International Standard ISO 4464

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Tolerances for building — Relationship between the different types of deviations and tolerances used for specification

Tolérances pour le bâtiment — Liaison entre les divers types d'écarts et de tolérances utilisés pour la spécification

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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 4464 was developed by Technical Committee ISO/TC 59, *Building construction*, and was circulated to the member bodies in February 1977.

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

Australia
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No member body expressed disapproval of the document.

Tolerances for building — Relationship between the different types of deviations and tolerances used for specification

0 Introduction

This International Standard forms one of a series concerning tolerances for building and building components. Some of these are already published (see clause 3). The others currently being prepared concern the following subjects :

- calculation of joint clearance and prediction of fit;
- methods for predicting deviations of assemblies and distribution of tolerances;
- series of values to be used for specification of tolerances;
- indication of tolerances on building and civil engineering drawing.

This series will continue with methods for the use of tolerances in sampling, quality control and approval.

Processes of manufacture, setting out, and erection on site of building components induce deviations. Tolerances define the limits of deviations and this International Standard identifies the tolerances that need to be considered. Not all of these tolerances will be relevant in every case; they may be used individually.

1 Scope

This International Standard describes the various types of tolerances which can be used in specifying accuracy in manufacture, setting out and erection. It illustrates where the deviations exist which are limited by these tolerances. Examples are given for deviations of different kinds existing together.

NOTE — The indications given on each expression are not, strictly speaking, definitions [which is the role of ISO 1803 (currently being revised)] but aim only to distinguish each expression from the others.

2 Field of application

This International Standard applies to components, both prefabricated and formed *in situ*, and spaces in all forms of building construction.

3 References

ISO 1101, *Technical drawings — Geometrical tolerancing — Tolerances of form, orientation, location and runout — Generalities, definitions, symbols, indication on drawings.*[1)]

ISO 1803, *Tolerances for building — Vocabulary.*[2)]

ISO 3443/1, *Tolerances for building — Part 1 : Basic principles for evaluation and specification.*

ISO 3443/2, *Tolerances for building — Part 2 : Statistical basis for predicting fit between components having a normal distribution of sizes.*

ISO 4463, *Measurement methods for building — Setting-out and measurement — Permissible measuring deviations.*

4 General

This International Standard deals with induced geometrical deviations in the processes of manufacture, setting out and erection caused, for example, by human error, inaccuracy of tools and limitations in the precision of instrumental measurement. Inherent deviations caused by physical and chemical changes, such as variations in temperature, moisture content, and strain, occur at the same time. It is therefore necessary when dealing with tolerances to specify reference conditions for example of temperature, humidity, loading and age under which the tolerances apply.

1) At present at the stage of draft. (Revision of ISO/R 1101-1969.)

2) ISO 1803 is still in force but is currently being revised. Since the ideas on which ISO 4464 is based are sometimes different, it should be used on its own and without referring to ISO 1803, cross-referencing not always being possible between these two documents. Furthermore, the authors of the revision of ISO 1803 which is being prepared are aware of the need for consistency between ISO 1803 revised, when its drafting is complete, and ISO 4464. All necessary modifications to these two documents can then be made.

5 Framework for tolerances

A framework for tolerances can be illustrated according to figure 1.

In order to specify optimized values, this diagram can be read from right to left as well as from left to right.

6 Tolerances[1]

The various types of tolerances covered by the system shown in clause 5 may be described as follows.

6.1 construction tolerance : The width of the space[2] on the site, related to reference points or lines, within the limits of which a point, a line or a surface of a component shall be situated.

NOTE — Manufacturing tolerance, setting-out tolerance and erection tolerance together compose the construction tolerance. Construction tolerances are determined by the requirements of the construction for satisfactory performance.

6.2.1 manufacturing tolerance : The width of the space related to the reference form, within the limits of which a point, a line or a surface of a component shall be situated after manufacture.

NOTE — Dimensional tolerance, orientation tolerance and form tolerance together compose the manufacturing tolerance. The latter is not related to any reference object on the site. See the "box principle" (clause 8).

6.2.2 setting-out tolerance : The width of the space on the site within the limits of which a setting-out point or line shall be situated.

NOTE — The positional and orientation tolerances for setting out together compose the setting-out tolerances.

6.2.3 erection tolerance : The width of the space on the site, related to the actual form of a component and the actual position for reference points or lines, within the limits of which a point, a line or a surface of a component shall be situated.

NOTE — For each component there is a reference position determined by reference points or lines set out on the site and by the actual form of the component. This position also gives the reference position for each point, line or surface of the component. From these positions, the erection tolerance determines the width of the space within the limits of which a given point, line or surface of the component shall be situated. The positional and orientation tolerances for erection together compose the erection tolerance.

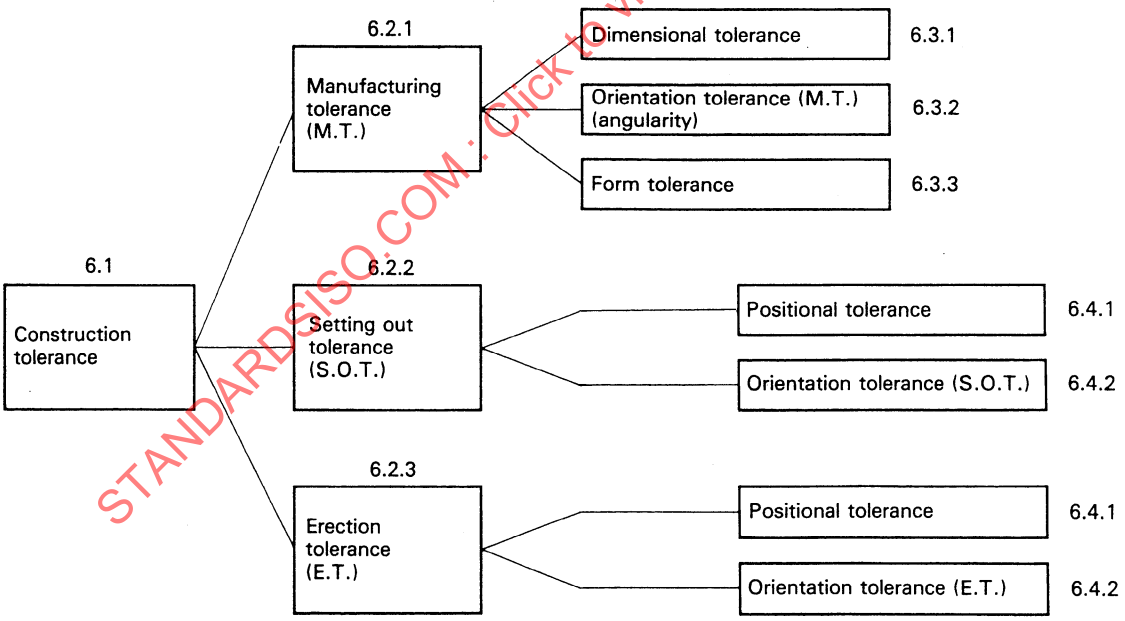


Figure 1 — Illustrative framework of tolerances

1) The numbering system used has been adopted in order to emphasize the relation between the different types of tolerance. A similar numbering system has been used for the deviations (see clause 7).

2) This space is generally indicated by the reference size and permitted deviations or permitted limits of size.

6.3.1 dimensional tolerance : The tolerance width governing the size of a dimension in a given direction of the component concerned : length, width, thickness, height, depth or diameter.

6.3.2 orientation tolerance (angularity) (M.T.) : The tolerance width governing the relative orientation of straight lines or planes of a component. (See also 6.4.2 and figure 1.)

6.3.3 form tolerance : The tolerance width governing the form of a line or a surface (e.g. of a component) relative to a reference form.

6.4.1 positional tolerance : The tolerance width governing the position of a point, a line, a plane or a surface relative to a reference position.

6.4.2 orientation tolerance (S.O.T.) (E.T.) : The tolerance width, after setting out or erection, governing the orientation of a straight line or plane surface relative to a reference orientation. (See also 6.3.2 and figure 1.)

7 Deviations

The deviations corresponding to the tolerances described in clause 6 are illustrated in this clause. Where it is desired to determine constituent deviations, they shall be measured as indicated in the figures. Alternatively, the manufacturing deviations may be determined according to the "box principle" (cf. clause 8). This specifies direct requirements for characteristics of importance to the insertion of a component without the necessity of differentiating between the constituent deviations. The envelope of deviations determined in this way may be used in calculations of the effect of deviations on fit.

Key to figures

●	actual position of a point
○	reference position for said point
———————— (thick)	actual position for a line
— — — — — — — —	reference position for said line
———————— (thin)	reference line

The location of components relative to reference lines may be specified in several ways. Four examples are given in figure 2. In this International Standard, the method shown in figure 2a) will be used.

7.1 construction deviation : The difference between the actual position of a point, line or surface of a component and the corresponding reference position established on the site. (See figure 3, stage 4.)

NOTE — In practice, the reference position must be established by using selected points, lines or planes of a component.

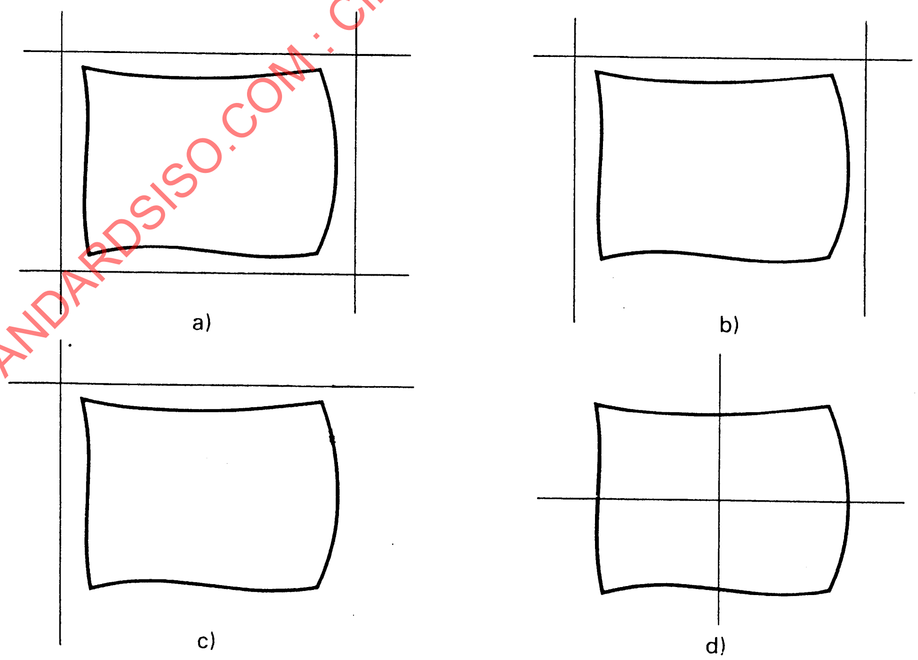


Figure 2 — Various ways of locating reference lines

7.2.1 manufacturing deviation : The difference between the actual position of a point, line or surface of a component and the corresponding position according to the reference form of the component. (See figure 3, stage 1.)

7.2.2 setting out deviation : The difference between the actual position of a point, a line or a surface after setting out and the corresponding reference position. (See figure 3, stage 2.)

7.2.3 erection deviation : The difference between the actual position of a point, line or surface of a component and the corresponding reference position as determined by the reference form of the component and setting out lines on the site. (See figure 3, stage 3.)

NOTE — In practice, the reference position must be defined by using selected points, lines or planes of a component.

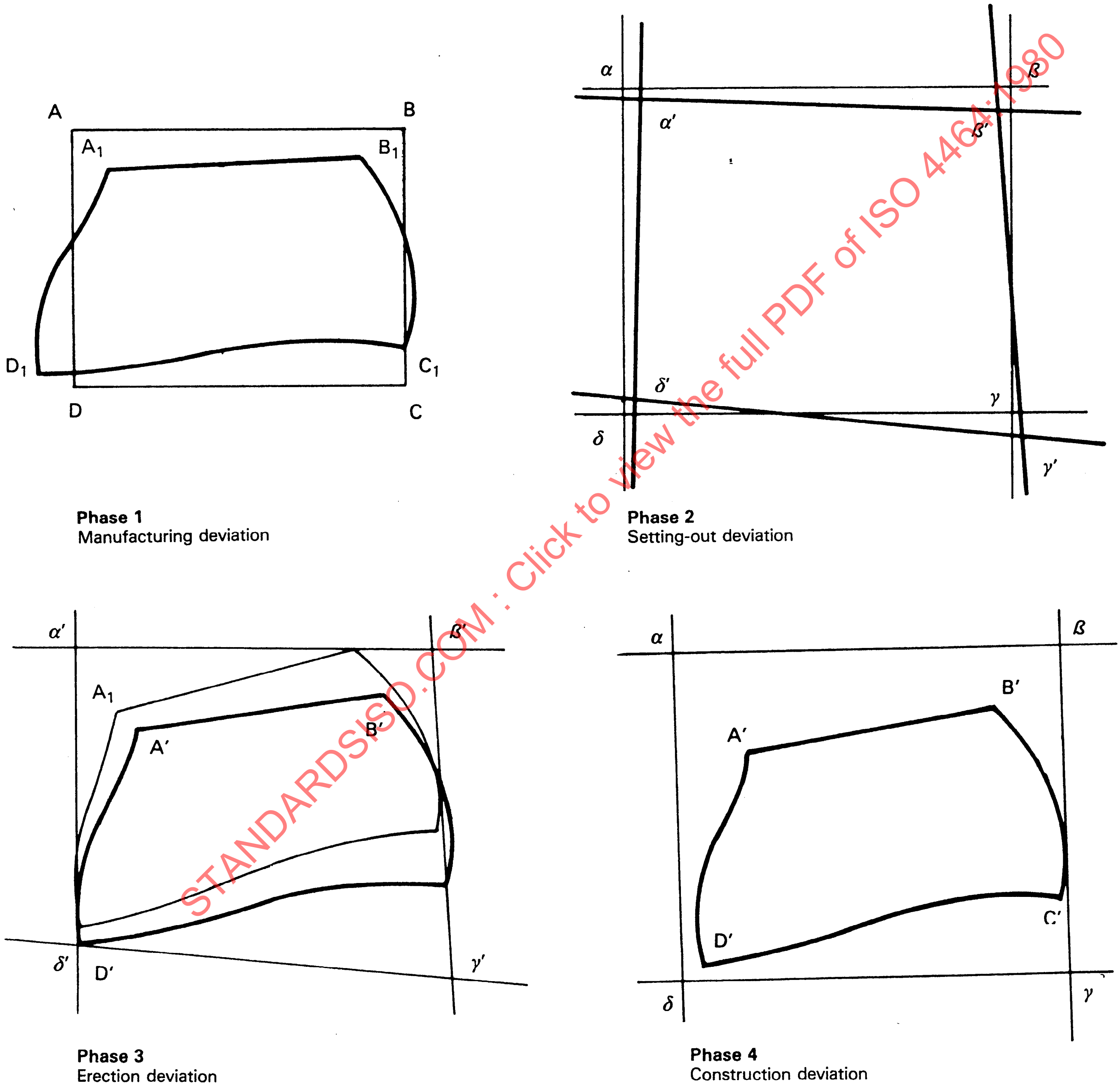


Figure 3 — Successive stages of deviation assessment

7.3.1 dimensional deviation : The difference between actual size and corresponding reference size. (See figure 4.)

NOTE — Dimensional deviations of a component are determined by the actual size between corner points, in principle as shown in figure 16.

Deviations designated by lower-case Roman letters are those which may be indicated unequivocally by a single value or a limited number of values.

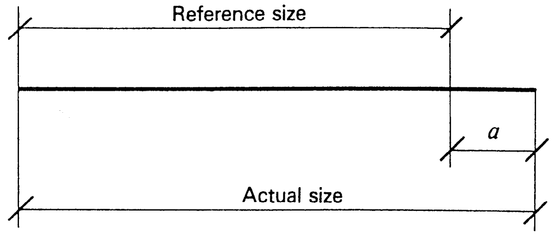
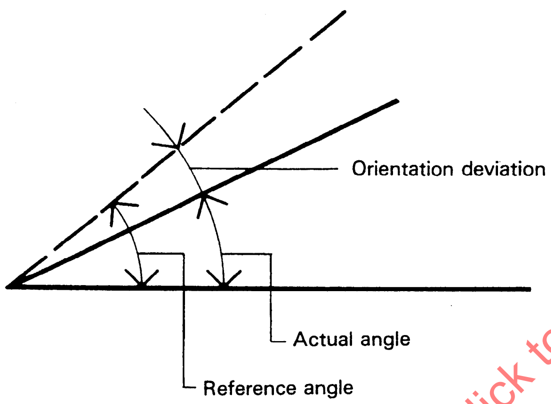
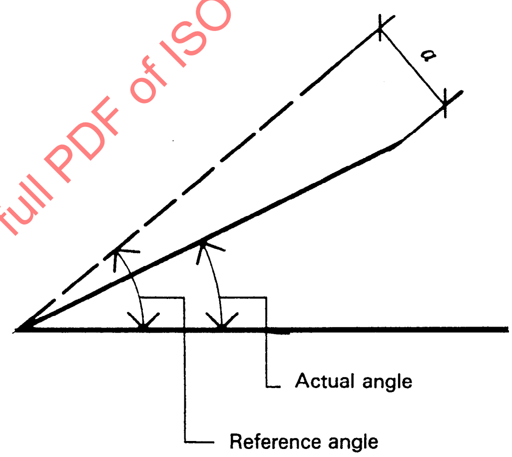


Figure 4 — Dimensional deviation

7.3.2 orientation deviation (angularity) : The difference between an actual angle and the corresponding reference angle. (See figure 5.)



Alternative a



Alternative b (linearization)

Figure 5 — Orientation deviation (angularity)

NOTES

1 If alternative *b* is put into practice, the orientation deviation shall be determined from the shorter side of the angle and shall be measured perpendicular to the corresponding side of the reference angle.

2 Parallelism deviation is another way to express the orientation deviation and is the difference between the orientation of a straight line or plane surface and the orientation of a parallel reference line or surface.

Parallelism deviations of component edges are to be determined in principle as shown in figure 6. An imaginary line is drawn through both end points of an edge of a component. Another imaginary line, parallel to the first, is drawn through one end of the opposite edge. The deviation is measured as the distance from the fourth corner to the second line.

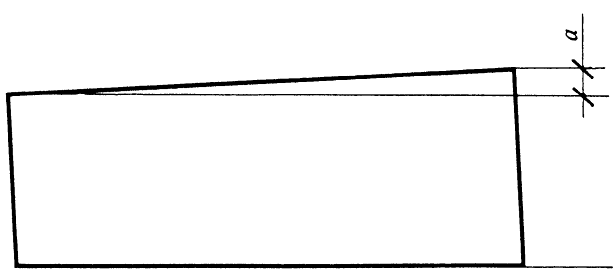


Figure 6 — Parallelism deviation of opposite edges of a rectangular sheet

7.3.3 deviation of form : The set of differences between points on the actual line or surface and the corresponding points on the reference line or surface.

7.3.3.1 straightness deviation : The set of differences between the actual form of a line and a straight line.

NOTE — Straightness deviation is determined, in principle, as in figure 7. Deviation is measured as the distance at any point on the line from an imaginary straight line joining the ends of the said line.

Deviations designated by lower-case Greek letters are those which cannot be indicated by isolated values, being the set of an infinite number of values.

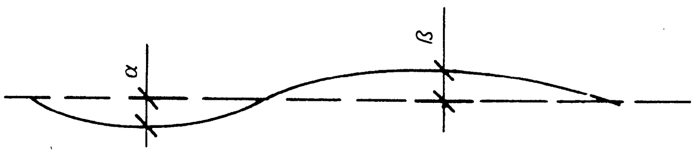


Figure 7 — Straightness deviation of one edge of a rectangular sheet

7.3.3.2 flatness deviation : The difference between the actual form of a surface and that of a plane surface.

NOTE — Flatness deviation is determined in principle as in figure 8. Deviation is the distance from any point on the surface to a surface representing a median plane for all four corner points. In practice the measurement is made from a plane exterior to the component and parallel to two main directions of the component.

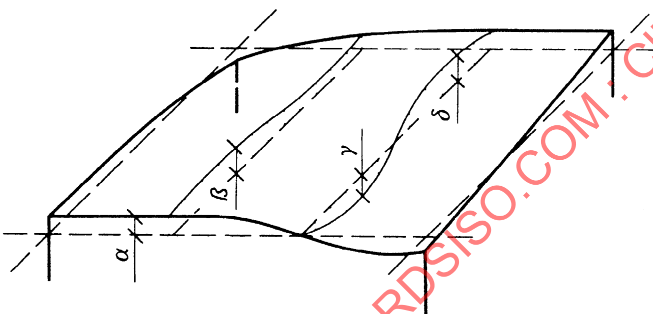


Figure 8 — Flatness deviation of a rectangular surface

(Deviation is measured at various points over the entire area not merely at certain sections as shown in the figure for the sake of simplicity.)

NOTE — Skewness is a special case of flatness deviation affecting a rectangular surface with well-defined corners. Skewness is the absolute value of the deviation of one corner from a plane passing through the other three corners. (See figure 9.) In practice, the measurement is made from an exterior plane.

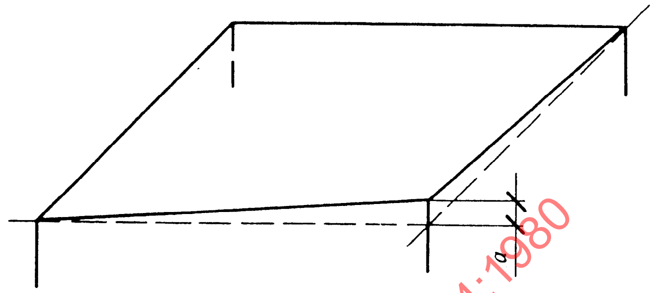


Figure 9 — Skewness

7.4.1 positional setting-out deviation[1] : The difference between the actual position of a setting-out point or line and the corresponding reference position. (See figures 10 and 11.)

NOTE — Complete information on positional deviation presupposes details of deviations in two or three directions from a fixed reference position.

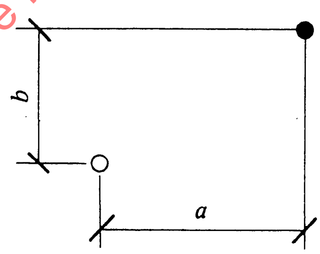


Figure 10 — Positional setting-out deviation in two directions for a point

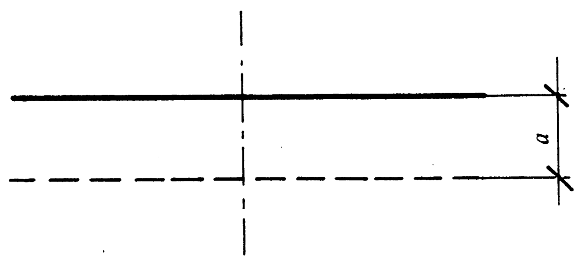


Figure 11 — Positional setting-out deviation for a line

1) See also ISO 4463.

7.4.2 orientation setting-out deviation[1] : The difference between the actual orientation of a line after setting out and the corresponding reference orientation. (See figure 12.)

NOTE — Complete information on orientation deviation presupposes details of deviations in two or three directions from a fixed reference position.

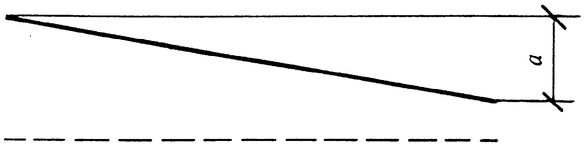


Figure 12 — Orientation setting-out deviation (linearization)

7.5.1 positional erection deviation : The difference between the actual position of a point, line or surface of a component, after erection, and the corresponding reference position. (See figure 13.)

NOTE — Complete information on positional deviation after erection presupposes details of deviations in three directions from a fixed reference position.

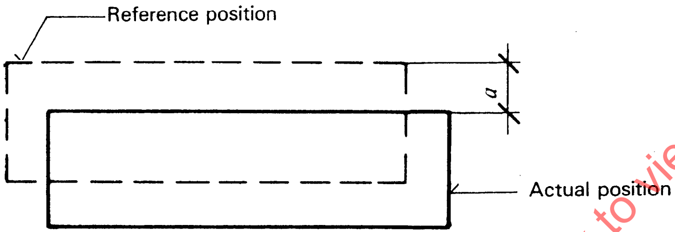


Figure 13 — Positional erection deviation for a component

7.5.2 orientation erection deviation : The difference between the actual orientation of a line or surface of a component, after erection, and the corresponding reference orientation. (See figure 14.)

NOTE — Complete information on orientation deviations presupposes details of deviations in two or three directions, from a fixed reference orientation.

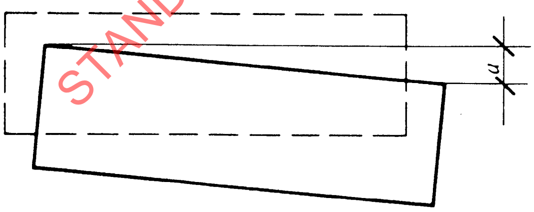


Figure 14 — Orientation erection deviation for a component (linearization)

8 Example of application of the system

8.1 Box principle

The volume to consider is the volume of the space which exists between two theoretical similar parallelepipeds[2] having the same orientation, one of them being situated inside the other. (See figure 15.)

The distance between the corresponding faces of these parallelepipeds may or may not be equally distributed depending on the tolerance widths which are specified. No point on the surface of the component shall transgress beyond this volume.

NOTE — This principle is also applicable when only two dimensions are under consideration. This will probably be the most common situation.

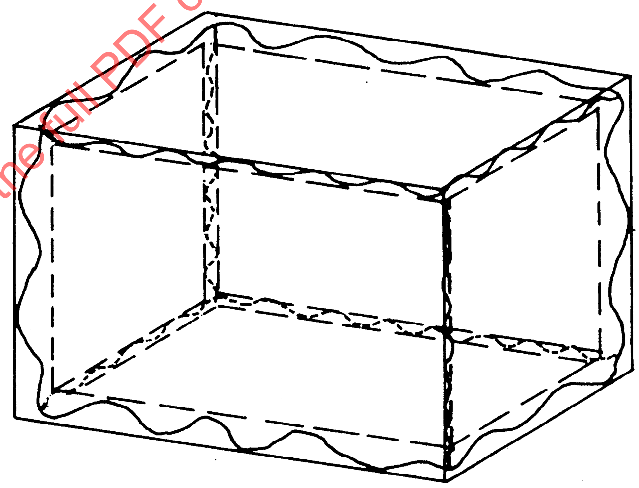


Figure 15 — Example of application of the box principle to a component

8.2 Examples of deviations existing simultaneously

Figures 16 to 18 show examples of simultaneously existing deviations of various kinds. They refer to a sheet of rectangular reference form, erected in conformity with the principles of dimensional co-ordination, i.e. so that the sheet is contained within its co-ordinating space. Thus, every example has to be considered taking into account the other existing deviations.

1) See also ISO 4463.

2) Or any other chosen three-dimensional shape.