm
Mass of the crankshaft (calculated):	18 kg
Mass of the enveloping body (rectangular block with length of 431 mm, width of 150 mm and height of 130 mm) (calculated):	66 kg
Shape complexity factor at 18:66 = 0,273 (see **4.4**):	Group S3
Category of steel for 28Mn6 with C content = 0,28 % by mass < 0,65 % by mass and Mn = 1,5 % by mass < 5 % by mass (see **4.3**):	Group M1
Die line:	Straight

A.3.3 *Determining the tolerances from the tables according to EN 10243-1*

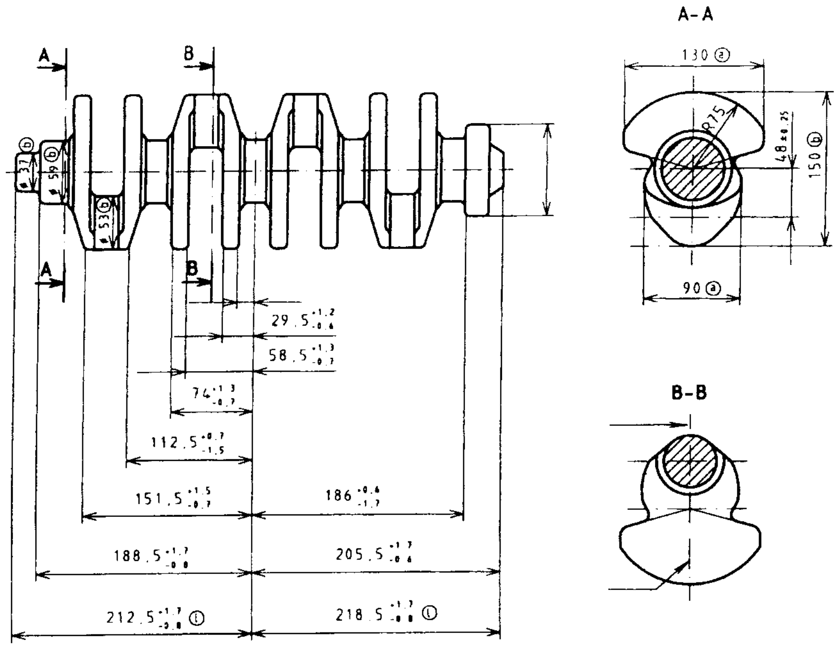
Dimensions	Permissible variations (mm) at	
	forging grade F	forging grade E
Length dimensions	Table 1: $^{+3,3}_{-1,7}$	Table 2: $^{+2,1}_{-1,1}$
Width/diameter dimensions	Table 1: $^{+2,4}_{-1,2}$	Table 2: $^{+1,5}_{-0,7}$
Height dimensions	Table 1: $^{+2,1}_{-1,1}$	Table 2: $^{+1,3}_{-0,7}$
Thickness/diameter dimensions	Table 3: $^{+2,7}_{-1,3}$	Table 4: $^{+1,7}_{-0,8}$
Mismatch	Table 1: 1,2	Table 2: 0,7
Residual flash/depth of chamfer	Table 1: 1,4	Table 2: 0,8
Straightness and flatness	Table 5: 1,4	Table 5: 0,9

The tolerances for the greatest length dimension are too large for general application to all the other length dimensions owing to the special manner in which they are entered. Therefore, tolerances for each length dimension are determined separately from the corresponding nominal dimension ranges of Table 2 for forging grade E.

Since the tolerances for the overall width, which normally are also applied to centre distances lying in the width direction, are too large for the 48 mm centre distance, the tolerances are obtained from Table 5 for forging grade E (±0,25 mm).

A.3.4 *Entry of tolerances on the forging drawing*

The tolerances for the length dimensions and for the centre distance are entered directly against these dimensions. In the case of length dimensions which are internal dimensions the maximum and minimum values of the permissible variations are interchanged with one another. All the other tolerances are entered in the corresponding columns of the table on the forging drawing.



Key

l = Length dimensions

b = Width dimensions

a = Thickness dimensions

EXAMPLE 2: Crankshaft

Tolerances and permissible variations according to EN 10243-1

Forging mass	Mass of enveloping body	Shape complexity factor	Category of steel	Forging grade
18 kg	66 kg	Group S3	Group M1	E

Type of dimension	Tolerances and permissible variations	Type of dimension		Tolerances and permissible variations
Length dimensions[a]	According to nominal dimension ranges	Trimming burr	Height	—
Width/diameter dimensions[a]	$^{+1,5}_{-0,7}$		Width	—
Height dimensions[a]	$^{+1,3}_{-0,7}$	Die line fin	Height	—
Thickness/diameter dimensions	$^{+1,7}_{-0,8}$		Width	—
Mismatch[b]	0,7	Special tolerances		No
Residual flash (+), depth of chamfer (–)[b]	0,8	Fillets and edge radii according to Table 6		
Straightness and flatness[b]	0,9	Depth of surface imperfections according to **5.2.4.3**		

[a] For internal dimensions, interchange numerical values for + and – variations.

[b] Additional to other tolerances.

A.4 Example 3: Stub axle

Material 42CrMo4 according to EN 10083-1:1991.

A.4.1 *General*

The stub axle is generally forged in hammers or presses. In view of the long shank its total thickness is very large so that by using forging grade F large tolerances for thickness dimensions would be obtained. Therefore, in this case, special tolerances were specified for the thickness dimensions.

A.4.2 *Information necessary for determining the tolerances*

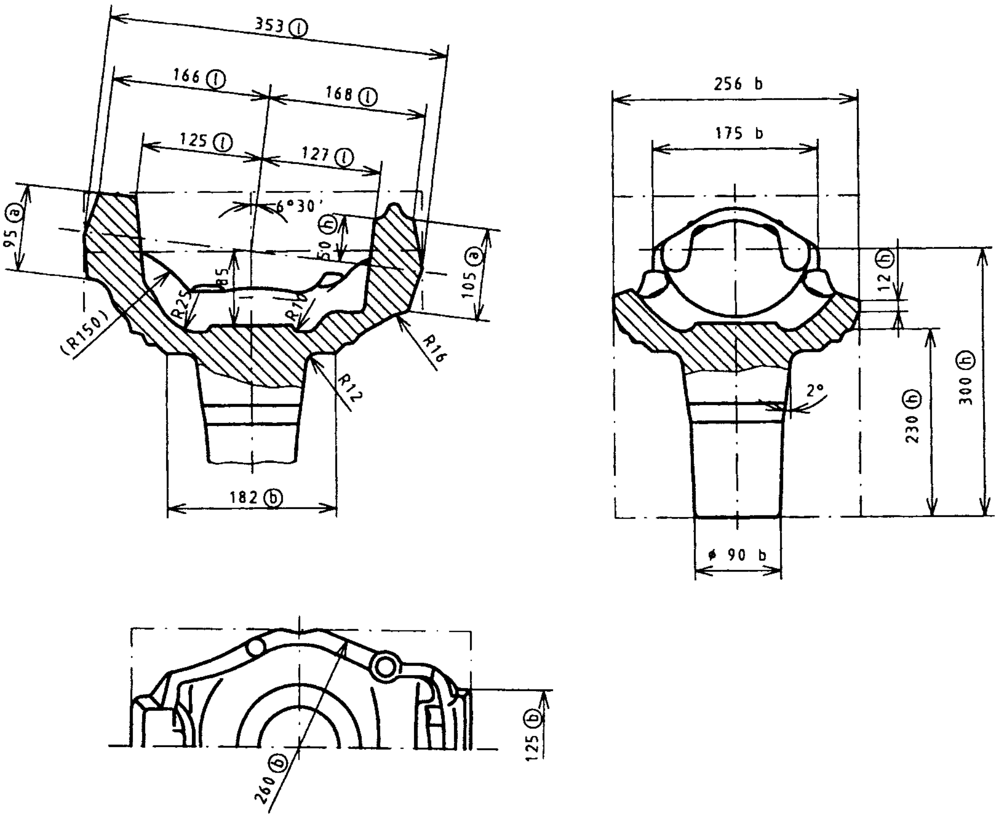
Maximum length:	353 mm
Maximum width:	256 mm
Maximum height:	300 mm
Maximum thickness (calculated):	366 mm
Mass of the stub axle (calculated):	39 kg
Mass of the enveloping body (rectangular block with width of 256 mm, length of 353 mm and height of 366 mm):	260 kg
Shape complexity factor at 39:260 = 0,15 (see **4.4**):	Group S4
Category of steel for 42CrMo4 with C content = 0,45 % by mass < 0,65 % by mass and summary MnCrMo = 2,4 % by mass < 5 % by mass (see **4.3**):	Group M1
Die line:	Asymmetrically cranked

A.4.3 *Determining the tolerances from the tables according to EN 10243-1*

Dimensions	Permissible variations (mm) at	
	forging grade F	forging grade E
Length dimensions	Table 1: $^{+3,7}_{-1,9}$	Table 2: $^{+2,4}_{-1,2}$
Width/diameter dimensions	Table 1: $^{+3,7}_{-1,9}$	Table 2: $^{+3,7}_{-1,9}$
Height dimensions	Table 1: $^{+3,7}_{-1,9}$	Table 2: $^{+2,4}_{-1,2}$
Thickness/diameter dimensions	Table 3: $^{+4,7}_{-2,3}$	Table 4: $^{+3,0}_{-1,5}$
Mismatch	Table 1: 1,7	Table 2: 1,0
Residual flash/depth of chamfer	Table 1: 2,0	Table 2: 1,2
Straightness and flatness	Table 5: 1,2	Table 5: 0,8

A.4.4 *Entry of tolerances on the forging drawing*

All the agreed tolerances determined above are entered in the corresponding columns of the table on the forging drawing. Since special tolerances have been determined for height and thickness dimensions it is advisable, for the purpose of simplifying future checks, to make reference to these special tolerances also in the columns for height dimensions and thickness dimensions. In this special case all height and thickness dimensions are included.



Key

l = Length dimensions

b = Width dimensions

h = Height dimensions

a = Thickness dimensions

EXAMPLE 3: Stub axle

Tolerances and permissible variations according to EN 10243-1				
Forging mass	**Mass of enveloping body**	**Shape complexity factor**	**Category of steel**	**Forging grade**
39 kg	260 kg	Group S4	Group M1	F

Type of dimension	**Tolerances and permissible variations**	**Type of dimension**		**Tolerances and permissible variations**
Length dimensions[a]	$^{+3.7}_{-1.9}$	Trimming burr	Height	2,5
			Width	1,2
Width/diameter dimensions[a]	$^{+3.7}_{-1.9}$	Die line fin	Height	—
			Width	—
Height dimensions[a]	● $^{+3.0}_{-1.5}$	Special tolerances		●
Thickness/diameter dimensions	● $^{+3.7}_{-1.9}$	Fillets and edge radii according to Table 6		
Mismatch[b]	1,7			
Residual flash (+), depth of chamfer (–)[b]	2,0	Depth of surface imperfections according to **5.2.4.3**		
Straightness and flatness[b]	1,2			

[a] For internal dimensions, interchange numerical values for + and – variations.

[b] Additional to other tolerances.

● In this case special tolerances have been agreed.

A.5 Example 4: Rocker arm

Material C45 according to EN 10083-2:1991.

A.5.1 *General*

The rocker arm is forged in hammers or presses. The demands on its dimensional accuracy are so exacting that, by way of exception, adoption of the tolerances for forging grade E is necessary for all dimensions. For thickness dimensions, in so far as they include functional surfaces, the standard of dimensional accuracy required is such that it can only be met by an additional operation (cold sizing). For centre distances the tolerances for forging grade E from Table 5 are applied. Additional to the dimensional tolerances there is also a weight tolerance, which restricts the full use of the dimensional tolerances.

A.5.2 *Information necessary for determining the tolerances*

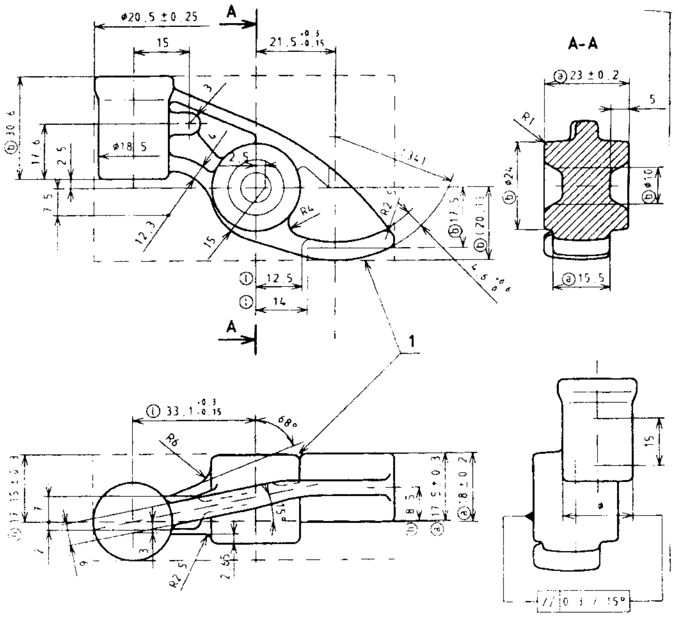
Maximum length (calculated from 67,7 mm + 0,5 × 20,5 mm):	77,95 mm
Maximum width (calculated from 20,1 mm + 30,6 mm):	50,7 mm
Maximum height (calculated from 8,5 mm + 0,5 × 20,5 mm):	18,75 mm
Maximum thickness:	23,0 mm
Mass of the rocker arm (calculated):	0,200 kg
Mass of the enveloping body (rectangular block with length of 77,95 mm, width of 50,7 mm and height of 18,75 mm) (calculated):	0,861 kg
Shape complexity factor at 0,200:861 = 0,232 (see **4.4**):	Group S3
Category of steel for C45 with C content = 0,45 % by mass < 0,65 % by mass and summary MnCrMoNi = 1,43 % by mass < 5 % by mass (see **4.3**):	Group M1
Die line	Asymmetrically cranked

A.5.3 *Determining the tolerances from the tables according to EN 10243-1*

Dimensions	Permissible variations (mm) at	
	forging grade F	forging grade E
Length dimensions	Table 1: $^{+1,1}_{-0,5}$	Table 2: $^{+0,7}_{-0,3}$
Width/diameter dimensions	Table 1: $^{+1,1}_{-0,5}$	Table 2: $^{+0,7}_{-0,3}$
Height dimensions	Table 1: $^{+0,9}_{-0,5}$	Table 2: $^{+0,6}_{-0,3}$
Thickness/diameter dimensions	Table 3: $^{+0,9}_{-0,5}$	Table 4: $^{+0,6}_{-0,3}$
Mismatch	Table 1: 0,5	Table 2: 0,3
Residual flash/depth of chamfer	Table 1: 0,6	Table 2: 0,4
Straightness and flatness	Table 5: 0,6	Table 5: 0,4

A.5.4 *Entry of tolerances on the forging drawing*

Apart from the tolerances for the centre distances, all the other tolerances determined from the tables are entered in the table on the forging drawing. The tolerances for centre distances obtained from Table 5 and the special tolerances agreed are entered against the dimensions concerned on the forging drawing. The tighter tolerances are identified as special tolerances involving an extra operation in manufacture by the addition of a * and the annotation “sized dimensions”.



Key

l = Length dimensions

b = Width dimensions

h = Height dimensions

a = Thickness dimensions

EXAMPLE 4: Rocker arm

Tolerances and permissible variations according to EN 10243-1				
Forging mass	**Mass of enveloping body**	**Shape complexity factor**	**Category of steel**	**Forging grade**
0,200 kg	0,861 kg	Group S3	Group M1	E

Type of dimension	**Tolerances and permissible variations**	**Type of dimension**		**Tolerances and permissible variations**
Length dimensions[a]	$^{+0,7}_{-0,3}$	Trimming burr	Height	—
			Width	—
Width/diameter dimensions[a]	$^{+0,7}_{-0,3}$	Die line fin	Height	—
			Width	—
Height dimensions[a]	$^{+0,6}_{-0,3}$	Special tolerances		●
Thickness/diameter dimensions	$^{+0,6}_{-0,3}$	Fillets and edge radii according to Table 6		
Mismatch[b]	0,3			
Residual flash (+), depth of chamfer (–)[b]	0,4	Depth of surface imperfections according to **5.2.4.3**		
Straightness and flatness[b]	0,2			

[a] For internal dimensions, interchange numerical values for + and – variations.
[b] Additional to other tolerances.

● In this case special tolerances have been agreed.

blank

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