NATIONAL PHYSICAL LABORATORY

METROLOGY CENTRE

Ref: MOY/SCMI/93 (Issue 3) **SPECIFICATION OF ACCURACY**

for

AN AUTOCOLLIMATOR WITH A PHOTO-ELECTRIC DETECTOR

Type: A TA3 Photo-electric Autocollimator. The autocollimator has a measuring range of 10 minutes of arc and the micrometer drum of the instrument is so graduated that angular deflections of a reflecting surface may be read to 0.1 second of arc. The autocollimator may be rotated through 90 degrees permitting angular measurement in two planes.

Made by: Rank Precision Industries Ltd
Metrology Division

Note: The nomenclature used in this Specification in relation to the field-of-view of the instrument is illustrated in Fig. 1 attached.

		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	Both the autocollimator and display unit shall be marked with an identification number and with the maker's name or trade-mark.	
2. **BASE**		
2.1	The top and side finished faces shall be flat	0.01 mm
2.2	The bottom finished face shall be flat. When placed on a truly flat surface the base shall be free from rock	0.01 mm
2.3	The top and bottom finished faces shall be parallel	0.025 mm over the length of the top face.
2.4	The side finished face shall be square to the bottom face	0.025 mm over the depth of the side face.
2.5	The three levelling screws shall operate smoothly.	
2.6	When the base is directly in contact with a flat horizontal surface the bubble of the circular level shall be approximately central.	
3. **EYEPIECE**		
3.1	The focusing movement of the eyepiece shall be smooth.	
3.2	With the eyepiece approximately at the centre of its focusing range it shall be possible to see in focus the microscope graticule setting-lines, the target cross-wires, and the image of the target cross-wires reflected from a truly flat surface *, by viewing from them through a low magnification telescope focused for infinity.	

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*	A 50 mm diameter reflector flat to within 0.0001 mm is suitable.	
3.3	The range of focusing movement of the eyepiece shall be	±5 dioptres minimum.

4. **MICROMETER**

4.1	The aperture in the cover over the micrometer drum shall be sufficiently large to expose two numbered graduation marks for all positions of the drum.	
4.2	The graduation marks on the drum shall be clearly defined.	
4.3	The fiducial mark shall be closely the same thickness as the graduation marks.	
4.4	The angular value of the scale shall be clearly marked in terms of the corresponding angle of deflection of an observed reflecting surface.	
4.5	The feel of the micrometer shall be smooth and even throughout its travel.	
4.6	The micrometer shall have an over-run of at least one revolution at each end of its 10-minute range.	

5. **MICROSCOPE GRATICULE SETTING-LINES**

5.1	The setting-lines shall be clearly defined and of uniform thickness.	
5.2	The spacing of the setting-lines shall exceed the width of the image of the target cross-wires as measured by the micrometer	5 seconds of arc approximately.
5.3	The setting-lines shall be square to the microscope transverse line	5 minutes of arc.

6. **EXTERIOR MINUTE SCALE**

6.1	The graduation marks shall be clearly defined.	
6.2	The graduations of the minute scale shall match the pitch of the micrometer screw	1%

7. **TARGET CROSS-WIRES**

7.1	The target cross-wires shall be clearly defined, straight and of uniform thickness as observed by a visual test.	
7.2	Settings made on the extremities of the appropriate target wire image by means of the microscope graticule setting-lines shall agree	1 second of arc as measured on the micrometer drum.

8. **ILLUMINATION**

8.1	The lighting unit shall provide adequate and uniform illumination over the field of view for short working distances and over the illuminated portion for longer working distances. It shall be possible to make satisfactory settings on the target image over distances up to 10m.	

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	Note: At the larger distances the field of view will naturally be restricted.	
9.	**TELESCOPE OBJECTIVE**	
9.1	The telescope objective lens shall be set accurately for infinity to suit the photo-electric system. With the instrument sighted on a flat reflector * placed within 300 mm of the objective lens, a 12 mm aperture positioned centrally with respect to the objective lens aperture shall be traversed ±6 mm parallel to the micrometer axis without causing the reflected image of the target wire to shift from its original setting (measured photo-electrically) by more than	2 seconds of arc.
	Note: A red filter glass is fitted in the eyepiece to ensure that correct focus is obtainable both photo-electrically and visually.	
10.	**ACCURACY OF PERFORMANCE**	
10.1	When the autocollimator is sighted on a flat reflector *, which has been set square to the top and side finished faces of the base of the instrument, the reflected image of the target cross-wires shall be visible in the field of view.	
10.2	With the instrument sighted on a flat reflecting surface * placed within 300 mm of the objective lens, the scale shall be calibrated (both photo-electrically and visually) for progressive and periodic error. The errors of the scale shall be determined at 1-minute intervals throughout its measuring range and at 5-second intervals over each of two revolutions of the micrometer in a central part of the range, and shall meet the following requirements: -	
	(i) The standard deviation of the observations during the calibration shall not exceed	0.15 second of arc (visual calibration). 0.10 second of arc (photo-electric calibration).
	(ii) Calibration errors (both photo-electrically and visually) shall be of a reasonably uniform nature and shall not exceed	2 seconds of arc overall or 0.5 second of arc over and 1-minute interval.
	(iii) Both the photo-electric and visual calibration within the working range shall agree to within	2 seconds of arc.
11.	**DISPLAY UNIT**	
11.1	The mechanical zero of the meter shall be capable of exact adjustment.	
11.2	The electrical zero of the meter shall be capable of exact adjustment.	
11.3	The “Noise” or total range random meter movement occurring at optimum maximum sensitivity with the autocollimator sighted close up on a flat reflecting surface * shall not exceed	0.03 second of arc
11.4	As the amplifier sensitivity control is rotated from maximum to minimum sensitivity the electrical zero of the meter shall not change by more than	1 ½ divisions.

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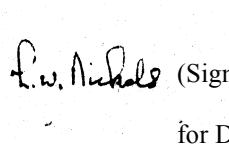
11.5	With the autocollimator sighted close up on a flat reflector * and the telescope objective lens aperture stopped down to 12 mm, the maximum sensitivity per meter division shall not be less than	0.05 second of arc.
11.6	The linearity of the meter readings with respect to the micrometer readings shall be within a total range of	10% of full scale.



(Signed)

for Director

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