

# NATIONAL PHYSICAL LABORATORY

## METROLOGY CENTRE

**Ref: MOY/SCMI/2 SPECIFICATION OF ACCURACY**  
**(Issue 6)**  
**for**  
**A TOOLMAKER'S MICROSCOPE**

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Type: A Toolmaker's Microscope having a measuring range 150 mm x 50 mm, (6 in x 2 in), as described in the maker's Brochure.

Made by: Optical Measuring Tools Ltd.

### LIMITING VALUE OR MAXIMUM PERMISSIBLE ERROR

#### 1. GENERAL

- 1.1 The workmanship and finish shall be in keeping with a precision measuring instrument of this class.
- 1.2 Each instrument shall be marked with the maker's name or trade mark and with an identification number. This identification number shall appear on the main base, the oculars, the work-centre cradle, the projection attachment, and the magnification scale.
- 1.3 When the glass plate in the work-table is set horizontal the bubble of the circular level shall be central.

#### 2. SLIDES

- 2.1 The motions of the longitudinal and transverse slides shall be straight in the horizontal plane. 0.005 mm over any 50 mm length  
0.010 mm over 150 mm  
  
(0.0002 in over any 2 in length, 0.0004 in over 6 in)
- 2.2 The motions of the longitudinal and transverse slides shall be straight in the vertical plane. 0.005 mm (0.0002 in)
- 2.3 The longitudinal and transverse motions shall be mutually square in the horizontal plane. 0.0025 mm per 25 mm  
(0.0001 in per in)
- 2.4 The abutments for the spacing blocks shall be: -
  - (i) Hard Minimum 800 HV
  - (ii) Flat 0.0025 mm (0.0001 in)
- 2.5 The coarse vertical motion of the microscope bracket shall, when the rake scale is set to zero, be perpendicular to the upper surface of the work-table. 0.025 mm (0.001 in) over the vertical travel of the microscope bracket

#### 3. WORK-TABLE

- 3.1 Both surfaces of the glass plate in the work-table shall be flat. 0.008 mm (0.0003 in)

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3.2 The surfaces of the glass plate in the work-table shall be parallel.	0.013 mm (0.0005 in) over its diameter
3.3 The upper surface of the glass plate in the work-table shall be parallel with the longitudinal and transverse motions of the slides.	0.010 mm per 25 mm (0.0004 in per in)
3.4 The upper surface of the glass plate in the work-table shall be square with the axis of rotation of the table.	0.013 mm (0.0005 in) over its diameter
3.5 The metal surface of the work-table shall be flat.	0.025 mm (0.001 in)
3.6 The upper surface of the metal work-table shall be square with the axis of rotation of the table.	0.013 mm (0.0005 in) over its diameter
3.7 The circular scale on the rotatable work-table shall be accurately divided.	±1 vernier division (±3')
3.8 The vernier of the rotatable work-table shall be accurately divided with respect to the main scale.	½ vernier division
3.9 The operation of the clamp shall not affect the rotational setting.	
3.10 The longitudinal and transverse micrometers shall be accurate: -	
(i) Progressive error (any error present shall be of a reasonably uniform nature)	0.005 mm over 25 mm (0.0002 in over 1 in)
(ii) Periodic error	±0.001 mm (±0.000 04 in)
3.11 The traverse of an object placed on the work-table in the plane of the centres, as controlled by the micrometers and spacing blocks, shall be accurate: -	
(i) Longitudinal	0.008 mm over 150 mm (0.0003 in over 6 in)
(ii) Transverse	0.005 mm over 50 mm (0.0002 in over 2 in)
3.12 The finished vee groove in the upper surface of the work-table shall be straight.	0.005 mm (0.0002 in) over its 150 mm length
3.13 When the vee groove (3.12) is set parallel to the transverse motion of the work-table the circular scale of the work-table shall read zero.	
<b>4. <u>WORK-CENTRES</u></b>	
4.1 The points and bearing surfaces of the work-centres shall be hard.	Minimum 800 HV
4.2 The bearing surfaces of the work-centres shall be straight.	0.008 mm (0.0003 in)
4.3 The work-centres shall be uniform in diameter and both shall be equal in diameter.	0.008 mm (0.0003 in)
4.4 The line of centres (external and internal) shall be parallel with the longitudinal motion in the vertical plane.	0.010 mm per 25 mm (0.0004 in per in)

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5.	<b><u>90° VEE CLAMP</u></b>	
5.1	The bearing surfaces contacting the cradle shall be straight.	0.008 mm (0.0003 in)
5.2	The axis of a precision mandrel, when clamped in the vee, shall be parallel with the motion of the longitudinal slide in the vertical plane.	0.010 mm per 25 mm (0.0004 in per in)
6.	<b><u>VEE SUPPORTS</u></b>	
6.1	The axis of a precision mandrel, when resting in the vee supports, shall be parallel with the motion of the longitudinal slide in the vertical plane. This shall apply for all positions of the cross-slides.	0.010 mm per 25 mm (0.0004 in per in)
7.	<b><u>HELIX ANGLE SCALE</u></b>	
7.1	When the scale is set to zero, the optical axis of the microscope shall be perpendicular to the line of centres, as judged from the symmetry of the “out of focus” pattern of a truly annular vee-groove cut in a mandrel mounted between the centres.	
7.2	The LH and RH portions of the scale shall be accurate.	±¼ ° with respect to zero.
7.3	The plane in which the microscope moves under the control of the helix angle adjustment shall be parallel with the longitudinal motion of the slide.	0.005 mm (0.0002 in) over the range of movement
8.	<b><u>MICROSCOPE</u></b>	
8.1	When the helix angle scale is set to zero, the fine focusing motion of the microscope shall be perpendicular to the longitudinal and transverse motions of the slide.	0.005 mm (0.0002 in) over its range
8.2	The field shall be free from astigmatism.	
9.	<b><u>PROTRACTOR OCULAR (When provided)</u></b>	
9.1	Angular measurement by means of the protractor ocular shall be accurate.	±2’
9.2	The angle between the 60° lines shall be accurate and symmetrical with respect to the horizontal line.	±2’
9.3	The vertical lines shall be parallel and also square with the horizontal line.	±2’
9.4	The overall length of the minute scale graticule shall agree with a one degree division on the circular scale.	
10.	<b><u>THREAD FORM OCULARS (When provided)</u></b>	
10.1	The thread forms shall be accurate.	0.013 mm (0.0005 in) at he scale of the object
10.2	The radial index line associated with each profile shall be parallel with the pitch line of the profile.	From ±5’ for the coarser itches to ±15’ for the finer itches.
10.3	The various angles appearing on the ocular shall be accurate.	±2’

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- 10.4 The radial index line associated with each angle referred to above shall be square with the bisector of the angle. ±5'
- 10.5 The marginal scale shall be accurate. ±3'
11. **PROJECTION ATTACHMENT (When provided)**
- 11.1 The magnification at the screen, when using the protractor ocular, shall agree with its nominal value as measured over a central interval of 75 mm (3 in). ±0.13 mm (±0.005 in)
- 11.2 The maximum displacement at the screen of any point in the image, when employing either the protractor or thread form ocular, shall not exceed ±0.25 mm up to a radius of 75 mm (±0.01 in up to a radius of 3 in)
- 11.3 The field shall be free from astigmatism.
12. **MAGNIFICATION SCALE (When provided)**
- 12.1 The magnification scale, shall be accurately divided. 0.13 mm (0.005 in) over any interval
13. **PERFORMANCE TEST**
- 13.1 The performance of the instrument shall be checked by using it to measure the diameters and flank angles of three known plug screw gauges, viz. ¼ in BSW, 1 in BSW and 2 in BSF.
- (i) The measured major, effective and minor diameters shall agree with the known sizes to within ±0.0003 in. ±0.008 mm
- (ii) Each measured flank-angle shall agree with the known value to within ±5'
- Note: For the above test the microscope, when fitted with the x3 objective, shall be focused on to the line of centres by means of the "OMT" focusing bar provided, and the focus shall not be subsequently disturbed.
- The diaphragm at the back of the instrument shall be set to the line marked "S".

(Signed) *L.W. Nichols*  
for Director

