NATIONAL PHYSICAL LABORATORY

METROLOGY CENTRE

Ref: MOY/SCMI/39 (Issue 3) **SPECIFICATION OF ACCURACY**

for

A PRECISION LINEAR DIVIDING MACHINE

Type: A Watts Precision Linear Dividing Machine for ruling scales automatically up to 1 metre (40 inches) in length to an accuracy of 0.0025 mm (0.0001 in) plus or minus.

		LIMITING VALUE OR MAXIMUM PERMISSIBLE ERROR
1. **GENERAL**		
1.1	The workmanship and finish shall be high class throughout.	
1.2	The machine shall be marked with an identification number and with the maker's name or trade-mark.	
2. **MAIN BED**		
2.1	The horizontal "ways" of the bed on which the work-table travels shall be flat and co-planar.	0.025 mm (0.001 in)
2.2	The vertical "way" which controls the motion of the work-table in the horizontal plane shall be straight.	0.05 mm (0.002 in)
3. **WORK-TABLE**		
3.1	The upper surface of the work-table shall be flat.	0.025 mm (0.001 in)
3.2	The mean plane of the upper surface of the work-table shall be parallel to its plane of motion.	0.025 mm (0.001 in) over its length.
3.3	The work-table shall be free from angular movements as it is traversed through its total range.	10 seconds of arc in the vertical plane. 20 seconds of arc in the horizontal plane.
3.4	The front edge of the work-table shall be straight.	0.025 mm (0.001 in)
3.5	The front edge of the work-table shall be parallel to its line of motion.	0.05 mm (0.002 in) over its length.
3.6	The accuracy of the travel of the work-table as controlled by the leadscrew shall comply with the following requirement: -	
	The error resulting from a displacement of the work-table with respect to any setting position of the leadscrew shall not exceed	0.002 mm (0.000 03 in)
	NOTE: This test shall be confined to a position 20 mm above the table and immediately over the leadscrew.	

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4.	**LEADSCREW DIVIDED DRUM**	
4.1	The graduated surface of the divided drum attached to the end of the leadscrew shall be of a dull, non-reflecting type, and the graduation lines shall be clearly cut and uniform in thickness.	
5.	**TEMPERATURE CORRECTOR BAR**	
5.1	The working face of the temperature corrector bar shall be flat.	0.05 mm (0.002 in)
5.2	The temperature corrector bar shall function correctly.	1 part in a million
NOTE:	1 scale division is equivalent to a compensation of 1 part in 500,000 on length ruled.	
6.	**LEADSCREW RATCHET WHEELS**	
6.1	The teeth of each interchangeable ratchet wheel shall be concentric with the axis of rotation.	0.013 mm (0.0005 in)
6.2	The teeth of the interchangeable ratchet wheels attached to the end of the leadscrew shall be accurately spaced.	3 minutes of arc maximum error between the spacing of any two teeth.
7.	**TRACELET MECHANISM**	
7.1	The ruling tool shall consistently follow the same path.	±0.000 25 mm (±0.000 01 in)
7.2	The abutment face for the tracelet mechanism shall be square to the horizontal "ways" of the main bed and also square to the vertical "way" of the main bed which controls the motion of the work-table.	1 minute of arc
7.3	The travel of the micrometer attachment for positioning the tool when ruling the two longitudinal lines shall be parallel to the abutment face of the tracelet mechanism.	0.025 mm (0.001 in) over the micrometer travel.
7.4	The various axis of the tracelet mechanism shall be parallel to the horizontal "ways" and also to the controlling vertical "way" of the main bed.	1 minute of arc.
8.	**MICROMETER MICROSCOPES**	
8.1	Each microscope shall be marked with an identification number which should appear also on the objective.	
8.2	If the tube length of the microscope is adjustable, means shall be provided for securely locking this adjustment.	
8.3	The graduated surface of the divided drum shall be of a dull, non-reflecting type and the graduated lines shall be clearly cut and uniform in thickness.	
8.4	The "feel" of the micrometer screw shall be uniform throughout its range.	
8.5	The progressive error of the micrometer readings shall not exceed	0.05% over the central 2 ½ mm (0.1 in) travel

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8.6	The periodic error of the micrometer readings shall not exceed	±0.000 25 mm (±0.000 01 in)

9. **PERFORMANCE TEST**

9.1 As an overall performance check on the general functioning and on the accuracy of the machine a scale shall be engraved on it. The overall length of the scale shall cover the total range of the machine and graduations shall be made at 1 mm or 0.05 in intervals throughout; in addition, graduations spaced at 0.1 mm or 0.01 in intervals shall be made over two 1 mm or 0.1 in ranges situated towards each end of the scale. Two longitudinal lines extending over the length of the scale shall also be engraved. This scale shall be designated as type T.1.

In addition, two scales shall be ruled which also cover the total range of the machine but these scales shall be confined to one central and two terminal lines. During graduation, one scale shall be displaced 25 mm (1 in) from the axis of the lead screw and the other similarly displaced from the axis but in the opposite direction. These two scales which should be designated as T.2B and T.2F respectively, may be ruled on the same bar but slightly staggered with respect to each other.

These test scales shall comply with the following requirements:

(All measurements refer to the basic temperature of 20º C)

T.1 Scale

9.2	The graduations shall be straight and their widths shall be uniform throughout the scale.	0.0025 mm (0.0001 in)
9.3	The graduations shall be mutually parallel and also square with the two longitudinal lines.	6 minute of arc.
9.4	The maximum error in the spacing of any graduation with respect to the zero graduation shall not exceed	±0.0025 mm (±0.0001 in)
9.5	The maximum error between any two graduations spaced up to 15 cm (6 in) apart shall not exceed	0.0025 mm (0.0001 in)
9.6	The maximum error between any two graduations in the 1 mm or 0.1 in range scales shall not exceed	0.0008 mm (0.000 03 in)

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T.2 Scales		
9.7	The maximum error in the scale intervals shall not exceed	±0.005 mm (±0.0002 in) overall 0.0025 mm (±0.0001 in) over half the range.

(Signed)

for Director

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