CRITERIA FOR LABORATORY ACCREDITATION IN DIMENSIONAL METROLOGY

Prepared by: SADCAS Advisory Committee – CLAS	**Approved by**: SADCAS CEO	**Approval Date**: 2019-11-12 **Effective Date**: 2019-11-12

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1. PURPOSE AND SCOPE

The purpose of this document is to define the specific environmental, general and technical requirements to be met by accredited laboratories in the field of dimensional metrology.

This document is applicable to Southern African Development Community Accreditation System (SADCAS) accredited Laboratories. This document does not address the requirements for accreditation of facilities for compliance to national legal metrology legislation.

2. DEFINITIONS

2.1. Nominal length

Length by which the measure is designated.

2.2. Principal scale marks

Two scale marks, the distance between which represents the nominal length of the measure.

2.3. Scale

Set of all the scale marks and associated numbering.

2.4. Scale interval

Value expressed in units of length of the difference between the values corresponding to two consecutive scale marks, for analog indication; or the difference between two consecutive indicated values, for digital indication.

2.5. End measure

Length measure which has the principal scale marks formed by two end surfaces or edges of the measure.

2.6. Line measure

Length measure which has the principal scale marks formed by two lines, holes or marks.

2.7. Composite measure

Length measure which has one of the principal scale marks formed by an end surface or edge and the other by a line, hole or mark.

2.8. Influence quantity

Quantity that is not the subject of the measurement but which influences the values of the measurand or the indication of the instrument.

2.9. Influence factor

Influence quantity having a value within the specified rated operating conditions of the instrument.

2.10. Rated operating conditions

Conditions of use, giving the range of values of influence quantities for which the metrological characteristics are intended to lie within the specified maximum permissible errors.

2.11. Reference conditions

Set of specified values of influence factors fixed to ensure valid inter comparison of the results of measurements.

2.12. Unit of measurement

The unit of length is the metre (symbol m) together with the authorized multiples and sub-multiples.

3. ENVIRONMENTAL REQUIREMENTS

An accredited laboratory working in the field of Dimensional measurements shall operate under the following conditions:

3.1. Reference temperature: 20°C or the temperature indicated on the measure. Tolerance ± 2°C;

3.2. Ambient relative humidity range: 45% to 55%;

3.3. Power source: the nominal (battery) voltage, or the voltage of a new fully charged battery according to the manufacturer's specification;

3.4. When the tension is specified, the measure shall be supported on a horizontal surface over the total length under test, practically without friction, and shall be stretched out by the tension indicated on the measure.

3.5. Where measurements are performed outside these specified requirements, the laboratory must produce documented evidence that it has made measurements under extreme conditions outside the prescribed requirements to determine that the measurement results are not invalidated.

Should the results be adversely affected, the evidence must be produced to indicate that these influences are considered in the uncertainty budgets. This should be recorded on the certificates.

3.6. Electrical power supply (where appropriate): – 15% to + 10% of nominal voltage and ± 2% of nominal frequency.

3.7. The reported measurements must be referred to the standard/reference temperature of 20°C and be recorded on the certificates.

3.8. Rates of change and gradients of temperature must be kept low.

3.9. A high degree of cleanliness shall be maintained and adequate lighting shall be provided.

3.10. The laboratory shall be sited away from such sources of mechanical vibration, shock, and electrical and radio interference, as this would affect the accuracy of measurement.

3.11. The laboratory shall take adequate measures against dust and external air pressure.

3.12. Lighting shall be adequate for the purpose.

4. MEASUREMENTS TO BE MADE

Note: Reasons for not measuring any parameter shall be stated on the calibration certificate.

4.1. For unknown coefficient of expansion, the laboratory shall quote the following recommended values:

Steel: 11, 5 µm per meter per 1°C
Tungsten Carbide: 4, 23 µm per meter per 1°C

4.2. In some cases, it may not be necessary to repeat all measurements or checks on all the parameters listed in this document when gauges are re-calibrated. The customer should be consulted to determine what measurements or checks he requires.

5. PARAMETERS

MEASURED QUANTITY, INSTRUMENT OR GAUGE	PARAMETERS THAT MUST BE MEASURED OR CHECKED
GAUGE BLOCKS	1. Parallelism 2. Length 3. Flatness

LENGTH BARS	1. Parallelism 2. Squareness 3. Straightness 4. Length 5. Flatness
OPTICAL PARALLELS	1. Length 2. Parallelism 3. Flatness
OPTICAL FLATS	1. Flatness
POLYGONS	1. Squareness of base to face 2. Angular error of facets 3. Flatness
MICROMETER SETTING PIECES:	
A) FLAT ENDED	1. Parallelism 2. Gauge length 3. Flatness
B) ROUND ENDED	1. Gauge length
THREAD MEASURING CYLINDERS	1. Actual diameter of individual wire 2. Uniformity of diameter
MICROMETER HEADS	1. Squareness of measuring face to spindle axis 2. Error over one revolution 3. Periodic error over full travel 4. Flatness
BENCH MICROMETER AND MICROMETER HEAD	1. Micrometer screw error 2. Parallelism of faces 3. Measuring force of fiducial indicator 4. Error over one revolution 5. Flatness
HEIGHT SETTING MICROMETER	1. Squareness to spindle base 2. Distance between measuring face (individual and cumulative) 3. Error over one revolution 4. Indexing error check on micrometer drum

RISER BLOCKS	1. Co-planarity of support pads 2. Parallelism of support pads 3. Mean height of riser blocks
DIAL INDICATORS PLUNGER TYPE	1. Repeatability of reading 2. Hysteresis (as per spec.) 3. Discrimination 4. Maximum error in reading (as per spec.) ln Going and Out Going
DIAL INDICATORS LEVER TYPE	1. Repeatability and hysteresis of readings (counter-clockwise and clockwise) 2. Discrimination (counter-clockwise and clockwise) 3. Maximum error of (counter-clockwise and clockwise)
SINE BARS & SINE TABLES	1. Flatness of all faces 2. Squareness of sides to measuring faces 3. Parallelism of measuring faces to axis of rollers 4. Parallelism of axis of rollers 5. Centre distance between rollers
SURFACE PLATES & TABLES (CAST IRON or GRANITE)	1. Flatness
ENGINEERS SQUARES	1. Straightness of blade edges 2. Parallelism of blade edges and stock edges 3. Flatness of working faces of stock 4. Squareness of blade edges to working faces of stock
SCREW PLUG GAUGES METRIC TYPE GO AND NO-GO	1. Major diameter 2. Simple effective diameter 3. Form of dearance 4. Thread profile 5. Pitch 6. Flank angle
SCREW PLUG GAUGES UNIFIED AND WHITWORTH	1. Major diameter 2. Minor diameter (Go only)

	3.	Simple effective diameter
	4.	effective diameter equivalent of pitch and angle error
	5.	Thread form
SCREW RING GAUGES	1.	Minor diameter
	2.	Simple effective diameter
	3.	Form of dearance and thread profile
	4.	Pitch
	5.	Flank angles
	6.	Or by means of calibrated check plugs
REFERENCE DISCS	1.	Diameter measured over the centre half of the gauge (lead, centre, trail - 0 & 90°)
	2.	Roundness
PLAIN RING GAUGES	1.	Diameter (lead, centre, trail - 0 & 90°)
	2.	Roundness
PLAIN PLUG GAUGES	1.	Diameter (lead, centre, trail - 0 & 90°)
	2.	Roundness
CYLINDRICAL TAPER GAUGES	1.	Diameter at datum point
	2.	Angle of taper
	3.	Length
	4.	Roundness
	5.	Straightness of taper
	6.	Datum step (where applicable)
TAPER RING GAUGES	1.	Diameter at datum point
	2.	Angle of taper
	3.	Length
	4.	Roundness
	5.	Straightness of taper
	6.	Datum step (where applicable)
CYLINDRICAL SQUARES	1.	Straightness of cylinder sides
	2.	Flatness of end faces
	3.	Squareness of cylindrical surface to end faces
SOLID AND OPEN	1.	Flatness
BLOCK SQUARES	2.	Parallelism and squareness of working surfaces

	3.	Flatness and squareness of front and back surfaces
RIGHT ANGLE AND BOX ANGLE PLATES	1.	Flatness and squareness of working faces
	2.	Parallelism of longitudinal and opposite end faces
	3.	Squareness of working faces to end faces
SCALES AND LINE STANDARDS	1.	Deviation from nominal length
	2.	Deviation from nominal at suitable intervals
	3.	Squareness of ends (steel rules)
TAPES AND WIRES	1.	Deviation from nominal at suitable intervals
	2.	Chord length with catenary correction
	3.	Mass per unit length
	4.	Tension
SCREW RING TAPER (ANTP AND BSPT)	1.	Simple effective diameter at specified points
	2.	Angle of taper
	3.	Tolerance step
SCREW PLUG TAPER (ANTP AND BSPT)	1.	Simple effective diameter at specified points
	2.	Angle of taper
	3.	Tolerance step
GAP GAUGES	1.	Dimensions across faces
	2.	Parallelism where applicable
ENGINEERING PARALLELS	1.	Squareness
	2.	Straightness
	3.	Parallelism
	4.	Thickness and width
	5.	Equality of pairs
VEE BLOCKS	1.	Flatness of faces
	2.	Parallelism of opposite faces
	3.	Squareness of adjacent exterior faces

	4.	Parallelism of Vee axis to side faces
	5.	Centrality of Vee
	6.	Equality of matched pairs
	7.	Equality of semi-angle of Vee
STRAIGHT EDGES	1.	Straightness of working faces
ROUNDNESS STANDARDS	1.	Radial error. (Spherical)
	2.	Radial error and squareness to base (Cylindrical)
TRIPOINT INTERNAL MICROMETERS	1.	Micrometer screw error
	2.	Set to zero
STICK MICROMETERS	1.	Error in length of each extension rod when thimble reads zero
	2.	Micrometer screw error
EXTERNAL MICROMETERS	1.	Flatness of measuring faces
	2.	Parallelism of measuring faces
	3.	Zero reading
	4.	Micrometer screw error
DEPTH MICROMETER	1	Micrometer screw error
	2	Flatness of base
	3	Error in length of each extension rod when thimble reads zero
VERNIER CALLIPERS	1	Parallelism of outside jaws
	2	Straightness and parallelism of inside jaw of knife-edges
	3	Accuracy of sliding scale in 5 to 8 positions
	4	Repeatability of dial if present
	5	Zero setting of depth rod
VERNIER HEIGHT	1.	Flatness and parallelism of working faces of measuring jaw (when applicable)
	2.	Parallelism of measuring jaw and scriber to base
	3.	Flatness of base
	4.	Accuracy of reading of beam and vernier scale at 5 to 8 places along working length

VERNIER DEPTH	1.	Flatness of stock face
	2.	Readings at a minimum of 3 equidistant positions throughout range
BEVEL PROTRACTORS MECHANICAL OR OPTICAL	1.	Straightness of working edge of stock
	2.	Straightness of working edge of blade
	3.	Parallelism of working edge of blade
	4.	Error of indication in blade positions at specified intervals
ROUNDNESS MEASURING INSTRUMENT	1.	Radial error
	2.	Magnification
	3.	Axial error of instrument
	4.	Straightness of column if applicable
	5.	Squareness
SURFACE TEXTURE	1.	Parameters and magnification according to standard available
BORE COMPARATOR	1.	Repeatability of measurement
	2.	Accuracy of setting masters
	3.	Accuracy of Dial / Analogue / Digital read-out if present

6. REFERENCES

1. SADCAS TR 12 - Estimation of the uncertainty of measurement by calibration laboratories and specification of calibration and measurement capability on schedules of accreditation
2. OIML R 35-2 Edition 2011 (E) - Material measures of length for general use Part 2: Test methods
3. ISO/IEC 17025:2017 - General requirements for the competence of testing and calibration laboratories.
4. OIML R 66 Edition 1985 (E) - Length measuring instruments
5. OIML R 35-1 Edition 2007 (E) - Material measures of length for general use Part 1: Metrological and technical requirements

APPENDIX A - AMENDMENT RECORD

Revision Status	Change			Approved by	Effective Date
	Page	Clause/ Sub-clause	Description of Change		
Issue 1	-	-	-	SADCAS CEO	2019-11-12

APPENDIX B: SAMPLE OF SCHEDULE OF ACCREDITATION

ANNEXURE A

SCHEDULE OF ACCREDITATION

DIMENSIONAL METROLOGY

Laboratory Accreditation Number: CAL-2 …… (ISO/IEC 17025:2017)

Permanent Address of Laboratory …. …. …. …. …. …. **Postal Address** …. …. …. **Tel** : …. **Cell** : …. **Fax** : …. **Email** : ….	**Technical Signatories** : …. …. …. …. …. **Nominated Representative** : …. **Issue No** : …. **Date of Issue** : …. **Expiry Date** : ….

ITEM	MEASURED QUANTITY OR TYPE OF GAUGE OR INSTRUMENT	METHOD	RANGE OF MEASURED QUANTITY	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (±)
2.1	**LINEAR DIMENSIONS**			
2.1.4	Height Gauge	Internal: *P-NMI - XYZ* Reference: *OIML R66*	0 to 200 mm 200 to 500 mm	16 µm 35 µm
2.2	**End Standards**			
2.2.1	Gauge Blocks	Internal: *P-NMI - XYZ* Reference: *SADCAS TR 20*	0 to 200 mm	0.4 µm
2.2.3	Micrometer Setting Pieces		0 to 200 mm	3.0 µm
2.2.6	Feeler Gauges		0 to 5 mm	2 µm

Original date of accreditation: ….

The CMC, expressed as an expanded uncertainty of measurement, is stated as the standard uncertainty of measurement multiplied by a coverage factor k = 2, corresponding to a confidence level of approximately 95%.

ANNEXURE A

Laboratory Accreditation No: **CAL-2** …… (ISO/IEC 17025:2005)
Issue No: …
Date of Issue: ……..
Date of Expiry: ……..

ITEM	MEASURED QUANTITY OR TYPE OF GAUGE OR INSTRUMENT	METHOD	RANGE OF MEASURED QUANTITY	CALIBRATION AND MEASUREMENT CAPABILITY EXPRESSED AS AN UNCERTAINTY (±)
2.3	**Line Standards**			
2.3.7	Engineers Tape Measure	Internal: *P-NMI - XYZ* Reference: *SADCAS TR*	0 to 12 m	0.6 mm
2.3.9	Engineers Steel Rule		0 to 1000 mm	0.3 mm
6	**VARIOUS DIMENSIONAL**			
6.1	**Hand Instruments**			
6.1.1	External Micrometers	Internal: *P-NMI - XYZ* Reference: SADCAS TR 20	0 to 300 mm	7.0 µm
6.1.4	Caliper (Electronic and Vernier)		0 to 200 mm	15 µm
			200 to 500 mm	28 µm
6.1.8	Dial Gauge		0 to 20 mm	8.0 µm
			20 to 50 mm	10.0 µm

Original date of accreditation: ……..

The CMC, expressed as an expanded uncertainty of measurement, is stated as the standard uncertainty of measurement multiplied by a coverage factor k = 2, corresponding to a confidence level of approximately 95%.

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SADCAS Technical Manager

APPENDIX C: **MAXIMUM PERMISSIBLE ERROR**

The instruments are divided into 3 accuracy classes, and the maximum permissible error on initial verification, under rated operating conditions shall be determined from: (a + b L) mm,

where: L is the value of the length in question, rounded up to the nearest whole number of metres, a and b are coefficients the values of which are given, for each accuracy class, in Table 1.

Table 1 – **Accuracy classes**

Accuracy class	*a*	*b*
I	0.1	0.1
II	0.3	0.2
III	0.6	0.4

The maximum permissible error, positive or negative, for the scale interval, i, less than or equal to 1 cm, is given for each accuracy class. For end or composite measures, the maximum permissible error, positive or negative, for the length of the terminal scale interval bounded by an end surface, is increased by:

- mm for measures of class I,
- 0.2 mm for measures of class II,
- 0.3 mm for measures of class III.

Table 2 – **Maximum permissible errors**

Scale interval, *i*	Accuracy class		
	I	II	III
$i \leq 1$ mm	0.1	0.2	0.3
1 mm < $i \leq 1$ cm	0.2	0.4	0.6