INTERNATIONAL STANDARD

ISO 8636-1

Second edition
2000-02-15

Machine tools — Test conditions for bridge-type milling machines — Testing of the accuracy —

Part 1: Fixed bridge (portal-type) machines

Machines-outils — Conditions d'essai des machines à fraiser à portique — Contrôle de la précision —

Partie 1: Machines à portique fixe

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 8636 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 8636-1 was prepared by Technical Committee ISO/TC 39, *Machine tools*, Subcommittee SC 2, *Test conditions for metal cutting machine tools*.

This second edition cancels and replaces the first edition (ISO 8636-1:1987) of which it constitutes a technical revision. Especially,

a) geometrical tests have been re-arranged; the new G numbers compared to the old ones are given in the following table:

ISO 8636-1:1999	6	7	8	9	10	11	12	13	14	15	16
ISO 8636-1:1987	9	6	5	1	4&7	3	14	13&15	16	12	11

b) the following extra modifications:

addition of notes in “Object” boxes for G6, G12, G13, G14 and G15; these notes have been added because the machines have several milling heads and the test items are applicable to all of the milling heads;

c) tolerances on accuracy and repeatability of positioning have been changed according to ISO 230-2:1997.

The actual deviations of all parameters shall be shown as test results, but the tolerances are limited only to certain parameters.

ISO 8636 consists of the following parts, under the general title *Machine tools — Test conditions for bridge-type milling machines — Testing of the accuracy*:

— *Part 1: Fixed bridge (portal-type) machines*

— *Part 2: Travelling bridge (Gartry-type) machines*

Annex A of this part of ISO 8636 is for information only.

Machine tools — Test conditions for bridge-type milling machines — Testing of the accuracy —

Part 1: Fixed bridge (portal-type) machines

1 Scope

This part of ISO 8636 specifies, with reference to ISO 230-1 and ISO 230-2, geometric tests, machining tests and tests for checking accuracy and repeatability of positioning of numerically controlled axes for general purpose, normal accuracy, bridge-type milling machines with a fixed bridge (portal type). This part of ISO 8636 also specifies the applicable tolerances corresponding to the above-mentioned tests.

This part of ISO 8636 is applicable to machines with moving tables and fixed double columns. It does not include single-column (open sided) machines and those with fixed tables and moving columns.

This part of ISO 8636 deals only with the verification of the accuracy of the machine. It does not apply to the testing of the machine operation (vibration, abnormal noise, stick-slip motion of components, etc.) nor to machine characteristics (such as speeds, feeds, etc.), which should generally be checked before testing the accuracy.

This part of ISO 8636 provides the terminology used for the principal components of the machine and the designation of the axes with reference to ISO 841[1].

NOTE In addition to terms used in the three official ISO languages (English, French and Russian), annex A of this part of ISO 8636 gives the equivalent terms in the German and Italian languages; these are published under the responsibility of the member bodies for Germany (DIN) and Italy (UNI). However, only the terms given in the official languages can be considered as ISO terms.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 8636. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 8636 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 230-1:1996, *Test code for machine tools — Part 1: Geometric accuracy of machines operating under no-load or finishing conditions.*

ISO 230-2:1997, *Test code for machine tools — Part 2: Determination of accuracy and repeatability of positioning of numerically controlled axes.*

3 Definitions and descriptions

For the purposes of this part of ISO 8636, the following definitions apply.

3.1 Definitions of the machining processes that can be carried out

3.1.1
milling operation
machining operation which consists of removing material by means of a rotary tool called a “milling cutter” of which there are several different types

NOTE The typical milling operations mostly involve face milling or end milling. The tools are mounted either in the spindle taper or on the spindle front face.

3.1.2
boring operation
operation which consists of machining the diameters of cylindrical, conical, blind or through holes, to the required size

3.1.3
drilling and tapping operations
operations which consist of drilling and/or tapping blind or through holes

3.2 Definition and classification of fixed bridge-type milling machines

3.2.1 Definition

3.2.1.1
fixed bridge-type (portal-type) milling machine
double-column machine with one or more vertical spindle heads mounted on the cross-rail, above a table which has a longitudinal traverse (X-axis) only

NOTE Additional horizontal spindle heads may be mounted on the columns. The horizontal spindle axes may have a tilting capability.

3.2.2 Classification

These machines are classified into two types depending upon their construction:

— bridge-type milling machines with a variable height cross-rail and a bridge or tie-piece between the columns;

— bridge-type milling machines with a fixed height cross-rail which may replace the bridge or tie-piece.

3.3 Descriptions of principal components

The principal components of these machines are described below. The number indicated in brackets is shown and explained in 4.1.

3.3.1 Bed and table

The bed (1) is the fixed base of the machine which may be constructed of several parts. It supports the table (3) which moves parallel to the major axis of the bed.

3.3.2 Column, cross-rail and bridge or tie-piece

The columns (4) and (5) provide the vertical frame of the machine and are fixed on either side of the bed.

The columns may be fitted with vertical slideways to accommodate side milling head(s) (9) with other horizontal or tilting spindle axis.

The tie-piece (10) is a fixed piece connecting both columns at or near the top.

The cross-rail (7) has its major axis parallel to the table plane and is fitted with slideways on which one or more milling heads (8), with vertical or inclinable spindles, can move.

The variable height cross-rail may be moved up and down the vertical slideways (6) on the columns.

In the case of machines with a fixed height cross-rail, the latter is also fastened to the columns and may replace the tie-piece.

3.3.3 Milling head(s)

These heads include the spindle and drive mechanism and the means for their mounting on the cross-rail or column. In some cases, the spindle may be mounted in a ram or quill (12) with a feed motion for drilling or boring operations.

3.3.4 Cutting motion

Cutting motion is provided by the spindles and drive mechanisms of the milling heads.

3.3.5 Feed motion

The following feed movements may be provided with a constant or variable feed rate:

— horizontal movement of the table;

— horizontal movement of the milling heads on the cross-rail or vertical movement of the side heads;

— vertical movement of spindle rams or quills (if any).

NOTE 1 In general, rapid traverse is available in addition to feed movement.

NOTE 2 The vertical movement of the cross-rail (if any) is usually a positioning movement.

4 Terminology and designation of axes

4.1 Terminology

See Figure 1 and Table 1.

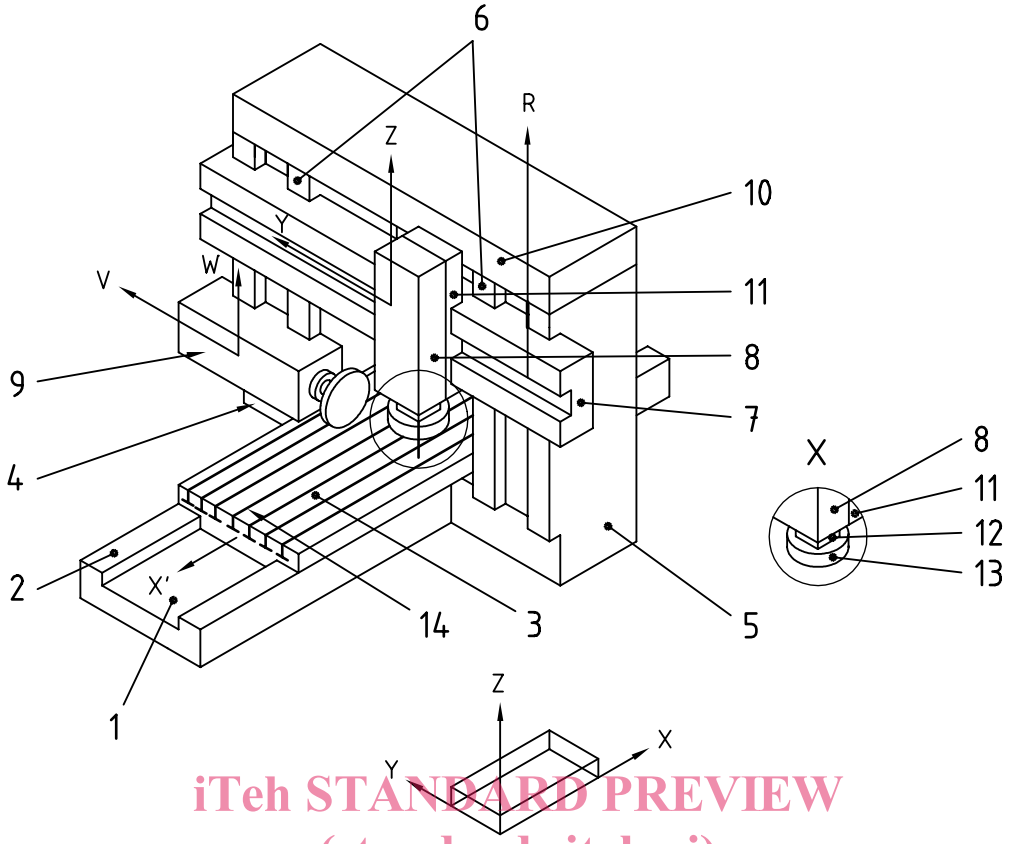


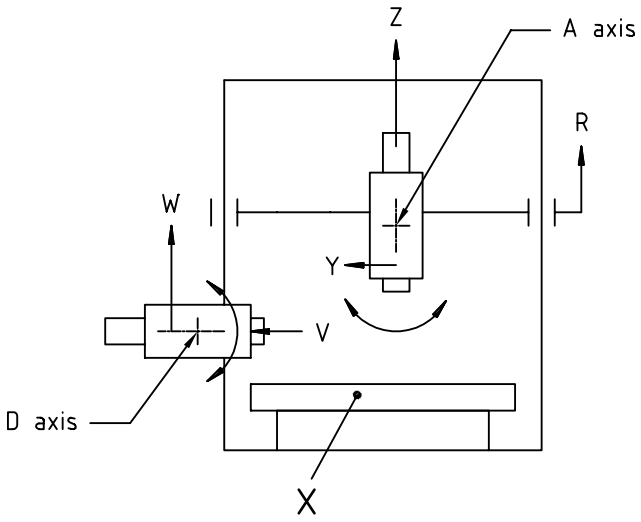
Figure 1 — Fixed bridge- (portal-) type milling machine with variable height cross-rail

Table 1 — Terminology

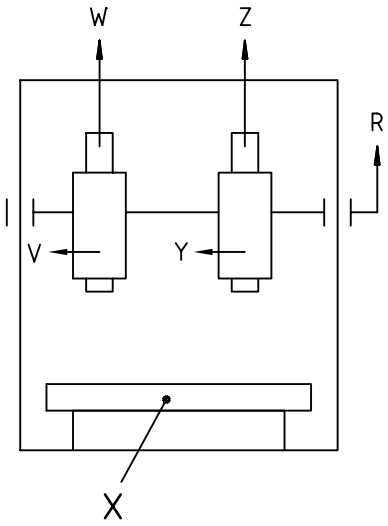
Ref.	English	French	Russian
1	Bed	Banc	Станина
2	Slideway, bed	Glissière du banc	Направляющая станины
3	Table (clamping surface)	Table (surface de bridage)	Стол (рабочая поверхностъ)
4	Left-hand column	Montant gauche	Левая стойка
5	Right-hand column	Montant droit	Правая стойка
6	Slideway, right-hand and left-hand column	Glissière des montants droit et gauche	Направляющая левой и правой стоек
7	Cross-rail (movable, fixed)	Traverse (mobile, fixe)	Траверса (подвижная, неподвижная)
8	Vertical milling head	Tête de fraisage verticale	Головка вертикально-фрезерная
9	Horizontal milling head	Tête de fraisage horizontale	Головка горизонтально-фрезерная
10	Tie-piece	Entretoise	Поперечная балка
11	Bottom slide (saddle)	Cuirasse	Каретка суппорта
12	Quill (ram)	Coulisseau (fourreau)	Ползун (втулка)
13	Tool (milling cutter)	Outil (fraise)	Инструмент (фреза)
14	Reference T-slot	Rainure de référence	Базовый паз

4.2 Designation of axes

See Figures 2 to 5.



a) One spindle milling head tilting on the A-axis, placed on the cross-rail, and one spindle milling head tilting on the D-axis, placed on the right- or left- hand column



b) Two milling heads on the cross-rail

Figure 2 — Type 1: Machines with two milling heads

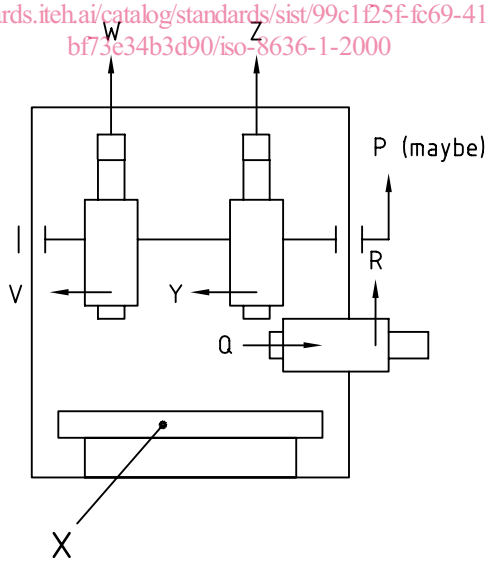


Figure 3 — Type 2: Machine with three milling heads

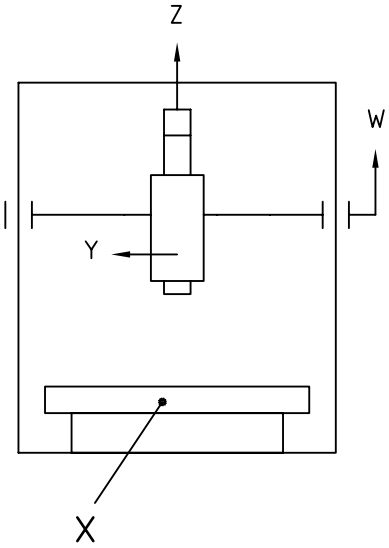


Figure 4 — Type 3: Machine with one milling head on the cross-rail

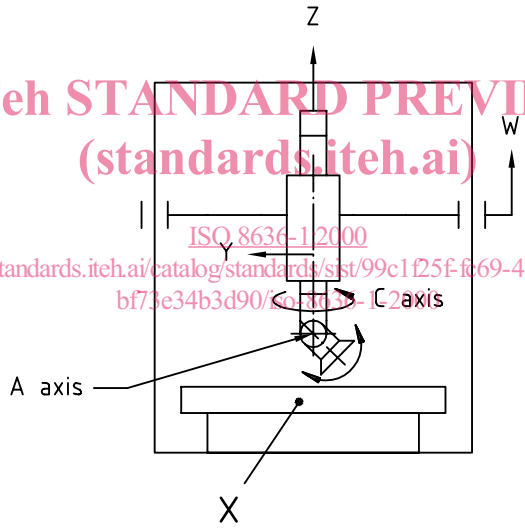


Figure 5 — Type 4: Machine with one milling head on the cross-rail swivelling on axes C and A

5 Preliminary remarks

5.1 Measuring units

In this part of ISO 8636, all linear dimensions, deviations and corresponding tolerances are expressed in millimetres; angular dimensions are expressed in degrees, and angular deviations and the corresponding tolerances are primarily expressed in ratios (e.g. $0{,}00x/1\,000$), but in some cases, microradians or arcseconds may be used for clarification purposes. The equivalence of the following expressions should always be kept in mind:

$0{,}010/1\,000 = 10\ \mu\text{rad} \approx 2''$

5.2 Reference to ISO 230-1

To apply this part of ISO 8636, reference shall be made to ISO 230-1, especially for the installation of the machine before testing, warming up of the spindle and other moving components, description of measuring methods and recommended accuracy of testing equipment.

In the “Observations” box of the tests described in the following clauses, the instructions are preceded by a reference to the corresponding clause in ISO 230-1 in cases where the test concerned is in compliance with the specifications of ISO 230-1.

5.3 Temperature conditions

The temperature conditions throughout the tests shall be specified by agreement between the supplier/manufacturer and user.

5.4 Testing sequence

The sequence in which the tests are presented in this part of ISO 8636 in no way defines the practical order of testing. In order to make the mounting of instruments or gauging easier, tests may be performed in any order.

5.5 Tests to be performed

When testing a machine, it is not always necessary nor possible to carry out all the tests described in this part of ISO 8636. When the tests are required for acceptance purposes, it is up to the user to choose, in agreement with the supplier/manufacturer, those tests relating to the components and/or the properties of the machine which are of interest. These tests are to be clearly stated when ordering a machine. Mere reference to this part of ISO 8636 for the acceptance tests, without specifying the tests to be carried out, and without agreement on the relevant expenses, cannot be considered as binding for any contracting party.

5.6 Measuring instruments

The measuring instruments indicated in the tests described in the following clauses are examples only. Other instruments measuring the same quantities and having at least the same accuracy may be used.

5.7 Minimum tolerance

When establishing the tolerance for a measuring length different from that given in this part of ISO 8636 (see 2.311 of ISO 230-1:1996), it shall be taken into consideration that the minimum value of tolerance is 0,005 mm.

5.8 Machining tests

Machining tests shall be made with finishing cuts only. Roughing cuts shall be avoided since they are liable to generate appreciable cutting forces.

5.9 Positioning tests

Positioning tests for numerically controlled machines shall refer to ISO 230-2. Tolerances in this part of ISO 8636 are given only for some parameters. The presentation of the test results shall be in compliance with ISO 230-2.

6 Geometric tests

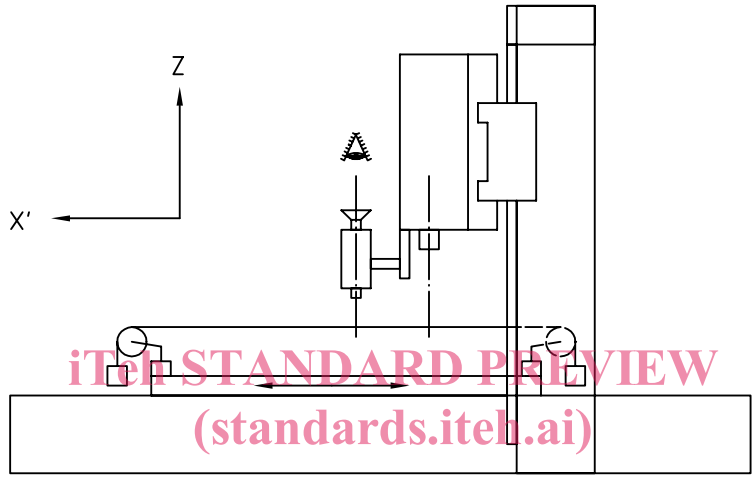
Tolerances are limited to the machines of table size up to 3 000 mm × 10 000 mm. When the machine is over this size in length or width, the tolerance shall be agreed upon between the supplier/manufacturer and user.

6.1 Coordinate axes of motion

Object **G1**

Checking of straightness of movement of the table (X-axis) in the horizontal XY-plane (EYX).

Diagram



Tolerance	**Measured deviation**
0,02 for a measuring length up to 2 000 Add 0,01 to the preceding tolerance for each 1 000 increase in length beyond 2 000 Maximum tolerance: 0,10 Local tolerance: 0,01 for any measuring length of 1 000	

Measuring instruments

Microscope and taut wire or other optical methods

Observations and references to ISO 230-1:1996 5.232.12, 5.232.13 and 5.232.14

When using microscope and taut wire, the microscope shall be mounted on the head, and the taut wire shall be fixed to each end of the table parallel [1)] to X-axis movement of the table.

Traverse the table in the X-direction and note the readings.

When using optical methods, the target shall be set on the spindle nose or on the head near the spindle.

The reticle is set on the table parallel to X-axis movement of the table and aligned with the target horizontally.

Traverse the table in the X-direction and record the readings.

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1) Parallel means: Readings of the telescope or reticle at both ends of the movement are the same. In this case, the maximum difference of the readings gives the straightness deviation.

Object **G2**

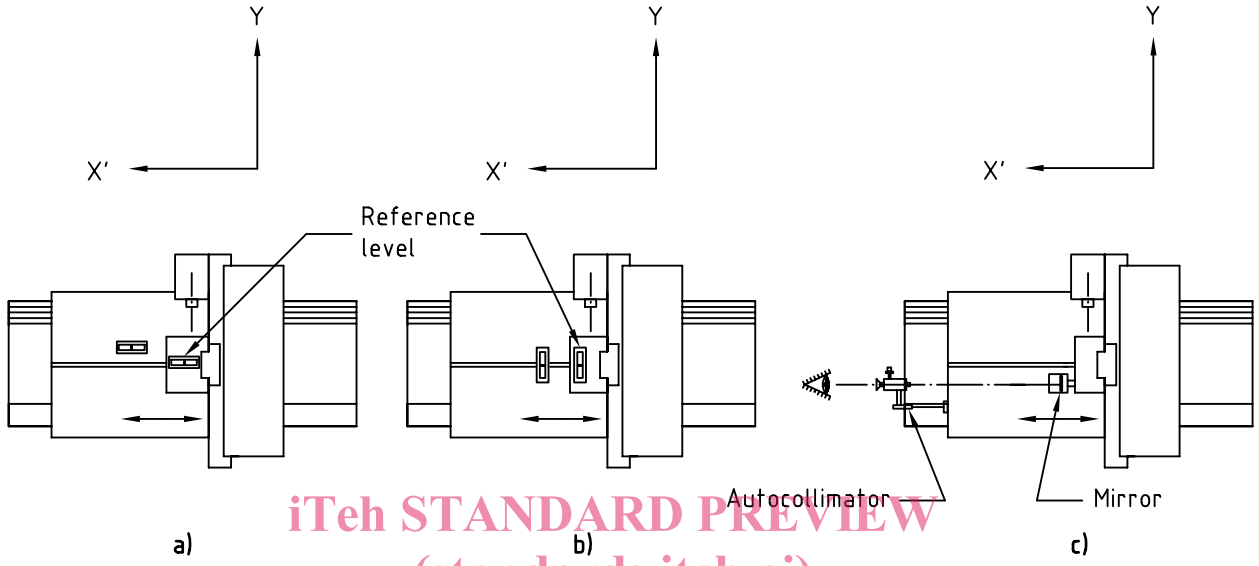
Checking of angular deviations of the movement of the table (X-axis):

a) in the vertical ZX-plane (EBX: pitch);

b) in the vertical YZ-plane (EAX: roll);

c) in the horizontal XY-plane (ECX: yaw).

Diagram



Tolerance			**Measured deviation**
	a) and c)	b)	X = . . .
X ⩽ 4 000	0,04/1 000	0,02/1 000	a)
X > 4 000	0,06/1 000	0,02/1 000	b)
Local tolerance: 0,02/1 000 for any measuring length of 1 000			c)

Measuring instruments

a) Precision level or optical angular deviation measuring instruments

b) Precision level

c) Optical angular deviation measuring instruments

Observations and references to ISO 230-1:1996 5.231.3 and 5.232.2

The level or instrument shall be placed on the movable component:

a) (EBX: pitch) in the X-axis direction, set vertically;

b) (EAX: roll) in the Y-axis direction, set vertically;

c) (ECX: yaw) in the X-axis direction, set the autocollimator horizontally.

When X-axis motion causes angular deviation of both the spindle head and work-holding table, differential measurements of the two angular movements shall be taken.

When differential measurement is applied, the reference level should be placed on the spindle head, and the spindle head shall be in the middle of its travel range.

Measurements shall be carried out at a minimum of five positions equally spaced along the travel, in both directions of movement.

The difference between the maximum and the minimum reading shall not exceed the tolerance.

For tests a) and b), the instrument shall be placed at the two ends and possibly in the middle of the table. The instrument located at one end of the table explores the characteristics of half of the bed.

The instrument located in the middle of the table reveals different deviations from the ones located at both ends of the table.