

# International Standard



# 2407

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

## Acceptance conditions for internal cylindrical grinding machines with horizontal spindle — Testing of accuracy

*Conditions de réception des machines à rectifier les surfaces de révolution intérieures, à broche horizontale — Contrôle de la précision*

Second edition — 1984-11-01

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Descriptors : machine tools, grinding machines (tools), tests, testing conditions, dimensional measurements, accuracy.

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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. Every 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.

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. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 2407 was prepared by Technical Committee ISO/TC 39, *Machine tools*.

ISO 2407 was first published in 1973. This second edition cancels and replaces the first, of which it constitutes a minor technical revision.

# Acceptance conditions for internal cylindrical grinding machines with horizontal spindle — Testing of accuracy

## 1 SCOPE AND FIELD OF APPLICATION

This International Standard describes, with reference to ISO/R 230, both geometrical and practical tests on general purpose and normal accuracy internal cylindrical grinding machines with horizontal spindle, whether fitted with a surfacing wheel slide or not, and gives the corresponding permissible deviations.

Complementary geometrical tests and a practical test for machines with a surfacing wheel slide are given in the annex.

It deals only with the verification of accuracy of the machine. It does not apply to testing the running of the machine (vibrations, abnormal noises, stick-slip motion of components, etc.), or to its characteristics (speeds, feeds, etc.) which should generally be checked before testing accuracy.

## 2 PRELIMINARY REMARKS

2.1 In this International Standard, all the dimensions are expressed in millimetres and in inches.

2.2 To apply this International Standard, reference should be made to ISO/R 230, especially for the installation of the machine before testing, warming up of spindles and other moving parts, description of measuring methods and recommended accuracy of testing equipment.

2.3 The sequence in which the geometrical tests are given is related to the sub-assemblies of the machine, and this in no way defines the practical order of testing. In order to make the mounting of instruments or gauging easier, tests may be carried out in any order.

2.4 When inspecting a machine, it is not always necessary to carry out all the tests given in this International Standard. It is up to the user to choose, in agreement with the manufacturer, those relating to the properties which are of interest to him, but these tests are to be clearly stated when ordering a machine.

2.5 Practical tests shall be made with finishing cuts and not with roughing cuts which are liable to generate appreciable cutting forces.

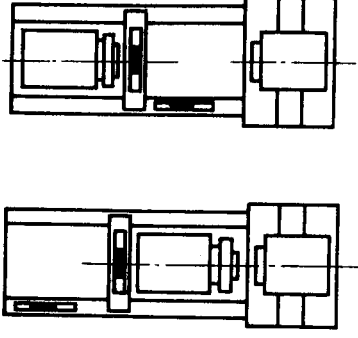
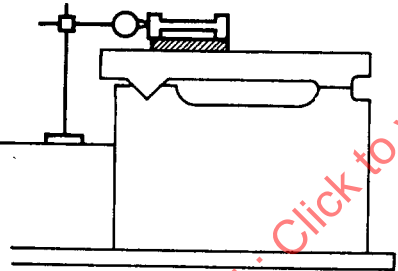
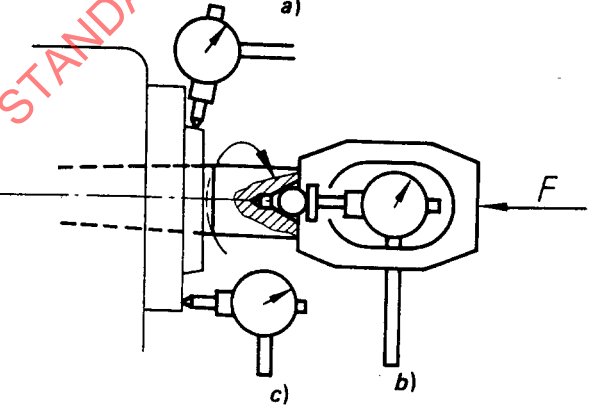
2.6 When the tolerance is established for a measuring range different from that indicated in this International Standard (see 2.311 in ISO/R 230) it should be taken into consideration that the minimum value of tolerances is 0,001 mm (0.000 04 in).

## 3 REFERENCE

ISO/R 230, *Machine tool test code*.

## 4 ACCEPTANCE CONDITIONS AND PERMISSIBLE DEVIATIONS

### 4.1 Geometrical tests

| No. | Diagram                                                                             | Object                                                                                                                                                                                                                                                                                |                               |
|-----|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|
| G0  |    | <p>Levelling of the machine.</p>                                                                                                                                                                                                                                                      |                               |
| G1  |  | <p><b>A – TABLE</b></p> <p>Checking of straightness of the table movement in the horizontal plane.</p>                                                                                                                                                                                | for a                         |
| G2  |  | <p><b>B – WORKHEAD</b></p> <p>a) Measurement of run-out of the external register diameter of the spindle;</p> <p>b) Measurement of periodic axial slip of the work spindle;</p> <p>c) Measurement of camming of the register face of the spindle (including periodic axial slip).</p> | <p>a)</p> <p>b)</p> <p>c)</p> |

| Permissible deviation |    | Measuring instruments | Observations<br>and references to the test code ISO/R 230 |
|-----------------------|----|-----------------------|-----------------------------------------------------------|
| mm                    | in |                       |                                                           |
|                       |    |                       |                                                           |

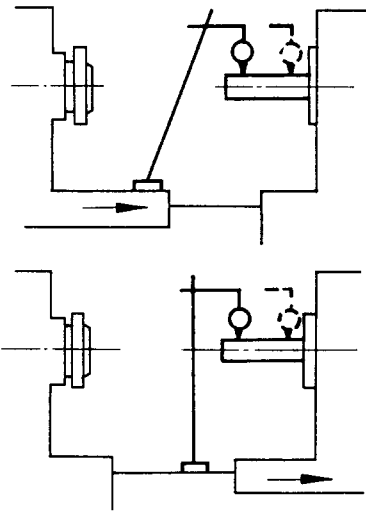
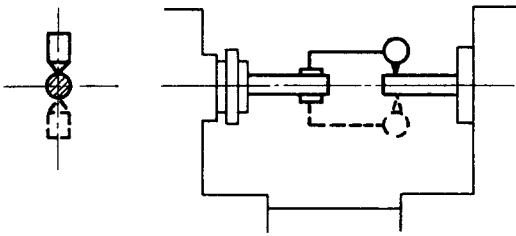
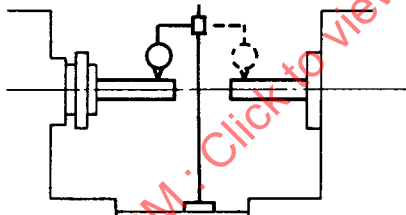
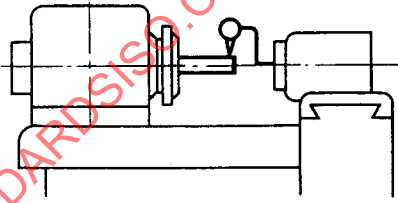
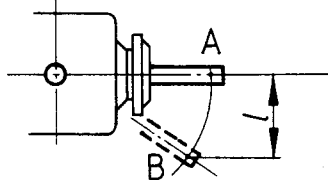
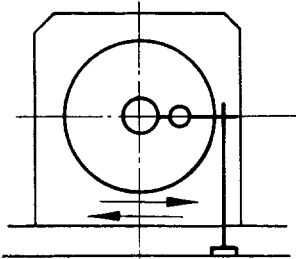
**In the case of internal cylindrical grinding machines, no part is to be dismantled (especially in the case of slideways mounted on roller elements). It will be satisfactory to check the levelling with the aid of levels set longitudinally and transversely on the machine according to the manufacturer's specifications.**

|                                                |                                                    |                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------------------------------------------------|----------------------------------------------------|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                |                                                    |                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 0,008<br>for a 300 mm travel                   | 0.0003<br>for a 12 in travel                       | Straightedge and dial<br>gauge | <p>Clause 5.232.1</p> <p>The dial gauge support shall be placed on a fixed part of the machine, the stylus touching a straightedge laid parallel to the general direction of the longitudinal movement of the table.</p>                                                                                                                                                                                                                           |
| <p>a) 0,005</p> <p>b) 0,005</p> <p>c) 0,01</p> | <p>a) 0.0002</p> <p>b) 0.0002</p> <p>c) 0.0004</p> | Dial gauge                     | <p>a) Clause 5.612.2</p> <p>In the case of a tapered spindle nose the stylus of the dial gauge shall be set normal to the surface to be checked.</p> <p>b) and c) Clauses 5.62, 5.621.2, 5.622.1, 5.622.2 and 5.632</p> <p>For the dial gauge position, see Figures 59 to 64 and 67, clauses 5.62, 5.622 and 5.632.</p> <p>The value of force <math>F</math> to be applied for the tests a), b) and c) shall be specified by the manufacturer.</p> |

| No. | Diagram | Object                                                                                                                                                                                                                                                                                   |                                            |
|-----|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|
| G3  |         | <p>Measurement of run-out of the taper or of the internal centring register of the spindle :</p> <p>a) at the outlet of the housing;</p> <p>b) at a distance from the outlet equal to <math>\frac{Da^*}{2}</math> [100 mm (4 in) minimum and 300 mm (12 in) maximum].</p>                | <p>a)</p> <p>b)</p>                        |
| G4  |         | <p>Checking of parallelism of the workhead spindle axis to the table movement (in the case of a moving workhead) or to the longitudinal movement of the grinding wheel spindle (in the case of a moving wheelhead) :</p> <p>a) in a horizontal plane;</p> <p>b) in a vertical plane.</p> | <p>a)</p> <p>b)</p> <p>(Test m upward)</p> |
| G5  |         | <p><b>C – GRINDING SPINDLE</b></p> <p>Measurement of run-out of the grinding wheel spindle (wheel mounting diameter) :</p> <p>a) at the outlet of the housing;</p> <p>b) at a distance equal to <math>\frac{Da^*}{2}</math> [100 mm (4 in) minimum and 200 mm (8 in) maximum]</p>        | <p>a)</p> <p>b)</p> <p>for of</p>          |

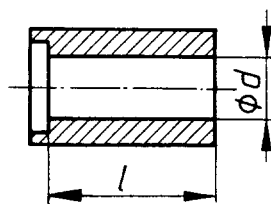
\*  $Da$  = Maximum diameter admissible for workpiece.

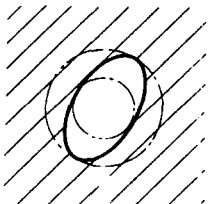
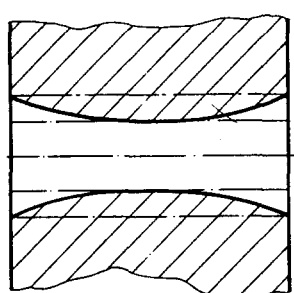
| Permissible deviation                                                                                                                                     |                                                                                                                                                           | Measuring instruments                                                   | Observations<br>and references to the test code ISO/R 230                                                                                                                                                                                                                                                                                                          |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| mm                                                                                                                                                        | in                                                                                                                                                        |                                                                         |                                                                                                                                                                                                                                                                                                                                                                    |
| <p>a) 0,005</p> <p>b) 0,015<br/>for a measuring length<br/>of 300</p>                                                                                     | <p>a) 0.0002</p> <p>b) 0.0006<br/>for a measuring length<br/>of 12</p>                                                                                    | Test mandrel according<br>to the type of spindle<br>nose and dial gauge | <p>Clause 5.612.3</p> <p>In the case of an internal taper, the test<br/>will be made with the aid of a mandrel.</p> <p>In the case of a cylindrical centring<br/>register, the test will be made with the<br/>aid of the dial gauge and without using a<br/>test mandrel. In this case, the value of <i>a</i>)<br/>will be taken as the permissible deviation.</p> |
| <p>a) 0,01<br/>for a measuring length<br/>of 300</p> <p>b) 0,025<br/>for a measuring length<br/>of 300</p> <p>(Test mandrel end directed<br/>upwards)</p> | <p>a) 0.0004<br/>for a measuring length<br/>of 12</p> <p>b) 0.001<br/>for a measuring length<br/>of 12</p> <p>(Test mandrel end directed<br/>upwards)</p> | Test mandrel and dial<br>gauge                                          | Clauses 5.412.1 and 5.422.3                                                                                                                                                                                                                                                                                                                                        |
| <p>a) 0,01</p> <p>b) 0,02<br/>for a measuring length<br/>of 200</p>                                                                                       | <p>a) 0.0004</p> <p>b) 0.0008<br/>for a measuring length<br/>of 8</p>                                                                                     | Test mandrel according<br>to the type of spindle<br>nose and dial gauge | <p>Clause 5.612.3</p> <p>In the case of an internal taper, the test<br/>will be made with the aid of a mandrel.</p> <p>In the case of a cylindrical centring<br/>register, the test will be made with the aid<br/>of the dial gauge and without using a test<br/>mandrel. In this case, the value of <i>a</i>) will<br/>be taken as the permissible deviation.</p> |

| No. | Diagram                                                                                                                                                                                          | Object                                                                                                                                                                                                                                                            |                                                       |
|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|
| G6  |                                                                                                                 | <p>Checking of parallelism of the grinding wheel spindle axis to the table movement in a vertical plane</p> <p><b>OR</b></p> <p>Checking of parallelism of the grinding wheel spindle axis to the longitudinal movement of the wheelhead in a vertical plane.</p> | <p>for a r<br/>of 300</p> <p>(Test me<br/>upwards</p> |
| G7  |  <p><b>Alternative</b></p>  | <p>Measurement of difference in height between the axis of workhead spindle and the axis of wheelhead spindle.</p>                                                                                                                                                |                                                       |
| G8  |                            | <p><b>SWIVELLING WORKHEAD</b></p> <p>Checking of parallelism of the mounting face of the swivelling workhead to the cross traverse of the wheelhead.</p>                                                                                                          |                                                       |
| G9  |                                                                                                               | <p>Measurement of repeatability of the finish approach of the wheel slide (or the work slide)</p>                                                                                                                                                                 |                                                       |

| Permissible deviation                                                             |                                                                                     | Measuring instruments          | Observations<br>and references to the test code ISO/R 230                                                                                                                                                               |
|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| mm                                                                                | in                                                                                  |                                |                                                                                                                                                                                                                         |
| 0,03<br>for a measuring length<br>of 300<br>Test mandrel end directed<br>upwards) | 0.0012<br>for a measuring length<br>of 12<br>(Test mandrel end directed<br>upwards) | Test mandrel and dial<br>gauge | Clauses 5.412.1 and 5.422.3                                                                                                                                                                                             |
| 0,025                                                                             | 0.001                                                                               | Dial gauge and special<br>rest | <p>Clause 5.442</p> <p>The test shall be carried out in the vertical plane after having obtained alignment in the horizontal plane.</p>                                                                                 |
|                                                                                   |                                                                                     |                                | <p><b>Alternative</b></p> <p>Clause 5.432.1</p> <p>The test can be carried out with the dial gauge support set directly on the table.</p>                                                                               |
| 0,01<br>for $l = 100$                                                             | 0.0004<br>for $l = 4$                                                               | Test mandrel and dial<br>gauge | <p>Clause 5.412.1</p> <p>A reading shall be made when the work-head is locked in position A.</p> <p>Swivel the workhead towards its external position B.</p> <p>Move the cross slide so as to obtain the reading B.</p> |
| 0,002                                                                             | 0.00008                                                                             | Dial gauge                     | Carry out six consecutive tests for the wheel slide positioning (or work slide positioning), the movement being obtained by a quick approach followed by a slow approach.                                               |

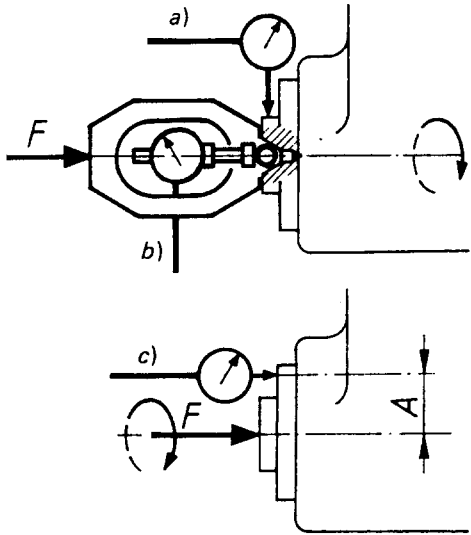
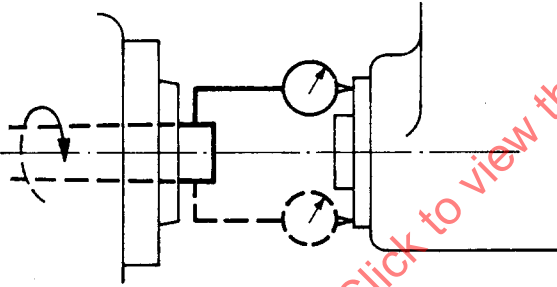
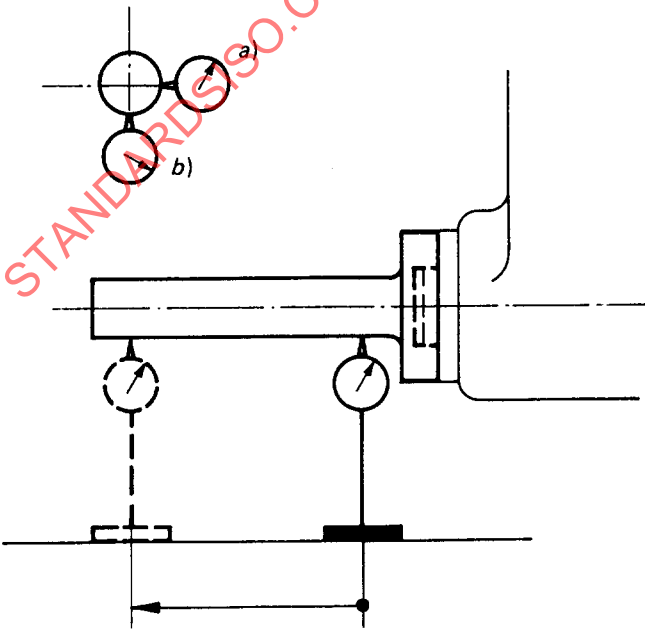
## 4.2 Practical test

| No.                                            | Diagram                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Nature of test                                 | Cutting conditions |     |          |    |    |               |    |    |                |    |     |           |     |     |                                                |     |     |           |     |   |                 |     |   |               |     |   |         |   |   |                                                                 |                                                                  |
|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|--------------------|-----|----------|----|----|---------------|----|----|----------------|----|-----|-----------|-----|-----|------------------------------------------------|-----|-----|-----------|-----|---|-----------------|-----|---|---------------|-----|---|---------|---|---|-----------------------------------------------------------------|------------------------------------------------------------------|
| P1                                             | <div></div> <div><p>Dimensions in millimetres</p><table><tr><th><math>D</math> = Maximum admissible diameter for grinding</th><th><math>d</math></th><th><math>l</math></th></tr><tr><td><math>D &lt; 40</math></td><td>15</td><td>25</td></tr><tr><td><math>40 &lt; D &lt; 80</math></td><td>30</td><td>50</td></tr><tr><td><math>80 &lt; D &lt; 150</math></td><td>60</td><td>100</td></tr><tr><td><math>D &gt; 150</math></td><td>100</td><td>150</td></tr></table><p>Dimensions in inches</p><table><tr><th><math>D</math> = Maximum admissible diameter for grinding</th><th><math>d</math></th><th><math>l</math></th></tr><tr><td><math>D &lt; 1.6</math></td><td>0.6</td><td>1</td></tr><tr><td><math>1.6 &lt; D &lt; 3.2</math></td><td>1.2</td><td>2</td></tr><tr><td><math>3.2 &lt; D &lt; 6</math></td><td>2.4</td><td>4</td></tr><tr><td><math>D &gt; 6</math></td><td>4</td><td>6</td></tr></table><p>Material: steel</p></div> | $D$ = Maximum admissible diameter for grinding | $d$                | $l$ | $D < 40$ | 15 | 25 | $40 < D < 80$ | 30 | 50 | $80 < D < 150$ | 60 | 100 | $D > 150$ | 100 | 150 | $D$ = Maximum admissible diameter for grinding | $d$ | $l$ | $D < 1.6$ | 0.6 | 1 | $1.6 < D < 3.2$ | 1.2 | 2 | $3.2 < D < 6$ | 2.4 | 4 | $D > 6$ | 4 | 6 | <p>Grinding of the bore of a test piece mounted on a plate.</p> | <p>Grinding along the whole length / (without arbor support)</p> |
| $D$ = Maximum admissible diameter for grinding | $d$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | $l$                                            |                    |     |          |    |    |               |    |    |                |    |     |           |     |     |                                                |     |     |           |     |   |                 |     |   |               |     |   |         |   |   |                                                                 |                                                                  |
| $D < 40$                                       | 15                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 25                                             |                    |     |          |    |    |               |    |    |                |    |     |           |     |     |                                                |     |     |           |     |   |                 |     |   |               |     |   |         |   |   |                                                                 |                                                                  |
| $40 < D < 80$                                  | 30                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 50                                             |                    |     |          |    |    |               |    |    |                |    |     |           |     |     |                                                |     |     |           |     |   |                 |     |   |               |     |   |         |   |   |                                                                 |                                                                  |
| $80 < D < 150$                                 | 60                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 100                                            |                    |     |          |    |    |               |    |    |                |    |     |           |     |     |                                                |     |     |           |     |   |                 |     |   |               |     |   |         |   |   |                                                                 |                                                                  |
| $D > 150$                                      | 100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 150                                            |                    |     |          |    |    |               |    |    |                |    |     |           |     |     |                                                |     |     |           |     |   |                 |     |   |               |     |   |         |   |   |                                                                 |                                                                  |
| $D$ = Maximum admissible diameter for grinding | $d$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | $l$                                            |                    |     |          |    |    |               |    |    |                |    |     |           |     |     |                                                |     |     |           |     |   |                 |     |   |               |     |   |         |   |   |                                                                 |                                                                  |
| $D < 1.6$                                      | 0.6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 1                                              |                    |     |          |    |    |               |    |    |                |    |     |           |     |     |                                                |     |     |           |     |   |                 |     |   |               |     |   |         |   |   |                                                                 |                                                                  |
| $1.6 < D < 3.2$                                | 1.2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 2                                              |                    |     |          |    |    |               |    |    |                |    |     |           |     |     |                                                |     |     |           |     |   |                 |     |   |               |     |   |         |   |   |                                                                 |                                                                  |
| $3.2 < D < 6$                                  | 2.4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 4                                              |                    |     |          |    |    |               |    |    |                |    |     |           |     |     |                                                |     |     |           |     |   |                 |     |   |               |     |   |         |   |   |                                                                 |                                                                  |
| $D > 6$                                        | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 6                                              |                    |     |          |    |    |               |    |    |                |    |     |           |     |     |                                                |     |     |           |     |   |                 |     |   |               |     |   |         |   |   |                                                                 |                                                                  |

| ing<br>ions                            | Checks to be applied                                                                                                                                                                                                                 | Permissible deviation                                                                                      |                                                                                                          | Measuring<br>instruments | Observations and references to<br>the test code ISO/R 230                                                                                                                                                                                                                                                                                                         |
|----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                        |                                                                                                                                                                                                                                      | mm                                                                                                         | in                                                                                                       |                          |                                                                                                                                                                                                                                                                                                                                                                   |
| ing<br>the<br>le<br>h /<br>out<br>sup- | <p>a) Circularity (roundness)<br/>(deviation for circularity = difference between the maximum diameter and the minimum diameter of a section).</p>  | a) 0,005                                                                                                   | a) 0.0002                                                                                                | Bore gauge               | <p>Clauses 3.1, 3.22, 4.1 and 4.2</p> <p>Tests for circularity should be made at several positions of the test piece and the greatest value of the deviation obtained.</p> <p>The measurements for consistency of diameter shall be carried out in a single axial plane.</p> <p>NOTE — Any tapes should be such that the major diameter is near the workhead.</p> |
|                                        | <p>b) Consistency of diameter :</p> <p>Variation of diameter measured at both ends and in the middle of the test piece.</p>                       | <p>b)</p> <p>for / = 25 : 0,005<br/>for / = 50 : 0,005<br/>for / = 100 : 0,010<br/>for / = 150 : 0,015</p> | <p>b)</p> <p>for / = 1 : 0.0002<br/>for / = 2 : 0.0002<br/>for / = 4 : 0.0004<br/>for / = 6 : 0.0006</p> |                          |                                                                                                                                                                                                                                                                                                                                                                   |

**COMPLEMENTARY GEOMETRICAL TESTS AND PRACTICAL TEST**  
**(IN THE CASE OF A MACHINE HAVING A SURFACING WHEEL SLIDE)**

**A.1 GEOMETRICAL TESTS**

| No.  | Diagram                                                                             | Object                                                                                                                                                                                                                                                                                                                                                                                                                          |                               |
|------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|
| AG 1 |    | <p>a) Measurement of run-out of the surfacing wheel spindle (wheel mounting diameter);</p> <p>b) Measurement of periodic axial slip of the surfacing wheel spindle;</p> <p>c) Measurement of camming of the face of the spindle nose (including periodic axial slip)</p>                                                                                                                                                        | <p>a)</p> <p>b)</p> <p>c)</p> |
| AG 2 |   | <p>Checking of squareness of the flange face of the surfacing wheel spindle to the workhead spindle axis.</p>                                                                                                                                                                                                                                                                                                                   |                               |
| AG 3 |  | <p><b>Moving workhead</b></p> <p>Checking of parallelism of the surfacing wheelhead spindle axis to the longitudinal table movement :</p> <p>a) in a horizontal plane;</p> <p>b) in a vertical plane.</p> <p><b>Moving wheelhead</b></p> <p>Checking of parallelism of the surfacing wheelhead spindle axis to the longitudinal movement of the wheelhead :</p> <p>a) in a horizontal plane;</p> <p>b) in a vertical plane.</p> | <p>a)</p> <p>b)</p>           |