NATIONAL PHYSICAL LABORATORY

METROLOGY CENTRE

Ref: MOY/SCMI/84 (Issue 4) **SPECIFICATION OF ACCURACY**

for

AN NPL 75 mm (3-INCH) INTERNAL MEASURING MACHINE

Type: A machine of NPL design, Drawing No. 1908, for measuring the internal diameter of cylindrical reference ring gauges of nominal size from 2.5 mm to 75 mm (0.1 in to 3 in) to an accuracy of ±0.000 25 mm (±0.000 01 in).

Note: A machine not strictly, in accordance with the drawing may be rejected if the modification introduced is likely to affect the performance. The Laboratory should therefore be consulted in advance by a manufacturer who proposes to introduce any modification.

		LIMITING VALUE OR MAXIMUM PERMISSIBLE ERROR
1.	**GENERAL**	
1.1	The workmanship and finish shall be in keeping with a precision instrument of this class.	
1.2	Each machine shall be marked: - (i) with the maker's name or trade mark. (ii) with an identification number. (This number shall also appear on the end-pieces for the box-standard). (iii) NPL design.	
1.3	The datum, to which all the alignments of the machine shall be referred, is the external surface of the cylindrical portion of the hollow shaft (Detail 35 on sheet 6 of Drawing No. 1908) which is mounted in the upper portion of the main casting and provides the bearing for the vee grooves of the adjustable slide.	
2.	**WORK-TABLE AND TELESCOPIC ELEVATING SHAFT**	
2.1	The upper surface of the work-table shall be flat.	0.008 mm (0.0003 in)
2.2	The upper surface of the work-table shall be square to the axis of rotation.	0.008 mm (0.0003 in) at a radius of 75 mm (3 in)
2.3	The work-table shall not tilt when it is raised or lowered through its total range.	12 seconds of arc.
2.4	The hand-clamp which locks the elevating motion shall function effectively.	
2.5	The upper surface of the work-table shall, in the mean, be parallel with the transverse motion of the adjustable slide.	0.025 mm over 25 mm (0.001 in over 1 in)
2.6	The upper surface of the work-table shall, in the mean, be parallel with the longitudinal motion of the adjustable slide.	0.025 mm over 12 mm (0.001 in over ½ in)

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2.7	With the stylus contacting either a box-standard or a ring gauge clamped to the work-table, no permanent change shall be observed in the autocollimator when a force of 5 N (1 lbf) is applied to the work-table or its supporting column in either direction along the line of measurement.	

3. ADJUSTABLE SLIDE

3.1	The transverse and longitudinal movements of the adjustable slide shall be smooth.	
3.2	The hand-clamp for locking the adjustable slide in the longitudinal direction shall function effectively.	
3.3	The action of locking the hand-clamp shall not cause any change in the autocollimator reading.	5 seconds of arc.

4. AUTOCOLLIMATOR

4.1	The autocollimator shall satisfy the requirements of the current Specification of Accuracy MOY/SCMI/28.	

5. MEASURING HEAD

5.1	The flatness of the two mirrors in the measuring head shall be such as to ensure that the reflected image in the autocollimator is clearly defined. Note: To achieve this, the mirrors should be flat to within 0.000 25 mm (0.000 01 in).	
5.2	The adjustments provided for tilting each mirror shall ensure a smooth motion of the reflected image as viewed in the autocollimator.	
5.3	The force exerted by the stylus contacts of the measuring head shall not exceed	0.15 N (1/2 ozf)
5.4	The two stops fitted in the measuring head shall be such as to allow a movement of the stylus of approximately 3 mm (1/8 in) on each side of the vertical position.	
5.5	With the optical axis of the autocollimator set parallel with the upper surface of the work-table and with the stylus contacting, in turn, the end pieces of the appropriate box-standard centrally mounted, it shall be possible to adjust each mirror in turn so as to return the image of the target crosswire approximately to the centre of the field of view of the autocollimator.	
5.6	In order that one division on the autocollimator drum (1 second of arc) shall be equivalent to a linear travel of the stylus contact tip of 0.000 25 mm (0.000 01 in) the nominal distance between the axis of rotation of the measuring head and the measuring axis of any one of the stylus holders shall be	51.55 mm (2.062 in)
5.7	The stylus holders and styluses provided with the machine shall be in accordance with NPL Drawing No. 1908.	
5.8	The contact tip of each stylus shall be hard.	850 HV minimum.

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5.9	Each stylus shall be well-finished and free from irregularities in the vicinity of the point of contact.	
6. **END PIECES FOR BOX-STANDARD**		
6.1	The working surfaces of the end-pieces shall be hard.	800 HV minimum.
6.2	The working surfaces (which define the length of the box-standard) shall be flat.	0.000 1 mm (0.000 004 in)
6.3	The lower bearing-surfaces shall be flat.	0.001 mm (0.000 04 in)
6.4	The working surfaces (defining the length of the box -standard) shall be square to the lower bearing surfaces.	0.005 mm (0.0002 in) over the depth of face.
	Note: This error of squareness is permitted on the understanding that, when lapping the lower bearing-surfaces, the two end-pieces are clamped together with the working surfaces (defining the length of the box-standard) in contact, thus ensuring parallelism of these surfaces.	
7. **PERFORMANCE**		
7.1	The machine shall be capable of measuring ring gauges of diameters from 2.5 mm to 75 mm inclusive (from 0.1 in to 3 in inclusive).	
7.2	Repeat settings in a box-standard or a ring gauge shall be reproducible.	½ second of arc. Equivalent to 0.000 12 mm (0.000 005 in) at nominal magnification.
7.3	The accuracy of measurement of the machine shall be verified by measuring three reference ring gauges of known diameters distributed over the measuring range of 2.5 mm to 75 mm (0.1 in to 3 in). In each case the result shall agree with the known diameter to within	±0.000 25 mm (±0.000 01 in)

L.W. Nichols (Signed)

for Director

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