Schedule to

CERTIFICATE OF ACCREDITATION

Laboratory	Metrology Calibration Services Limited
Address	PO Box 10024, Te Rapa, Hamilton, 3241 750 Te Rapa Road, Te Rapa, Hamilton, 3200
Telephone	07 849-6296
Fax	07 849-2928
URL	www.metrologygroup.co.nz
Authorised Representative	Mr Lyndon Kapoor Laboratory/Technical Manager
Client No.	3916
Programme	Metrology & Calibration Laboratory
Accreditation Number	618
Date of Accreditation	1 August 1996
Conformance Standard	NZS ISO/IEC 17025:2005 General requirements for the competence of testing and calibration laboratories
Testing Services Summary	5.01 Engineers' Limit Gauges 5.02 Jigs, Fixtures, Cutting Tools and Components 5.03 Engineers' Measuring Tools and Instruments 5.04 Machine Tools 5.05 Geometric Form 5.11 Working Standards of Length and Angle 5.12 Precision Measuring Instruments 5.51 Force Measuring Devices 5.53 Testing Machines 5.55 Speed Measuring Devices
Signatories	Mr Jack Brown — 5.01, 5.02, 5.03, 5.05, 5.11, 5.12, 5.51, 5.55 Mr Lyndon Kapoor — 5.01, 5.02, 5.03, 5.04, 5.05, 5.11, 5.12, 5.51, 5.53, 5.55 Mr Nigel Kapoor — 5.01, 5.02 (excluding CMMs), 5.03 , 5.05, 5.12(excluding CMMs)

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Calibration temperature 20 ºC ± 1 ºC.
All measurement uncertainties are based on a level of confidence of at least 95 %.
Unless stated elsewhere in this schedule, calibrations are performed at the premises of the accredited laboratory.

5.01 Engineers' Limit Gauges

	Range (mm) Unless stated otherwise	Least uncertainty of measurement
Plain plug, ring and gap gauges.		
(a) Plain gap gauges in accordance with BS 969 and CP 139		
Length	10 to 50	± 0.9 µm
	50 to 100	± 1 µm
	100 to 200	± 1.4 µm
Parallelism		± 0.7 µm
Plain parallel plug gauges in accordance with BS 969 and CP137		
Diameter	10 to 25	± 0.6 µm
	25 to 50	± 0.7 µm
	50 to 75	± 0.8 µm
	75 to 100	± 0.9 µm
	100 to 200	± 1.1 µm
	200 to 345	± 1.5 µm
Plain tapered plug gauges in accordance with CP138		
Taper up to 1 in 8 on diameter		
Diameter	3 to 50	± 3 µm
	>50 to 100	± 4 µm
	>100 to 200	± 8 µm
Taper above 1 in 8 up to 1 in 3 on diameter		
Diameter	3 to 50	± 5 µm
	>50 to 100	± 6 µm
	>100 to 200	± 12 µm
Plain taper ring gauges in accordance with CP140		
Taper up to 1 in 8 on diameter		
Diameter	3 to 50	± 6 µm
	>50 to 100	± 8 µm
	>100 to 200	± 12 µm
Taper above 1 in 8 up to 1 in 3 on diameter		

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Diameter	3 to 50	± 8 µm
	>50 to 100	± 10 µm
	>100 to 200	± 14 µm

(b) Parallel screw plug and ring gauges. Adjustable thread calliper gauges for parallel threads.

Parallel screw plug gauges in accordance with BS 3643/2, BS 1580/1 & 2:1962 and BS 919/3:1968, BS 919/1:1960 and CP116

Simple effective diameter	up to 300	± 2.5 µm
Major Diameter	up to 300	± 2.5 µm
Minor Diameter	up to 300	± 2.5 µm
Flank Angles		± 10 minutes of arc
Pitch		± 2.5 µm

Parallel screw ring gauges in accordance with CP119

Simple effective diameter	10 up to 200	± 4.0 µm
Major Diameter	10 up to 200	± 4.0 µm
Minor Diameter	10 up to 200	± 4.0 µm
Flank Angles		± 10 minutes of arc
Pitch		± 2.5 µm

Parallel screw ring gauges in accordance with CP165

Diameter to check plugs	1mm to 10 mm	± 3.0 µm

(c) Taper screw plug and ring gauges. Adjustable thread calliper gauges (3 roll type) for taper threads.

Tapered screw plug gauges in accordance with BS 21, ANSI/ASME B1.20.1 and B1.20.5 and CP117

Simple effective diameter	up to 6 inches	± 3.5 µm
Major Diameter	up to 6 inches	± 3.5 µm
Minor Diameter	up to 6 inches	± 3.5 µm
Flank Angles		± 10 minutes of arc
Pitch		± 2.5 µm

Tapered screw ring gauges in accordance with BS 21, ANSI/ASME B1.20.1 and B1.20.5 and CP118

Virtual effective Diameter	NPT/BSPT up to 4 inches	± 7.0 µm
Minor Diameter		
Flank angles		± 10 minutes of arc
Pitch		± 2.5 µm
To check plugs		

Crimp tool plug gauges to manufacturer's specifications and CP179

Insulation, Braid, Barrel, Contact	± 0.6 µm

5.02 Jigs, Fixtures, Cutting Tools and Components

(calibration may be carried out on site)

Ranges and least uncertainties as specified in class 5.01 and 5.03. Actual uncertainties calculated on a case by case basis.

Thread Cutting Taps including Odd Flute Taps to CP212

	Least uncertainty of measurement
Effective Diameter	± 5 µm
Major/Minor Diameter	± 5 µm
Flank angles	± 12 minutes of arc

Measurement using Axiom CMM to CP242

Volume performance	± 0.011 µm
Bi-directional accuracy	± 0.004 µm

5.03 Engineers' Measuring Tools and Instruments

(calibration may be carried out on-site)
(a)(b) Equipment as listed below

Angle plates incl Box in accordance with BS 5535:1978 and CP131

	Range (mm) Unless otherwise stated	Least uncertainty of measurement
Squareness		± (2+8 L) µm where L is length in m
Flatness		± (1.5+0.8 x diagonal in m) µm
Parallelism	<250 mm x 200 mm	± 1.8 µm
	>250 mm x 200 mm	± 3.0 µm

Callipers in accordance with ISO 3599:1976, ISO 6906, BS 887, JIS B 7507, DIN 862 and CP101 (may be carried out on-site)

	Range (mm) Unless otherwise stated	Least uncertainty of measurement
Accuracy of indication	up to 150	± 15 µm
	150 to 500	± (15+10L) µm where L is

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		length in m
	500 to 2000	± (15+15 L) µm where L is length in m
Accuracy of Internal Jaws	up to 300	± 16 µm
Combined Ext/Int. Jaws	up to 300	± 8 µm
Combined width of Int. Jaws		± 3 µm
Accuracy of depth probe		± 28 µm
Parallelism of external Jaws (test indicator method)		± 2 µm
	(three point measurement)	± 15 µm
Parallelism of external Jaws		± 4 µm

Dial gauges plunger type 0.001 mm in accordance with CP105 (may be carried out on site)

Accuracy of Indication	up to 25 mm	± (0.5 + 0.05 L) µm where L = travel in mm
Repeatability		± 0.4 µm
Discrimination		± 0.4 µm

Dial gauges plunger type 0.01 mm in accordance with BS 907:1965 and CP105 (may be carried out on site)

Accuracy of indication	up to 50 m	± (2 +0.05 L) µm where L = travel in mm
Repeatability		± 0.4 µm
Discrimination		± 0.4 µm

Dial gauges lever type 0.002 mm in accordance with BS 2795, AS 2103:1978 and CP106 (may be carried out on-site)

Accuracy of indication	± 0.6 µm
Repeatability (drum method)	± 0.6 µm
(roller method)	± 0.8 µm
Discrimination	± 0.6 µm

Dial gauges lever type 0.01 mm to BS 2795, AS 2103:1978 and CP106 (may be carried out on-site)

Accuracy of indication	± 2.0 µm
Repeatability (drum method)	± 1.0 µm
(roller method)	± 2.0 µm
Discrimination	± 1.0 µm

Digital gauges plunger type 0.001 mm to CP125 (may be carried out on-site)

Accuracy of indication	± (1.0 + 0.05 L) µm where L = travel in mm
Repeatability	± 1.0 µm
Discrimination	± 1.0 µm

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Digital gauges plunger type 0.0001 mm to CP125		
Accuracy of indication		± (0.2 + 0.05 L) µm where L = travel in mm
Repeatability		± 0.2 µm
Discrimination		± 0.2 µm
Engineer's Levels to BS 3509 & BS 958 and CP114		
Mean sensitivity		± 10 % of nominal minimum 2 seconds of arc
Base flatness		± 2 µm
Roll error		± 10 % of nominal
Feeler gauges to BS 959:1950 and CP107		
Thickness		± 0.7 µm
Parallelism		± 0.4 µm
Height gauges – Vernier 0.02 mm/0.001 inch to BS 1643, JIS B 7517 and CP108 (may be carried out on-site)		
Accuracy of reading	up to 2000 mm	± (8 + 5 L) µm where L is length in m
Parallelism		± 2.0 µm
Flatness		± 2.0 µm
Perpendicularity		± (2 + 8 L) µm where L is in metres
Setting blocks supplied with height gauge		
Length		± 0.5 µm
Parallelism		± 0.5 µm
Height Gauges – Digital 0.01 mm/0.0005 inch in accordance with JIS B 7517 and CP127 (may be carried out on-site)		
Accuracy of reading	up to 1000 mm	± (8 + 5 L) µm where L is length in m
Parallelism		± 2.0 µm
Flatness		± 2.0 µm
Micrometers – External in accordance with BS 870:1950, DIN 863 + JIS B 7502 and CP109 (may be carried out on-site)		
Range of error to traverse of the Micrometer Screw	0 to 25	± 0.7 µm

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	25 to 75	± 2 µm
	>75	± 0.8 µm
Parallelism	0 to 75	± 0.25 µm
	100 to 150	± 1.5 µm
	>150	± 3 µm
Flatness		± 0.15 µm
Zero setting	0 to 25	± 1 µm
	25 to 100	± 1.5 µm
	>100	± (1 + 9 L) µm where L is length in m

Micrometers – Internal/Stick in accordance with BS 959:1950, + JIS B 7502, + DIN 863/4 and CP110

Range of error of traverse of the Micrometer screw		± 2 µm
Zero setting at minimum range (Int. Misc)		± (2 + 5 L) µm where L is length in m
Extension tube lengths	up to 300	± (0.4 + 3 L) µm where L is length in m
	up to 600	± 3 µm
	up to 1000	± 5 µm
Spacing collar length		± 0.6 µm
Gap setting gauge length		± (0.4 + 3 L) µm where L is length in m
Gap setting gauge parallelism		± 0.4 µm
Flatness		± 0.2 µm

Micrometers – Depth in accordance with BS 6468 and CP104
(may be carried out on-site)

Range of error of traverse of the Micrometer screw	± 2 µm
Zero setting at minimum range	± (2 +4 L) µm where L is length in m
Flatness (optical flat method)	± 0.2 µm
(test indicator method)	± 2 µm

Micrometer heads type 3 in accordance with BS 1734:1951 and CP112

Error of traverse of measuring face (progressive error)	± 0.4 µm
(periodic error)	± 0.3 µm
Repeatability	± 0.2 µm

Protractors – Bevel mechanical and optical in accordance with BS 1685 and CP112

Accuracy of indication	± 1.5 minutes of arc
Straightness	± 2.5 µm
Parallelism	± 3 µm
Flatness	± 2 µm

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Rulers – Steel in accordance with BS 4372:1968 and JIS B 7516 and CP133

Accuracy of graduation centreline relative to datum end	up to 2000	± (42 +0.01 L) µm where L is measured length in mm

Retractable steel pocket rules and tape measures in accordance with JIS B 7512, AS 1290: Part 4 and CP167

Accuracy of graduation centreline relative to blade tip inside face	up to 50 m	± (50 + 12 L) µm where L is measured length in m

Straightedges up to 6 m in accordance with BS 5204: Part 2:1977 and CP103

Straightness	± (1.5+0.5x length in m) µm
Parallelism	± 3 µm

Squares – Engineers incl Cylindrical and Block in accordance with BS 939:1977 and CP102

Try Squares up to 600 mm	± (2 + 8 L) µm where L is length in m
Cylindrical/Block squares not exceeding 140 mm dia/width	± (1 + 4 L) µm where L is length in m
Cylindrical/Block squares exceeding 140 dia/width	± (2 + 4 L) µm where L is length in m

Parallelism

Try squares blade	± 2.3 µm
stock	± 1.8 µm
Block squares	± 1.8 µm

Flatness

Try/Block squares (by comparison to reference surface)	± 1.8 µm
Block squares using Talyvel Electronic Level	±(1.5 + 0.8 x diagonal in m) µm
Cylindrical square by comparison to reference surface	± 1.8 µm
under 95 mm dia by optical interference	± 0.2 µm

Straightness

Try square	± (1 + 4 L) µm where L is length in m
Cylindrical squares	± 1.8 µm

Surface plates and tables in accordance BS 817:1988, DIN 876/1
Federal specification GGG-P-463c,: 1973 and CP115
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Flatness		± (1.5 + 0.8 x diagonal in m) µm
Variation (using variation gauge to BS817)		± 0.4 µm
Precision vernier depth gauges 0.02 mm/0.001 inch in accordance BS 6365 and CP142		
up to 300 mm		
Accuracy of reading		± 12 µm
Flatness by optical interference		± 0.2 µm
Flatness by comparison to ref surface		± 1.8 µm
Parallelism		± 1.8 µm
Straightness		± 1.8 µm
Bore Gauges – Cylinder type, 2 point contact, to JIS B 7515 and CP123		
Sphericity of measuring faces		± 4 µm
Overall performance	0.001 mm dial	± 2 µm
	0.01 mm dial	± 7 µm
	0.005 inch dial	± 0.0003 inch
3 line contact type to DIN 863 part 4 and CP123		
Overall performance		± 1 µm
Engineers Parallels to BS 906 parts 1 & 2 and CP132		
Thickness/Width		± 0.7 µm
Straightness		± 1.3 µm
Parallelism		± 0.4 µm
Ultrasonic Calibration Blocks to BS2704:1978 and CP135		
Length		± 3 µm
Diameter		± 5 µm
Degrees Scales		± 30 seconds of arc
Angle Gauges – Workshop/Inspection to CP213 (Not precision angle gauges)		
Plane angle		± 4 seconds of arc
Squareness		± (0.7 + 0.007 L) µm where L is length in m
Parallelism		± 1 µm
Wet Film Thickness Gauges – wheel type to manufacturer's specification and CP191		
Accuracy of indication		± 0.8 µm
Thread Micrometers to DIN 863 part 3 and CP201		
Range of error of traverse of the micrometer screw		± 2 µm
Zero setting		± 1 µm
Cone/vee semi angles		± 6 minutes of arc

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Linear Counting Wheels to CP194	± (30 + 0.2 L) mm where L is length in m
Inclinometers to manufacturer's specification and CP210	
Digital 0.1˚ resolution	± 4 minutes of arc
Pendulum type 1 minute of arc resolution	± 30 seconds of arc
Flatness of Base	± 2 µm
Parallelism	± 1 µm

5.04 Machine Tools
(carried out on-site)

(a)	Geometric testing to CP156 including	Least uncertainty of measurement
Flatness of beds and tables		± (1.5 + 0.8 x diagonal in m) µm
Straightness of guide ways		± (1.5 + 0.5 L) µm where L is length in m
Squareness/Parallelism		± (1.5 + 0.01 L) µm where L is length in m
(b)	Practical tests to CP156 including	
Digital machine scales 0.01 mm		± (10 + 0.01 L) µm

5.05 Geometric Form
(calibration may be carried out on-site)

Geometric Form to CP214

		Least uncertainty of measurement
(a)	Surface texture	± 0.05 µm + 2 % of nominal
(b)	Roundness @ x 10,000	± 0.12 µm
(c)	Straightness	± (1.5 + 0.5 L) µm where L is length in m
(d)	Flatness	± (1.5 + 0.8 L) µm where L is diagonal length in m
(e)	Eccentricity	± 0.3 µm
(f)	Squareness	± (0.7 + 0.007 L) µm where L is length in m
(g)	Angle	± 3 second of arc

5.11 Working Standards of Length and Angle

(a) Gauge blocks and accessories

Gauge Block verification, central length and variation in length to BS4311 and ISO 3650 used as a guide
Verification by comparison, using a TESA 0.01 µm dual probe differential probing system
Measurement uncertainty expanded to reflect in-house method.

Central Length	
≤ 10 mm	± 0.12 µm
> 10 mm up to 25 mm	± 0.12 µm
> 25 mm up to 50 mm	± 0.14 µm
> 50 mm up to 75 mm	± 0.18 µm
> 75 mm up to 100 mm	± 0.24 µm
Variation	± 0.07 µm

Gauge Block Accessory Sets to BS 4311 part 2 and CP126

Type A Jaws flatness	± 0.15 µm
length	± 0.3 µm
Type B Jaws flatness	± 0.15 µm
Centre Point flatness	± 0.15 µm
Deviation of centre point from plance of wringing face	± 3 µm
Scriber Point flatness	± 0.15 µm
Base flatness	± 0.15 µm
Platform flatness	± 0.15 µm
parallelism	± 3 µm
height	± 0.4 µm

(b) Length bars and accessories

Thread Micrometer Setting Standards to in-house method and CP201

Effective diameter	± 5 µm
Cone/vee flank angles	± 12 minutes of arc

Micrometer settings rods – Spherical Ended to BS870:1950 – Section 3 + JIS B 7502 and CP129

up to 1000 mm	± (0.6 + 3 L) µm where L is length in m
up to 40 inch	±(26 + 2 L) µ inch where L is

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		length in inches

Micrometer setting rods (flat parallel ended) in accordance with BS 870:1950, Section 3
Setting gauges JIS B 7502 and CP129

Length		± (0.5 + 3 L) µm where L is length in m ± (20 + 3 L) µ inch where L is length in inches
Parallelism		± (0.4 + 0. 5 L) µm where L is length in m ± (15 + 0.5 L) µ inch where L is length in inches

(c) Cylindrical standards, internal and external

Cylindrical setting standards in accordance with MOY/SCM161M issue 3.2001 and CP136

	Range (mm) Unless otherwise stated	Least uncertainty of measurement
Diameter	up to 25	± 0.6 µm
	25 to 50	± 0.7 µm
	50 to 75	± 0.8 µm
	75 to 100	± 0.9 µm
	100 to 200	± 1.1 µm
	200 to 345	± 1.5 µm
Roundness (MZC)		± 0.12 µm
Concentricity		± 3 µm

Plain parallel setting ring gauges in accordance with BS 4064:1966, DIN 2250, CP139

Diameter	10 to 50	± 0.9 µm
	50 to 100	± 1.0 µm
	100 to 200	± 1.4 µm
Parallelism		± 0.5 µm
Roundness to BS 3730 (MZC)		± 0.12 µm

Plain Parallel Setting Ring Gauges to CP211

	from 0.6 up to 11	± 2 µm

Orifice Plates to BS/EN/ISO 5167-2, ANSI/API MPMS 14.3.2 and CP205

Surface finish (Ra)	± 0.02 µm Ra+ 2 % of reading
Flatness	± 6 µm
Orifice Diameter	± 3 µm

Plate thickness (E)		± 5 µm
Bevel Angle		± 8 minutes of arc

(i) Pi Tapes to manufacturers specification and CP187

On diameter	inch	± 0.001 inch
On diameter	millimetre	± 0.03 mm

Dip Tapes to JIS B 7512 and CP199

Graduation centreline position relative to cardinal point	± (50 + 12 L) µm where L is length in m

(m) Reference standards for surface finish

0.3 µm to 12 µ inch Surface Roughness Specimen to BS 1134 part 1 & 2 and CP214(a)	
Surface Finish (Ra)	± 0.025 µm Ra
0.7 µm to 28 µ inch Surface Roughness Specimen to BS 1134 part 1 & 2 and CP214(a)	
Surface Finish (Ra)	± 0.045 µm Ra
6 µm to 240 µ inch Surface Roughness Specimen to BS 1134 part 1 & 2 and CP214(a)	
Surface Finish (Ra)	± 0.25 µm Ra

5.12 Precision Measuring Instruments

(calibration may be carried out on-site)

(d) Precision projection apparatus to manufacturer's specification and CP144

		Least uncertainty of measurement
Linear scales		± 2 µm
Degrees scale		± 1.5 minutes of arc
Squareness		± (1+0.01 L) µm where L is length in m
Parallelism		± (1+0.01 L) µm where L is length in m
Performance	@ 10 x mag'n	± 0.1 %
Measured	@ 20 x mag'n	± 0.04 %
	@ 50 x mag'n	± 0.01 % value
	@ 100 x mag'n	± 0.005 %

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(I) Sine bars and sine tables

Sine Bars to BS 3064: 1978 and CP113

Flatness	optical interference	± 0.2 µm
	test indicator method	± (0.5 + 0.006 L) µm where L is length in m
Squareness		± 0.6 µm / 25 mm
Roller Centres		± (0.7 + 0.002 L) µm where L is length in m
Equality of Roller Diameters		± 0.6 µm
Roundness		± 0.12 µm
Parallelism		± 1 µm
Performance (Plane angle)		± 4 seconds of arc

Computerised digital height gauges 0.001 mm to 0.000 05 inch to manufacturer's specifications to CP120
(calibration may be carried out on-site)

Accuracy of reading		± (1 + 3 L) µm where L is measured length in m
Squareness	up to 500 mm	± 3 µm
Straightness		± 2 µm
Flatness (gauge block method)		± 2 µm
(test indication method)		± 2 µm
Parallelism		± 2 µm
Computed and calculated results		± as calculated (see note)

Note: From 10 repeat readings using the height gauge and calibrated ring and plug gauges and 2D artefact.

Mu-Checkers to CP158

Accuracy of Indication	± 1 % of range minimum 0.2 µm
Repeatability	± 0.1 µm
Discrimination	± 0.1 µm

Extensometers to ISO 9513 and CP237

Relative bias error	up to 50 mm/2 inch	± 0.3 µm or 12 µ inch
Gauge length		± 0.025 mm or 0.001 inch

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Performance verification of Co-ordinate Measuring Machines to ASME B89.4.1 and BS EN/ISO 10360-2

	Least uncertainty of measurement (where L is length in metres)
BS/ISO 10360-2:	
Probe repeatability	± 1 µm
Volume accuracy	± (1.2 + 3.5 L) µm

Uncertainties based on a machine with 1 micron resolution

Repeatability	± 0.7 µm
Point to point probing	± 0.8 µm
Bi-directional probing	± 0.9 µm
Linear displacement accuracy	± (0.9 + 3.5 L) µm where L is length in meters
Volumetric accuracy	± 1.7 µm per 300 mm

5.51 Force Measuring Devices

(a) Spring balances CP 180 and manufacturer's specifications

Range	Least uncertainty of measurement
0 kg to 25 kg x 10 g	± 2 g
0 kg to 25 kg x 50 g	± 14 g
0 kg to 25 kg x 100 g	± 23 g

(b) Digital force gauges to manufacturer's specifications and CP180

up to 50 kg	± 0.1 g
5 kg x 0.001 kg	± 0.001 kg
10 kg x 0.002 kg	± 0.002 kg
25 kg x 0.005 kg	± (5 + 0.1f)/1000 kg
50 kg x 0.01 kg	± (10 + 0.1f)/1000 kg where f is measured force in kg

(The constant 0.1 is to account for the combining of several weights)

5.53 Testing Machines

Calibration of Durometer hardness testers of scale types A, B, C, D, DO and O in accordance with

ASTM D2240, Section 7.

	Least uncertainty of measurement
Indentor spring	± 0.04 N
Indentor shape (Diameter)	± 0.005 mm
Indentor angle	± 12 minutes of arc
Extension	± 0.005 mm
Setting Blocks	± 0.002 mm

5.55 Speed Measuring Devices

(a) Tachometers to manufacturer's specification and CP198

		Least uncertainty of measurement
Non Contact Type		
Digital	30 rpm to 30,000 rpm	± 1 LSD
Contact Type		
Digital	100 rpm to 30,000 rpm	± 1 LSD + 1 rpm to 5,000 rpm
Analogue	100 rpm to 30,000 rpm	± 20 % minimum resolution

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