

NATIONAL PHYSICAL LABORATORY

METROLOGY CENTRE

Ref: **MOY/SCMI/94**                      **SPECIFICATION OF ACCURACY**  
**(Issue 2)**

**for**

**A UNIVERSAL OPTICAL PROJECTOR**

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Type:            A Hilger Universal Measuring Projector Type TT 877, intended for engineering precision inspection at magnifications of up to 100 times. The work-holder motions are controlled by micrometers graduated to read direct to 0.002 mm (0.0001 in). The light source is a 250-watt mercury vapour lamp.

Note:        This specification also covers the following types of projector: -

- TT 777, as TT 877 but with inch micrometers.
- TT 878, as TT 877 but with solid-source filament lamp.
- TT 876, as TT 878 but with inch micrometers.

Designed & Made by: - Rank Precision Industries Ltd., Metrology Division.

LIMITING VALUE OR  
MAXIMUM PERMISSIBLE  
ERROR

1. GENERAL

- 1.1        The general workmanship and finish shall be in keeping with a precision instrument of this class.
- 1.2        Each instrument shall be marked with the maker's name or trade-mark and with an identification number.

2. CAPACITY

- 2.1        The instrument shall accommodate objects up to

<u>Length</u>	<u>Diameter</u>
200 mm (8 in)	150 mm (6 in)
or	
250 mm (10 in)	75 mm (3 in)

3. MEASURING RANGE

- 3.1        The measuring range of the instrument shall be

Horizontal  
140 mm (5 ½ in) for diameters up to 75 mm (3 in).  
  
50 mm (2 in) for diameters above 75 mm (3 in) and up to 150 mm (6 in)

Vertical  
55 mm (2 ¼ in)

4. **MECHANICAL AND OPTICAL ALIGNMENTS**

4.1	The transverse motion of the work-holder shall be straight over its 140 mm (5 ½ in) travel	0.008 mm (0.0003 in) in the vertical plane 0.025 mm (0.001 in) in the horizontal plane.
4.2	The vertical motion of the work-holder shall be straight over its 55 mm (2 ¼ in) travel	0.008 mm (0.0003 in) in the vertical plane parallel to the transverse motion. 0.015 mm (0.0006 in) in the vertical plane at right angles to the transverse motion.
4.3	The transverse and vertical motions of the work-holder shall be mutually square	0.003 mm per 25 mm (0.0001 in per in)
4.4	The focusing motion of the work-holder shall be straight, in both the horizontal and vertical planes over its 30 mm (1 ¼ in) travel	0.005 mm (0.0002 in)
4.5	The focusing and vertical motions of the work-holder shall be mutually square	0.005 mm per 25 mm (0.0002 in per in)
4.6	The vertical surface of the work-holder shall be flat	0.015 mm (0.0006 in)
4.7	The vertical surface of the work-holder shall be parallel to the vertical and transverse motions	0.005 mm per 25 mm (0.0002 in per in) with respect to the transverse motion.  0.012 mm per 25 mm (0.0005 in per in) with respect to the vertical motion.
4.8	The centre rods shall be straight and each pair shall be of equal diameter	0.008 mm (0.0003 in)
4.9	The male and female conical portions of the rods shall be: -  (i) hard  (ii) concentric with the cylindrical portion	700 HV minimum.  0.015 mm (0.0006 in) FIM.
4.10	The line of centres shall be parallel to the transverse motion of the work-holder in both the horizontal and vertical planes	0.003 mm per 25 mm (0.0001 in per in) in the vertical plane. 0.005 mm per 25 mm (0.0002 in per in) in the horizontal plane.
4.11	The slip gauge platform shall be parallel to the transverse motion	0.005 mm per 25 mm (0.0002 in per in)
4.12	The measuring abutment face on the work-holder shall be hard	800 HV minimum.
4.13	The measuring abutment face of the work-holder shall be: -  (i) flat (ii) normal to the transverse motion of the work-holder (iii) square to the surface of the slip gauge platform	0.0015 mm (0.0006 in) 0.025 mm (0.001 in) over the diameter of face. 0.003 mm (0.0001 in) over the diameter of face.

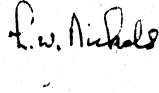
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|------|--|---|
| 4.14 | The measuring faces of the two micrometers which control, respectively, the horizontal and vertical travel of the work-holder shall be hard  | 800 HV minimum.   |
| 4.15 | The measuring faces of the micrometers shall be slightly rounded.  |   |
| 4.16 | The micrometers shall be accurate  | progressive error<br>0.003 mm over 25 mm<br>(0.0001 in over 1 in)<br><br>periodic error<br>±0.0005 mm (±0.000 02 in)                  |
| 4.17 | When the work-holder is set square to the focusing motion there shall be no observable error in the zero of the rake scale.  |   |
| 4.18 | The rake scale shall be accurate over its range of ±30 degrees   | 0.25 degrees relative to the zero graduation.   |
| 4.19 | With the projector lamp set according to the instructions given in the handbook supplied by the makers, and the work-holder set to zero on the rake scale, the out of focus pattern of a projected annular vee-groove held between centres shall be symmetrical. |   |
| 4.20 | The combined readings of the protractor scale and the associated thimble scale of the fine adjustment micrometer shall be accurate   | 1 minute of arc.  |
| 4.21 | The cross lines of the protractor screen shall be mutually square  | 1 minute of arc.  |
| 4.22 | The point of intersection of the 90-degrees cross-lines on the projector screen shall lie on the axis of rotation of the protractor scale, after the latter has been centred   | 0.008 mm (0.0003 in)  |
| 4.23 | The magnification given by each lens shall be correct  | 0.15 mm (0.005 in) as measured over a 300 mm (12 in) interval on the screen.  |
| 4.24 | The lenses shall not give rise to any appreciable distortion in the field of view specified by the makers  | The error in the separation between any two points in the field of view shall not exceed 0.25 mm (0.01 in) as measured at the screen. |
- Note: If any of the above lenses are intended to be used for the projection of screw threads, the test enumerated in paragraph 4.24 shall be repeated with the illuminating beam inclined by ±5 degrees to the optical axis. Under these conditions the permissible error quoted in paragraph 4.24 shall not be exceeded by more than 50%.

5. **PERFORMANCE TEST**

5.1 A performance test on the overall accuracy of the motions of the work-holder as controlled by the micrometers shall be made when the work-holder is loaded as follows: -

	<u>Transverse</u>	<u>Vertical</u>
for loads up to 2 Kg (5lb)	0.012 mm (0.0005 in)	0.010 mm (0.0004 in)
for loads above 2 Kg (5lb) and up to 4.5 Kg (10lb)	0.025 mm (0.001 in)	0.015 mm (0.0006 in)

Note: When testing the transverse motion the vertical slide shall be set to its maximum height.

 (Signed)  
for Director

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