International Standard 3443/1

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

Tolerances for building — Part 1 : Basic principles for evaluation and specification

Tolérances pour le bâtiment — Partie 1 : Principes fondamentaux pour l'évaluation et la spécification

First edition — 1979-06-15

UDC 69 : 721.01 **Ref. No. ISO 3443/1-1979 (E)**

Descriptors : buildings, construction, joints, compatibility, fits, dimensional tolerances, statistical analysis.

Price based on 2 pages

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 3443/1 was developed by Technical Committee ISO/TC 59, *Building construction*, and was circulated to the member bodies in October 1977.

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

Australia	Hungary	Poland
Austria	Israel	Romania
Belgium	Italy	South Africa, Rep. of
Canada	Japan	Spain
Czechoslovakia	Korea, Rep. of	Sweden
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Finland	Netherlands	USSR
France	New Zealand	
Germany, F.R.	Norway	

No member body expressed disapproval of the document.

Printed in Switzerland

Tolerances for building — Part 1 : Basic principles for evaluation and specification

1 SCOPE AND FIELD OF APPLICATION

This International Standard describes the nature of dimensional variability in building and the purposes for which it has to be quantified, and defines the factors to be taken into account in the evaluation, specification and verification of tolerances for the manufacture of building components and for site work. It applies to components and buildings generally, including those designed in accordance with the principles of modular co-ordination.

2 REFERENCE

ISO 2445, *Joints in building — Fundamental principles for design.*

Other standards regarding tolerances for building construction are presently being prepared.

3 GENERAL

The process of building construction presents specific problems in the field of tolerances and fits, which require detailed examination in relation to the technique of assembly, the performance requirements and the costs of the completed building. The creation under site conditions of a large-scale geometric form, involving the assembly of dimensionally variable components by means of a sequence of measuring and positioning operations, can result in substantial variations from the designed size and shape (induced deviations). Coupled with this are the inevitable dimensional variations resulting from movements and changes of size of materials, which arise from extrinsic and intrinsic physico-chemical causes (inherent deviations). The object of international standardization in the field of tolerances and fits is to provide a coherent system by means of which

a) dimensional and positional variabilities may be both analysed and allowed for in design;

b) tolerances may be communicated clearly in specification;

c) the sizes and shapes of components and buildings may be subjected to any necessary control measures during manufacture and construction.

When building components are located in relation to a continuous reference system (such as a modular grid), so that the structure is subjected to overall dimensional control, deviations of size, shape and position have to be absorbed within the jointing system. The consideration of tolerances for the manufacture of components and for the construction of buildings is therefore inseparable from the design of joints to provide the required dimensional flexibility (see ISO 2445). This does not mean that all joints must necessarily have this capability, but it is necessary for deviations to be accommodated at some point; this may be achieved at the joints between individual components, or by the provision of special joints at intervals. In addition, tolerances should be considered in relation to the structural, aesthetic, legal and direct functional consequences of dimensional variability in order to achieve the overall quality required.

Analysis of joint width variation is required for the determination of work sizes for components, so that they can be designed for use with jointing techniques of known dimensional flexibility. This applies equally to standard components and to purpose-made components. It may also be necessary to check the suitability of a standard component for use with the same or a different jointing technique in particular situations in building designs. The object in all cases is to ensure that assembly of the components is possible without unpredicted problems of fit, and that the joints achieve the required performances. If the analysis of induced deviations is based on statistical principles, a limited incidence of "misfit" is accepted in the design, the extent of which has to be decided in relation to the nature of the component and its jointing technique.

The specification of tolerances defining the limits of induced deviations that have been allowed for in the design has to be linked to methods of measurement by means of which compliance with the specification can be tested. The specification and verification of tolerances must refer to standard reference conditions for measurement, to allow for the effects of inherent deviations on actual sizes. Tolerances may conveniently be specified in grades relating to methods of construction (materials, processes and techniques) and appropriate levels of accuracy. However, it is still necessary to examine the dimensional compatibility of components used in particular situations even when their tolerances fall within the same grade, owing to the complex and unique factors governing the distribution of deviations.

4 SOURCES OF DIMENSIONAL VARIABILITY

4.1 Induced deviations

Any process of measurement, alignment or positioning is subject to some degree of variability due to human error and the limitations of measuring instruments. Such variabilities are termed "induced deviations", and may be grouped as follows :

a) **manufacturing deviations :** deviations of size and form arising in the manufacture of components;

b) **setting-out deviations :** deviations of size and position arising in the measuring and marking of dimensions on site;

c) **erection deviations :** deviations of position and orientation arising in the positioning of components in relation to setting-out marks, and in their horizontal and vertical alignment.

The values of induced deviations will, in many cases, follow a normal, statistical distribution around the mean size or position (represented by the Gaussian curve for random errors). They may also exhibit a bias reflecting systematic, rather than random, variability, such as progressive variation in size during the course of production, or a fixed deviation due to maladjustment of measuring instruments. Gross deviations due to serious measurement errors are generally disregarded in analysis, since the results will almost certainly be unacceptable.

Randomly occurring induced deviations may with advantage be treated according to statistical principles, so that account can be taken of the relative probability of small and large values, and may be expressed in terms of the standard deviation, as a measure of variability. Systematically occurring deviations must generally be treated as definite, recurring values that apply to batches or groups of components or measurements.

4.2 Inherent deviations

Virtually all materials exhibit dimensional changes due to physical or chemical causes. These are termed "inherent deviations", and include reversible and permanent changes due to variations in temperature, moisture content and stresses and to chemical reactions, etc.

Settlement of foundations is also a source of permanent inherent deviations.

5 CONSEQUENCES OF DIMENSIONAL VARIABILITY

Dimensional and positional deviations must be allowed for in the design of buildings, building components and their joints, in respect of their effects on the following aspects :

a) **Performance of the building** — Variations in the sizes and shapes of spaces or openings and in the smoothness, flatness, horizontality and verticality of surfaces, including the variations in joint width,[1] may affect directly the performance of the completed building.

b) **Assembly of components and performance of joints** — The variation in joint width due to induced and inherent deviations must be reflected in the evaluation of suitable work sizes for components, and in the choice of jointing techniques with suitable width capabilities.

c) **Structural stability** — Dimensional and positional deviations may produce eccentricities of loading and reduced areas for load bearing; inherent deviations may, of themselves, induce stresses.

d) **Appearance** — Deviations of size, form and orientation of components and spaces, and variations in joint width may need to be controlled or concealed for the sake of appearance.

e) **Legal sizes** — Deviations may affect dimensions for which maximum or minimum sizes are laid down in regulations or legislation.

6 CHOICE OF TOLERANCE VALUES

Tolerances define the limits of induced deviations for which allowance has been made in design, and within which actual sizes are acceptable. Thus, they should be specified only for those dimensions or positions which are critical with respect to one or more of the consequences of variability listed in clause 5. The choice of values for tolerances reflects the economic balance between the cost of improving accuracy and the cost of accommodating deviations in the design. It is likely that the consideration of assembly and joint performance will be the most critical for assessing this balance, when there may be a choice between fine tolerances with simple joints and coarse tolerances with complex joints.

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1) The expression "joint width" is used in this International Standard as it is the term currently used. In this case, it should be made clear that it indicates the notion which is expressed in ISO 2444 by the less commonly used term "joint clearance" as follows :

joint clearance : The distance between the joint faces of two components set side by side, i.e. the distance considered in order to achieve fit.