

Accuracy of machine tools and methods of test —

Part 21: Specification for boring and milling machines, horizontal spindle table type and rotary table type

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Committees responsible for this British Standard

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- Advanced Manufacturing Technology Research Institute
- Cranfield Institute of Technology
- Department of Trade and Industry
- Health and Safety Executive
- Institution of Production Engineers
- Ministry of Defence
- University of Aston in Birmingham

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Foreword

This Part of BS 4656 has been prepared under the direction of the Machine, Engineers and Hand Tools Standards Committee and implements agreements of the International Organization for Standardization (ISO).

This Part is a revision of BS 4656-21:1978 which is withdrawn.

This Part of BS 4656 contains information that is technically equivalent to the information contained in the following International Standards:

ISO 3070-0:1982 (see Appendix A)

ISO 3070-1:1987

ISO 3070-1: Addendum 1:1987

Clauses 1 and 2 of this Part are presented in accordance with an accepted format for the BS 4656 series of standards and are expressed in accordance with accepted English usage. Subclause 2.6 and clauses 3 and 4 have been added.

In accordance with the UK policy of metrication, inch dimensions given in ISO 3070-1 and its addendum 1 have not been included in this British Standard.

In column 6 of Table 1, Table 2 and Table 3 reference to ISO 230-1 “*Acceptance code*” has been replaced by reference to BS 3800.

In test 1G4 clarification that the table is unlocked has been retained from BS 4656-21:1978.

In test 2G4 clarification in respect of testing at whole numbers of degrees has been added.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 34, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This Part of BS 4656 specifies, with reference to BS 3800, both geometrical and practical tests for boring and milling machines of horizontal spindle table type and rotary table¹⁾ type and gives corresponding permissible deviations which apply. This standard is applicable to machines of general purpose use and normal accuracy.

It deals only with the verification of accuracy of the machine. It does not apply to the testing of the running of the machine (vibrations, abnormal noises, stick-slip motion of components, etc.) nor to its characteristics (speeds, feeds, etc.) which should generally be checked before testing accuracy.

NOTE The titles of the publications referred to in this standard are listed on the inside back cover.

2 Application of test methods

2.1 In applying the tests detailed in Table 1 and Table 2, reference should be made to BS 3800, especially concerning the installation of the machine before testing, warming up of spindles and other moving parts, the description of measuring methods and the recommended accuracy of testing equipment.

2.2 The tests may be applied in any order that is practicable and that makes for ease of mounting of instruments or gauging. The sequence in which the geometrical tests are listed in Table 1 is related to the sub-assemblies of the machine and it is not intended to impose the practical order in which the tests are to be done.

2.3 It is not always necessary for all the tests specified in this standard to be carried out. The purchaser shall be at liberty to select, in agreement with the manufacturer, those tests relating to the properties that are of interest to him. The appropriate tests are to be clearly stated when the machine is ordered.

2.4 Practical tests shall be made with finishing cuts.

2.5 When establishing the tolerance for a measuring range different from that given in this standard (see **2.311** of BS 3800:1964), it should be taken into consideration that the minimum value of tolerance is 0.0025 mm for geometrical and practical tests.

2.6 Unless otherwise specified, geometrical tests are carried out with the arm set at mid-travel on the column.

3 Abbreviations

For the purposes of this Part of BS 4656, various methods of expressing permissible deviations are employed, each having a particular type of application. The methods employed are as follows.

- - -/- - - This type of expression applies to deviations of perpendicularity that are ratios.
- - - for any length of - - - This type of expression applies to deviations of straightness and parallelism, and is used in fact for local permissible deviations, the measurement length being obligatory.
- - - per - - - This type of expression applies to deviations of straightness and parallelism and is used to recommend a measurement length, but in this case the proportionality rule comes into operation if the measurement length differs from that indicated.

4 Diagrams

For reasons of simplicity the diagrams in this standard illustrate only one type of machine.

¹⁾ This is the integral rotary table type as opposed to the accessory rotary table type.

Table 1 — Geometrical tests for boring and milling machines, horizontal spindle table type

All dimensions are in millimetres.

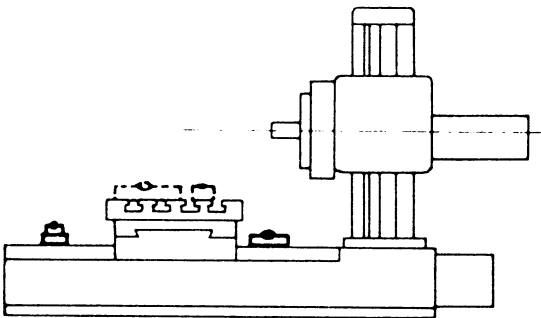
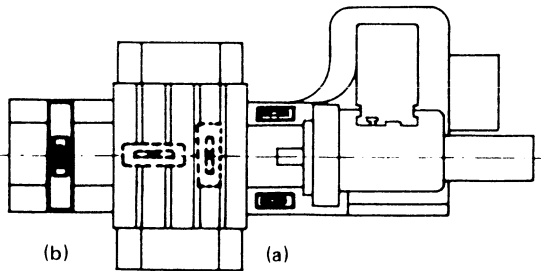
1	2	3	4	5	6
No.	Diagram	Object	Permissible deviation	Measuring instruments	Observations and references to the test code BS 3800
1G01		Verification of levelling of the bed slideways: (a) longitudinal verification (W axis): straightness of slideways in the vertical plane	(a) 0.02 up to 1 000 (flat to convex) For each 1 000 mm increase in length add to the preceding tolerance: 0.01 Maximum permissible deviation: 0.05 Local tolerance: 0.006 over any measuring length of 300	Precision level, optical or other methods	(a) 3.11, 3.21, 5.212.21 and 5.212.22 Measurements shall be made at a number of positions equally spaced along the length of the bed: 1) the table shall be placed in the middle of its longitudinal travel and transverse travel 2) the table shall then be placed at the extremities of the longitudinal travel and in the middle of the transverse travel The levels may be placed on the table [this is valid for (a) and (b)]
		(b) transverse verification (X axis): slideways shall be in the same plane	(b) Variation of level: 0.02/1 000	Precision level and support	(b) 5.412.7 A level shall be placed transversely and measurements taken at a number of positions equally spaced along the length of the bed. The variation of level measured at any position shall not exceed the permissible deviation

Table 1 — Geometrical tests for boring and milling machines, horizontal spindle table type

All dimensions are in millimetres.

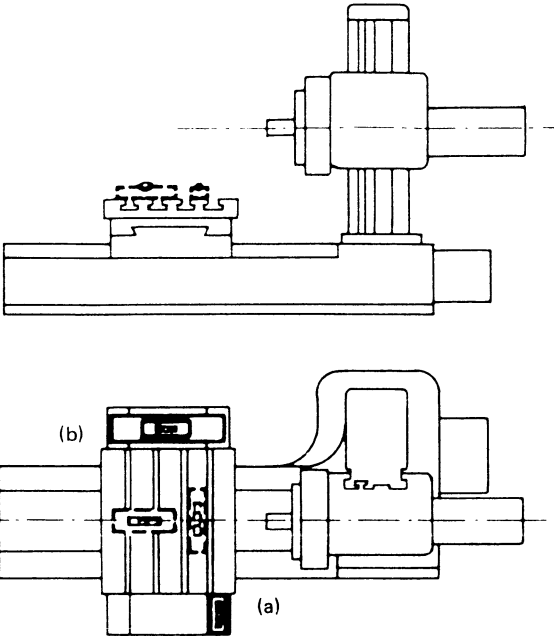
1	2	3	4	5	6
No.	Diagram	Object	Permissible deviation	Measuring instruments	Observations and references to the test code BS 3800
1G02		Checking of levelling of the slideways of the table base or table in a vertical plane: (a) in the longitudinal direction of the slideways (X axis)	(a) 0.02 up to 1 000 For each 1 000 mm increase in length, add to the preceding tolerance: 0.01 Maximum permissible deviation: 0.05	Precision level, optical or other methods	(a) 3.11, 3.21, 5.212.21 and 5.212.22 Measurements shall be made at a number of positions equally spaced along the length of the slideways Levels may be placed on the table [this is valid for (a) and (b)]
		(b) in the transverse direction of the slideways (W axis)	(b) Variation of level: 0.03/1 000	Precision level and support	(b) 5.412.7 A level shall be placed transversely on the slideways and measurements taken at a number of positions equally spaced along the length of the slideways. The variation of level measured at any position shall not exceed the permissible deviation

Table 1 — Geometrical tests for boring and milling machines, horizontal spindle table type

All dimensions are in millimetres.

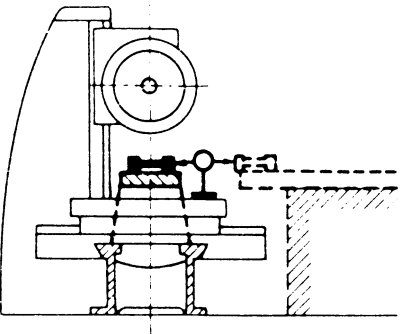
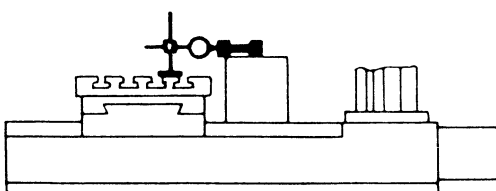
1	2	3	4	5	6
No.	Diagram	Object	Permissible deviation	Measuring instruments	Observations and references to the test code BS 3800
1G1		Checking of straightness of motion of the saddle along the axis parallel to the spindle (W axis) in the horizontal and vertical planes	0.02 up to 1 000 For each 1 000 mm increase in length, add to the preceding tolerance: 0.01 Maximum permissible deviation: 0.05 Local tolerance: 0.006 over any measuring length of 300	Dial gauge, straightedge and supports or optical methods	5.232.1 The dial gauge shall be fixed on the middle position of the saddle touching a straightedge laid parallel to the Z axis The straightedge shall be placed on a fixed part, independent of or integral with the machine and as near as possible to the slideways to be checked
1G2		Checking of straightness of motion of the table along the axis square to the spindle axis (X axis)	0.02 up to 1 000 For each 1 000 mm increase in length, and to the preceding tolerance: 0.01 Maximum permissible deviation: 0.05 Local tolerance: 0.006 over any measuring length of 300	Dial gauge, straightedge, supports or optical methods	5.232.1 The dial gauge shall be fixed on the middle position of the table with the stylus touching a straightedge laid parallel to the X axis The straightedge shall be placed on a fixed part, independent of or integral with the machine and as near as possible to the slideways to be checked

Table 1 — Geometrical tests for boring and milling machines, horizontal spindle table type

All dimensions are in millimetres.

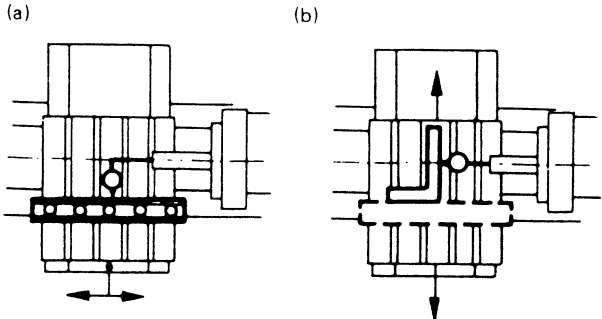
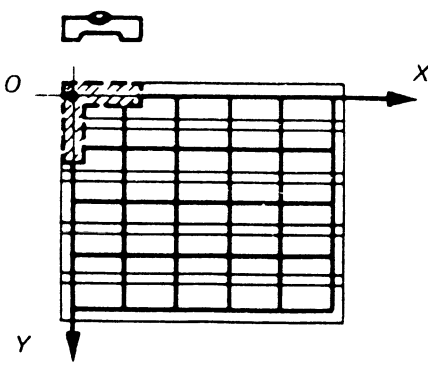
1	2	3	4	5	6
No.	Diagram	Object	Permissible deviation	Measuring instruments	Observations and references to the test code BS 3800
1G3		Checking of squareness of the longitudinal movement of the table (W axis) to its transverse movement (X axis)	0.04/1 000	Dial gauge, straightedge and square	5.522.4 (a) The straightedge shall be set parallel to the table saddle longitudinal movement; then the square shall be placed against the straightedge. The table shall then be locked in the central position (b) The transverse movement of the table shall then be checked. If the spindle can be locked the dial gauge may be mounted on it. If the spindle cannot be locked, the dial gauge shall be placed on a fixed part of the machine
1G4		Checking of flatness of the table surface	(a) 0.03 up to 1 000 (flat to concave) For each 1 000 mm increase in length, add to the preceding tolerance: 0.01 Maximum permissible deviation: 0.05 Local tolerance: 0.02 over any measuring length of 300	Precision level or straightedge and gauge blocks	5.322 and 5.323 Table in its mid-position and not locked. Table saddle and table base set in mid-travel and locked when possible

Table 1 — Geometrical tests for boring and milling machines, horizontal spindle table type

All dimensions are in millimetres.

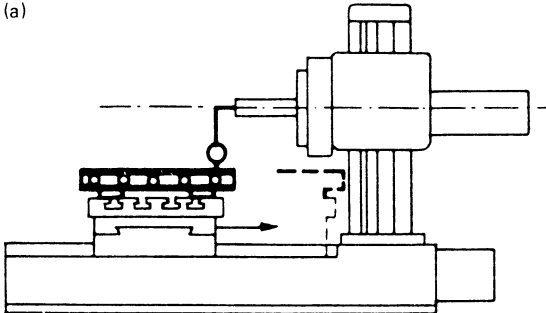
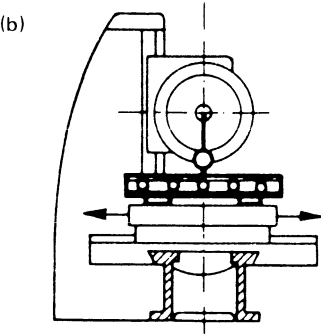
1	2	3	4	5	6
No.	Diagram	Object	Permissible deviation	Measuring instruments	Observations and references to the test code BS 3800
1G5	(a)  (b) 	Checking of parallelism of the table surface to its movements: (a) longitudinally to the saddle motion (W axis) (b) transversely (X axis)	(a) 0.04 up to 1 000 For each 1 000 mm increase in length, add to the preceding tolerance: 0.01 Maximum permissible deviation: 0.06 Local tolerance: 0.015 over any measuring length of 300 (b) 0.04 over any measuring length of 1 000	Straightedge and dial gauge	5.232.1 or 5.422.21 The stylus of the dial gauge shall be placed approximately in a vertical plane coaxial with the spindle axis Measurement may be made on a straightedge laid parallel to the table surface. If the table length is greater than 1 600 mm, carry out the inspection by successive movements of the straightedge If the spindle can be locked, the dial gauge may be mounted on it. If the spindle cannot be locked, the dial gauge shall be placed on a fixed part of the machine (a) Carry out the test with the transverse movement locked for the table (b) Carry out the test with the longitudinal movement locked for the table

Table 1 — Geometrical tests for boring and milling machines, horizontal spindle table type

All dimensions are in millimetres.

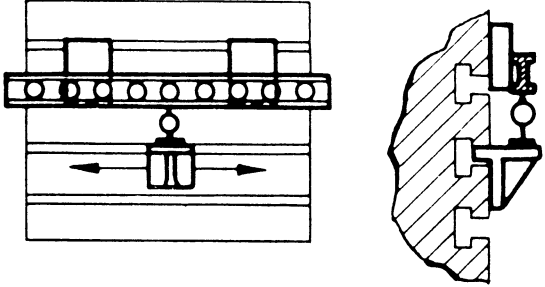
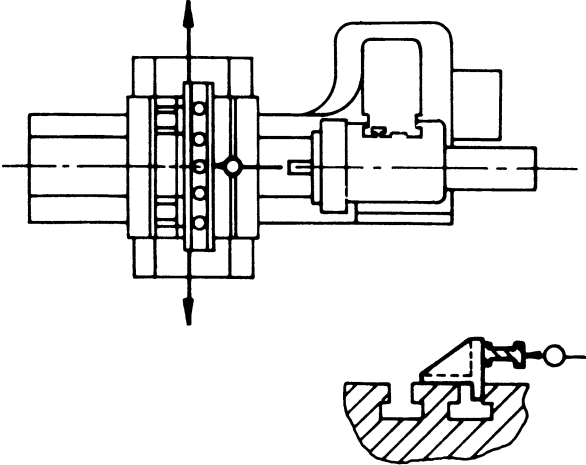
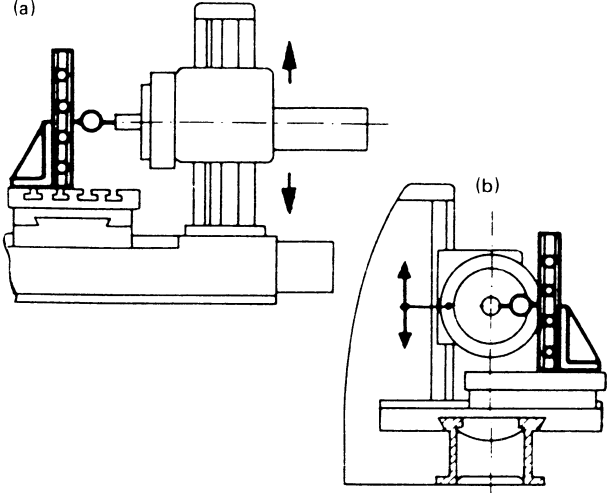
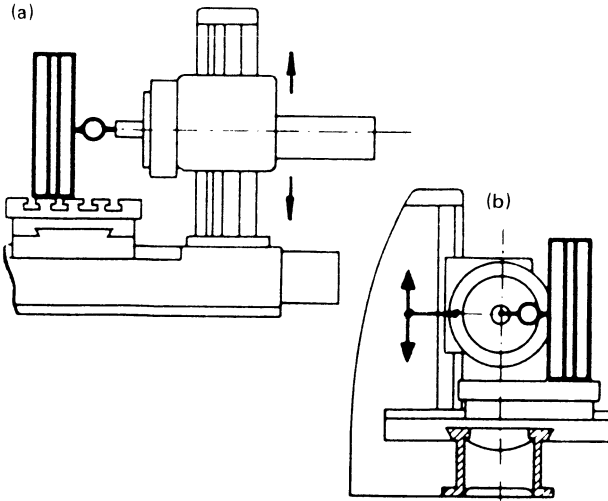
1	2	3	4	5	6
No.	Diagram	Object	Permissible deviation	Measuring instruments	Observations and references to the test code BS 3800
1G6		Checking of straightness of the median or reference T slot of the table	0.02 for any measuring length of 1 000 Maximum permissible deviation: 0.03	Straightedge and dial gauge, or gauge blocks, or microscope and taut wire	5.212, 5.212.1, 5.212.3 or 5.232 The straightedge may be set directly on the table
1G7		Checking of the parallelism of median or reference slot to the table displacement (X axis)	0.03 for a measuring length of 1 000 Maximum permissible deviation: 0.04	Straightedge, gauge blocks and dial gauge	5.232.1 and 5.422.21 If the spindle can be locked, the dial gauge may be mounted on it; otherwise, it shall be mounted on a fixed part of the machine

Table 1 — Geometrical tests for boring and milling machines, horizontal spindle table type

All dimensions are in millimetres.

1	2	3	4	5	6
No.	Diagram	Object	Permissible deviation	Measuring instruments	Observations and references to the test code BS 3800
1G8		Checking of straightness of the vertical movement of the spindle head (Y axis) (a) in the vertical plane coaxial with the spindle axis (b) in the vertical plane perpendicular to the spindle axis	(a) 0.02 for a measuring length of 500 (b) 0.02 for a measuring length of 500	Dial gauge and straightedge	5.232.1 Carry out the test with the table saddle and table base locked and the table and table base set in mid-travel and locked when possible As an exception to the acceptance code, a square may be used instead of a straightedge If the spindle can be locked, the dial gauge may be mounted on it. If the spindle cannot be locked, the dial gauge shall be placed on the spindle head of the machine
1G9		Checking of squareness of the vertical movement (Y axis) of the spindle head to the table surface (a) in the vertical plane coaxial with the spindle axis (b) in the plane perpendicular to the spindle axis	(a) 0.02/500 (b) 0.02/500	Dial gauge and square	5.522.2 Carry out the test with the table saddle locked and the table and table base set in mid-travel and locked when possible Lock the spindle head when taking measurements If the spindle can be locked, the dial gauge may be mounted on it. If the spindle cannot be locked, the dial gauge shall be placed on the spindle head of the machine The square is placed at the centre of the table