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Specification for

The accuracy of machine tools and methods of test —

**Part 4: Milling machines, bed type,
horizontal or vertical spindle**

Co-operating organizations

The Mechanical Engineering Industry Standards Committee, under whose supervision this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:

Associated Offices' Technical Committee	Engineering Equipment Users' Association
Association of Consulting Engineers	Gas Council
Association of Mining Electrical and Mechanical Engineers	Institution of Civil Engineers
Board of Trade	Institution of Gas Engineers
British Chemical Plant Manufacturers' Association	Institution of Heating and Ventilating Engineers
British Compressed Air Society	Institution of Mechanical Engineers*
British Electrical and Allied Manufacturers' Association*	Institution of Mechanical Engineers (Automobile Division)*
British Gear Manufacturers' Association	Institution of Production Engineers*
British Internal Combustion Engine Manufacturers' Association	Locomotive and Allied Manufacturers' Association of Great Britain
British Steel Industry	London Transport Executive
British Mechanical Engineering Confederation	Machine Tool Trades Association*
British Pump Manufacturers' Association	Ministry of Defence, Army Department*
Crown Agents for Oversea Governments and Administrations	Ministry of Public Building and Works*
Department of Employment and Productivity (H.M. Factory Inspectorate)	Ministry of Technology*
Electricity Council, the Central Electricity Generating Board and the Area Boards in England and Wales	Ministry of Technology — National Engineering Laboratory
	Ministry of Transport
	National Coal Board
	National Physical Laboratory (Ministry of Technology)
	Royal Institute of British Architects

The Government departments and scientific and industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this British Standard.

Association of Scientific, Technical and Managerial Staffs	Production Engineering Research Association
Ministry of Defence, Air Force Department	Society of Motor Manufacturers and Traders Ltd.
Ministry of Defence, Navy Department	Trades Union Congress
National Federation of Engineers' Tool Manufacturers	

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Foreword

This standard makes reference to the following British Standard:

BS 3800, *Methods for testing the accuracy of machine tools*.

This Part of this British Standard has been prepared under the authority of the Mechanical Engineering Industry Standards Committee under an accelerated procedure for implementing agreements of the International Organization for Standardization (ISO) in British Standards. This Part of the standard is compatible with ISO 1984, “*Test conditions for milling machines with table of fixed height, with horizontal or vertical spindle, testing of accuracy*”, which has been prepared by Technical Committee 39, Machine Tools, of ISO, except that the practical test is not recommended and is shown in Appendix A for information only.

Appendix B contains comments relating to slideway straightness.

This Part of this standard whilst based on ISO 1984 incorporates slight alterations so that it is applicable to the type of machine manufactured in the United Kingdom.

The modifications, principally to drawings, to the ISO agreements have not affected tolerances or the nature of tests carried out. These have been solely concerned with ensuring that the tests are not only applicable to machines with transverse table movement, which are manufactured in Europe, but also to machines with transverse movement achieved by moving columns or quill type cutter spindles as manufactured in the United Kingdom.

Certain additional alternative test methods for tests GI4 and GI5 included in the ISO agreements have also been omitted as they were considered technically unsound and are not used by manufacturers in the United Kingdom.

Appendix C gives terminology that is technically equivalent to ISO 1984-0, “*Test conditions for milling machines with table of fixed height with horizontal or vertical spindle, testing of accuracy — Part 0: General introduction*”. Reference to side and face milling, slot milling using end mills and profile milling using the side of end mills 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 22 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 this British Standard specifies requirements for the accuracy of milling machines of bed type with horizontal or vertical spindle by establishing permissible deviations from certain essential dimensional and geometrical characteristics, and by prescribing, by reference to BS 3800, the details of the tests to be carried out to verify compliance with these requirements.

The standard deals only with the verification of accuracy, and does not apply to the testing of the running of the machine (vibrations, abnormal noises, stick-slip motion of components etc.) nor to machine characteristics (speeds, feeds etc.) which should generally be checked before testing accuracy. Definitions and terminology are given in Appendix C.

NOTE The title of the British Standard referred to in this standard is given on page ii.

2 Accuracy requirements

Machines shall comply with the accuracy requirements given in column 4 of Table 1.

The tests to be made in order to verify these requirements shall be in accordance with the details given in Table 1, and the requirements specified in Clause 3.

3 Application of test methods

3.1 In applying the tests detailed in Table 1, 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.

3.2 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 relates to the sub-assemblies of the machine, and it is not intended to impose the practical order in which the tests are to be made.

3.3 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, and these tests are to be clearly stated when the machine is ordered.

3.4 When establishing the tolerance for a measuring range different from that given in this standard (see **2.311** in BS 3800:1964) it should be taken into consideration that the minimum value of tolerance is 0.01 mm for milling machines.

3.5 These tests may be applied not only to machines which have transverse table movement but also those with moving columns or quill shaft units. Those tests which are applicable to a particular type of machine are indicated where appropriate.

4 Abbreviations

For the purposes of this standard, 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.

Table 1 — Geometrical tests for milling machines of bed type with horizontal or vertical spindles

All dimensions are in millimetres.

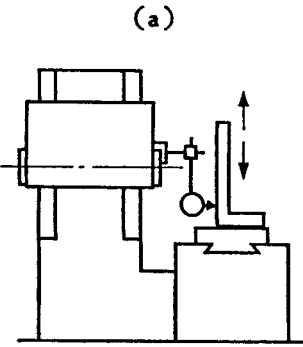
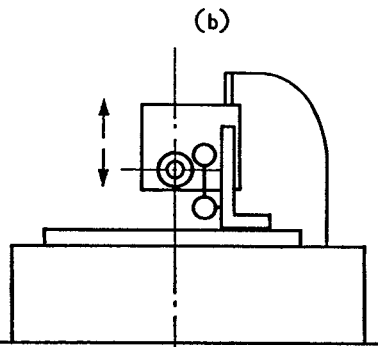
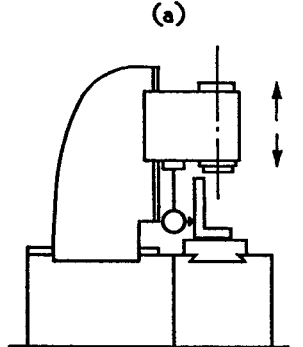
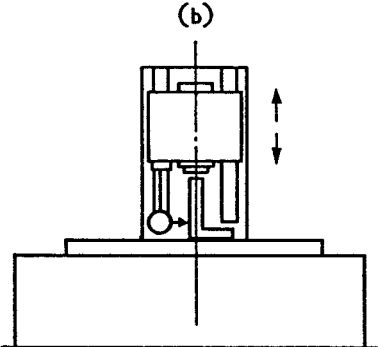
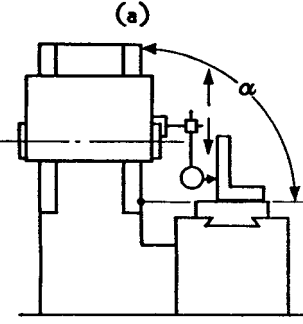
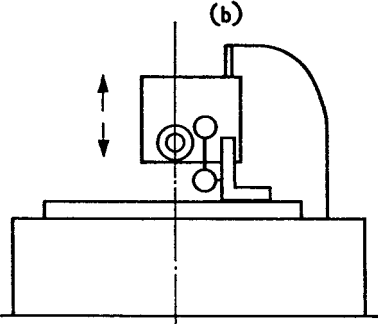
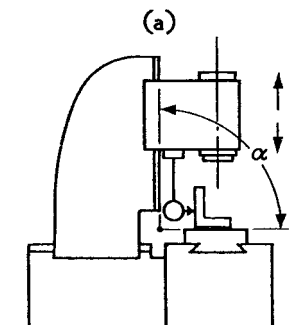
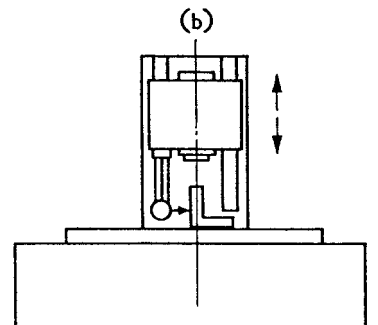
1	2	3
No.	Diagram	Test to be applied
G1		Verification of straightness of the vertical movement of the spindle head slide: (a) in the vertical plane of symmetry of the machine or transverse vertical plane (b) in the plane perpendicular to the plane of symmetry of the machine or transverse vertical plane
		
		
		
G2		Verification of squareness of the table surface to the column ways for the spindle head slide (in three positions in the middle and near the extremities of the travel) (a) in the vertical plane of symmetry of the machine (b) in the plane perpendicular to the vertical plane of symmetry of the machine
		
		
		

Table 1 — Geometrical tests for milling machines of bed type with horizontal or vertical spindles

All dimensions are in millimetres.

4	5	6
Permissible deviation	Measuring instruments	Observations and references to the test code BS 3800
(a) 0.025 for a measuring length of 300 (b) 0.025 for a measuring length of 300	Dial gauge and straightedge set upright	5.232.1 Instead of a straightedge use the vertical arm of a square Table in central position, all longitudinal and transverse movements locked If the spindle can be locked the dial gauge may be mounted on it. If the spindle cannot be locked, it should be placed on the spindle head of the machine
(a) 0.025/300 with $\alpha \leq 90^\circ$ (b) 0.025/300	Dial gauge and square	5.522.2 Table in central position, all longitudinal and transverse movements locked Spindle head slide locked 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 should be placed on the spindle head of the machine

Table 1 — Geometrical tests for milling machines of bed type with horizontal or vertical spindles

All dimensions are in millimetres.

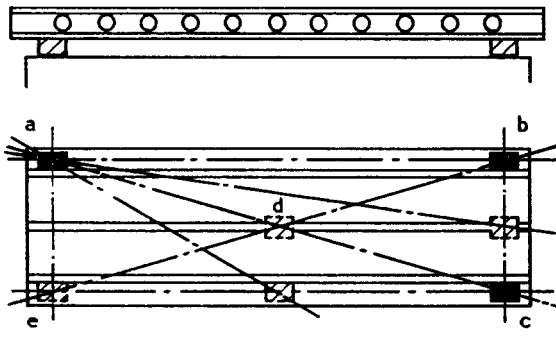
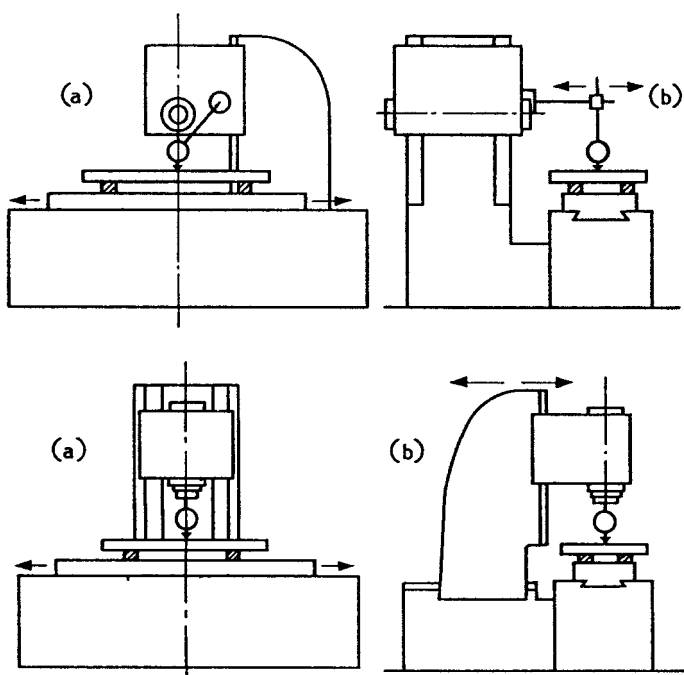
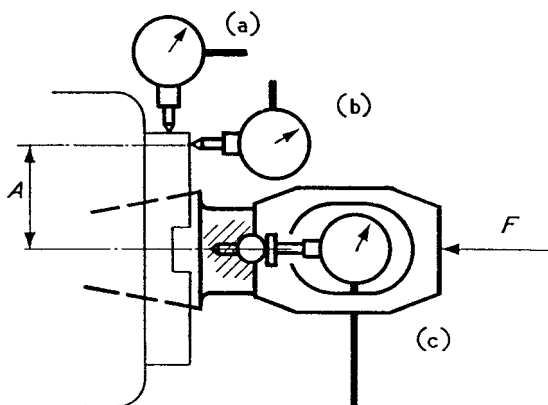
1	2	3
No.	Diagram	Test to be applied
G3		Verification of flatness of the table surface
G4		(a) Verification of the parallelism of the table surface to the longitudinal movement (b) Verification of the parallelism of the table surface to the transverse movement
G5		(a) Measurement of vertical run-out of the external centring surface on the spindle nose (for machines having this feature) (b) Measurement of axial run-out (camming) of the face of the spindle nose (including periodic axial slip) (c) Measurement of periodic axial slip

Table 1 — Geometrical tests for milling machines of bed type with horizontal or vertical spindles

All dimensions are in millimetres.

4	5	6
Permissible deviation	Measuring instruments	Observations and references to the test code BS 3800
0.04 up to 1 000 For each 1 000 increase in table length, add 0.005 up to a maximum permissible deviation of 0.05 Local tolerance: 0.02 for any 300 length	Precision level or straightedge and slip gauges	5.322 and 5.323 Table and cross slide in central position, table not locked, cross slide locked
(a) 0.025 for any 300 length Maximum permissible deviation 0.05 (b) 0.025 for any 300 length	Straightedge and dial gauge	5.422.21 The stylus of the dial gauge to be placed approximately at the working position of the tool The measurement may be made on a straightedge laid parallel to the table surface If the table length is greater than 1 600 mm the inspection shall be carried out by successive movements of the straightedge If the spindle can be locked, then after locking the spindle head slide, the dial gauge may be mounted on it If the spindle cannot be locked, then the dial gauge should be placed on a fixed part of the machine (a) Cross slide and spindle head slide locked (b) Table and spindle head slide locked
(a) 0.01 (b) 0.02 (c) 0.01	Dial gauge	(a) 5.612.2 (b) 5.632 The distance <i>A</i> of dial gauge (b) from the spindle axis should be as large as possible (c) 5.622.1 and 5.622.2 A force <i>F</i>, specified by the manufacturer of the machine should be exerted by pressing towards the housing for tests (b) and (c)