SRILANKA ACCREDITATION
BOARD FOR CONFORMITY
ASSESSMENTS

SPECIFIC CRITERIA *for* CALIBRATION LABORATORIES IN MECHANICAL DISCIPLINE

AMENDMENT SHEET

Date	Doc No	Page/ Section	Description of change	Revision No	Approval

ABBREVIATIONS

SLAB	Sri Lanka Accreditation Board
CMC	Calibration & Measurement Capability

PREFACE

This document clarifies SLAB's stand on the accuracy and measurement capability levels. SLAB intends to uphold its policy of granting accreditation to laboratories as per their requirements of accuracy and measurement capability.

These criteria are applicable to laboratories, which perform calibrations in various parameters and desire accreditation from SLAB.

These criteria provide guidelines for use by laboratories and those who are associated with the programme of accreditation of calibration laboratories e.g. experts, assessors, officials engaged with day-to-day activities of accreditation. These criteria cover all areas/ fields of calibration.

This document provides the laboratories with necessary information on the requirements for assessment/ surveillance and to assist them in carrying out internal audit of their system.

The information in this document has been compiled in three parts.

PART – I

General Guidelines for Accreditation of Calibration Laboratories

This part contains relevant information on general requirements of a laboratory engaged in Calibration in the field of Mechanical Measurements. The laboratory seeking accreditation must comply with the requirements of ISO/ IEC 17025: 2005 and this document.

PART – II

Specific Criteria for Accreditation of Calibration Laboratories

This part provides information on special requirements of the laboratories, which are specific to the parameters covered in the respective fields

PART – III

Guidelines Regarding Accuracy of Standards & Measurement Uncertainty in Calibration

This part contains guidelines of the Specified accuracies of measurement standard and uncertainties of measurement generally achieved in laboratories using equipment and instruments of different classes of uncertainties for different parameters under Mechanical measurements.

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PART – I

GENERAL GUIDELINES FOR ACCREDITATION OF CALIBRATION LABORATORIES

1.0 SCOPE

1.1 Calibration laboratories are accredited by SLAB after it is demonstrated that a laboratory complies with the requirements of international standard ISO/IEC 17025: 2005. In view of generic nature of the standard the requirements stated there in, need to be further redefined in specific fields of calibration. This specific criteria lays down those specific requirements in the field of mechanical calibration. This part of the document thus amplifies the generic requirements for mechanical calibration and supplement the requirements of ISO/IEC 17025:2005.

1.2 Best Measurement Capability (CMC) is one the parameters that is used by SLAB to define the scope of an accredited calibration laboratory, the others being parameter/quantity measured, standard/master used, calibration method used and measurement range. The CMC is expressed as ”the smallest uncertainty that a laboratory can achieve when calibrating a device that is effectively ideal”. It is an expanded uncertainty estimated at a confidence level of approximately 95% corresponding to a coverage factor k=2.

The laboratory’s ability to achieve their claimed CMC shall be evaluated based on its performance during the on-site assessment and by review of proficiency testing results, wherein the laboratory has participated.

1.3 The definition of CMC implies that within its accreditation a laboratory is not permitted to report a smaller uncertainty of measurement than the CMC endorsed on its scope of accreditation.

1.4 All the parameters for which accreditation is sought must be expressed in S.I. Units, wherever applicable. However, in exceptional case like pressure measurement, the laboratory may use ‘bar’. In such a case, the laboratory shall include in their calibration certificates, a conversion equation to SI unit (pascal vs bar).

2.0 CRITERIA FOR ACCREDITATION

Accreditation of a calibration laboratory will require assessment in respect of organization, staff, equipment and traceability of its calibration, laboratory accommodation and environmental conditions, safety, handling of calibrated equipment and equipment under calibration, measurement capability and recording system, etc., as per **ISO/ IEC 17025: 2005 General Requirements for the Competence of Testing and Calibration Laboratories.** Some explanatory notes of this document are given in the following clauses.

3.0 ORGANISATION

3.1 The Calibration Laboratory shall be organized in such a way that all staff members are aware of both the extent and the limitations of their area of responsibility. This organization shall specify and document the responsibility and authority of the Technical Manager/ Quality Manager. The Quality Manager has the direct access to the top management. All personnel will perform or verify work affecting the quality of calibrations as per general guidelines and specific criteria laid down for the accredited parameters. The calibration laboratory shall be organized in such a way so as to ensure the integrity and training of its staff and operations for ensuring unbiased Calibration.

3.2 Deputies for key managerial positions should be appointed. The laboratory shall also clearly define authorized signatory for the calibration certificates/ reports issued by the laboratory.

4.0 MANAGEMENT SYSTEM

4.1 The calibration laboratory shall have a Quality Manual which shall be maintained up-to-date and available for scrutiny, in compliance with ISO/ IEC 17025: 2005 and SLAB requirements, with emphasis on following information:

a) A quality policy statement, including objectives and commitments by the top management.

b) A statement on the organization of the calibration laboratory.

c) Names, qualifications and experience of the persons responsible for managerial, and scientific/ technical activities.

d) A clearly defined charter of responsibility showing the relationship between management and support services.

e) Scope and operation together with information on measurement capability and traceability of calibration of all measuring instruments to national measurement standards.

f) The reference of document number on detailed calibration procedures adopted in the laboratory, which should be compiled in the form of a manual for the use of calibration staff.

g) The reference list of all national/ international standards being referred to or used in the performance of calibration work (copies of such standard specifications should be available in the laboratory for the use of calibration staff.)

h) All amendments made in any of the documents must be dated and listed in the Quality Manual.

4.2 The calibration facilities established in accordance with the general guidelines and specific criteria shall be audited periodically and reviewed by or on behalf of the management to ensure the continued effectiveness of the system.

4.3 The calibration laboratory shall clearly specify, document and make known to the customers, the administrative and other procedures to be followed for getting calibration done from the laboratory. The procedure for providing redress of redress of technical complaints should also be clearly specified and documented.

4.4 The laboratory shall have authorized signatories for approving and issuing calibration certificates for each calibration parameter as mentioned in the scope of accreditation. Any officer competent to evaluate calibration results critically and occupying a position involving responsibility for the adequacy of calibration results is eligible for acceptance by SLAB as an authorized signatory of endorsed calibration documents. Once the suitable persons are selected the names should be sent to the SLAB for acceptance.

5.0 PERSONNEL

5.1 The calibration laboratory shall have adequate number of qualified competent and trained personnel as follows:

Laboratory personnel performing calibration: Diploma in Engineering (relevant branch) or Physical Science graduate with 1 year of relevant experience.

Authorized Signatory: Bachelors degree from a recognized university of Engineering/Post Graduate in Science (relevant branch) with 1 year of relevant experience or Diploma in Engineering (relevant branch) with minimum 3 years of relevant experience.

5.2 Arrangements for improvement of qualifications and periodic refresher courses and practical training should also exist for the staff so as to keep them in touch with latest developments in the relevant fields.

5.3 The Technical Manager of the calibration laboratory shall have a Post Graduate in Physical Science or Engineering or Chartered Engineering and 2 years experience in precision Mechanical and other relevant parameter measurements. In exceptional cases, a graduate in physics or

diploma holder in Mechanical Engineering with long experience could be accepted.

6.0 ACCOMMODATION AND ENVIRONMENTAL CONDITIONS

6.1 Vibrations

The calibration area shall be adequately free from vibrations generated by central air-conditioning plants, vehicular traffic and other sources to ensure consistent and uniform operational conditions. The laboratory shall take all special/ protective precautions like mounting of sensitive apparatus on vibration free tables and pillars etc., isolated from the floor, if necessary.

6.2 Acoustic Noise

Acoustic noise level in the laboratory shall be maintained to facilitate proper performance of calibration work. A threshold noise level of 60 dBA is recommended unless otherwise stated.

6.3 Illumination

The calibration area shall have adequate level of illumination. Where permissible, to avoid localized heating and temperature drift. The recommended level of illumination is 450-700 lux on the working table with glare index of 19 for the laboratory.

6.4 Environmental Conditions and Monitoring

The environmental conditions for the activity of the laboratory shall be such as not to adversely affect the required accuracy of measurement. Facilities should be provided whenever necessary for recording temperature, pressure and humidity values prevailing during calibration. The atmospheric conditions maintained in the laboratory during calibration should be reported in the calibration report/ certificate whenever relevant.

6.5 Entry to the Calibration Area

As possible, only the staff engaged in the calibration activity shall be permitted entry inside the calibration area.

7.0 EQUIPMENT

Each calibration laboratory should have measurement standards or equipment of required accuracy in respect of each parameter covered by it in order to be able to realize and to substantiate the corresponding measurement capability claimed. Stability of the standards, accuracy of the values realized through them and repeatability, should be regularly monitored.

Any bias resulting from ageing of standards should be precisely determined. Instructions for operating each standard and equipment/ instrument should be readily available for use by the laboratory staff members.

7.2 The standards/ measuring equipment of the laboratory should be calibrated at regular intervals, with higher accuracy standards. The calibration certificates, performance history sheets in respect of the reference secondary/ working standards and measuring equipment should be held safely by the laboratory.

7.3 Proper record shall be maintained for each standard and equipment with the following information:

a) Name of the equipment
b) Manufacturers name and address
c) Type, range, identification and serial number
d) Date of procurement and commissioning
e) Details of Calibration
f) Details of maintenance and repairs
g) Performance history with dates
h) Availability of service manual

7.4 Details of periodic calibration schedule of new and old standards and measuring equipment should be worked out in consultation with higher accuracy laboratory and this schedule should be observed.

7.5 Details of re-calibration of used, serviced and repaired equipment should also be available and proper precautions shall be observed to identify equipment, which are not in service.

7.6 Any alterations in the observations/ data shall be signed by the calibration staff and duly authenticated. Instructions to this effect should be printed on data sheet used for writing observations/ data in the laboratory.

8.0 RANGE, UNCERTAINTY OF MEASUREMENT AND TRACEABILITY

8.1 The level of uncertainty of measurement of the standards to be maintained by a laboratory and the **measurement capabilities** to be generated by it in respect of various parameters shall be as demonstrated during assessment.

8.2 All the Standard Equipment of the Laboratory shall be calibrated periodically against Calibration Standards of a laboratory accredited by SLAB/ equivalent MRA partners having superior measurement capability or MUSSD/ other international NMIs.

8.3 In the event when the levels of uncertainty of measurement and measurement capability of an accredited laboratory are revised, the laboratory shall be required to intimate SLAB secretariat and undergo surveillance / reassessment as applicable.

9.0 CALIBRATION CERTIFICATE/ REPORT

9.1 The result of calibration carried out by the calibration laboratory, shall be presented in a comprehensive manner, using a standard format which shall unambiguously and objectively present the measurement results and all relevant information in order to facilitate easy comprehension and usage.

9.2 The calibration report/ certificate shall include the following additional information:

a) Date of receipt of the item and date of completion of the calibration work
b) Environmental conditions maintained during the measurements
c) Signature and title of authorized person (authorized signatory) accepting responsibility for the report and date of issue
d) A statement of the accreditation measurement capability relevant to the job under calibration
e) A symbol of SLAB or statement or both clarifying the status of accreditation of the laboratory.
f) The Uncertainty of measurement
g) An evidence that the measurements are traceable to National/ International Standards through unbroken chain of Accredited Laboratories.

9.3 The calibration report/ certificate shall not contain any recommendation on the calibration interval except where this has been agreed with the client. This requirement may be superseded by legal regulations.

10.0 PROFICIENCY TESTING PROGRAMME

10.1 To give further assurance to the accuracy or Uncertainty of measurements, a laboratory will be required to participate, from time to time, in Proficiency Testing Programmes. The laboratory shall remain prepared to participate in the Proficiency Testing Programme through inter-laboratory, inter-comparison schemes wherever it is technically feasible. In case any abnormalities, in terms of En number are detected through these inter-comparisons, appropriate corrective action will be taken, the standards/ equipment shall be replaced/ repaired and re-calibrated with a higher accuracy standard. Reports on such inter-comparisons should be documented with reference. The Proficiency Testing practice should be included in the Quality Manual.

PART – II

SPECIFIC CRITERIA FOR ACCREDITATION OF CALIBRATION LABORATORIES IN THE FIELD OF MECHANICAL MEASUREMENTS

1.0 SCOPE

1.1 An accredited laboratory shall be classified as calibration laboratory for the accredited parameters in the field of Mechanical Measurements in accordance with its Measurement Capability.

1.2 A calibration laboratory seeking accreditation to offer calibration services in the field of Mechanical Measurements will generally carry out calibration in the following areas:

a) Length
b) Angle
c) Mass
d) Force
e) Pressure
f) Vacuum
g) Acoustics
h) Ultrasonics

1.3 The accredited calibration laboratory shall mainly be connected with the measurement of one or more of the following parameters.

1 Length and Angle
2 Mass, Volume & Density
3 Force [concerned with calibration of (a) Proving devices and Force measuring devices (b) Verification of testing machines]
4 Pressure and Differential Pressure
5 Vacuum and Altitude (by vacuum measurements)
6 Ultrasonic intensity, Ultrasonic pressure, Ultrasonic total power, Vibrational amplitude, Ultrasonic velocity & Attenuation.
7 Acoustic Pressure, Acoustic Power, Vibration Amplitude/ acceleration, Frequency and Attenuation. Other parameters could be considered on request.

2.0 RANGE AND UNCERTAINTY OF MEASUREMENT

2.1 A calibration laboratory will be accredited according to its demonstrated Measurement Capability expressed in terms of uncertainty.

3.0 ENVIRONMENTAL CONDITIONS

3.1 The laboratory shall specify limits on the environmental conditions to be achieved in the laboratory. The condition shall appropriate to the level of accuracy required for the calibration undertaken by the laboratory.

In force measurement, for proving devices, additional requirements include the following:

Temperature control will not be necessary for calibration of force measuring devices provided the rate of change of temperature of 1°C/ hour is not exceeded and the calibration room is free from droughts.

In case of verifications of testing machines, it must be ascertained that the result of verification is not affected by direct sunlight falling on the force proving devices, local heating droughts or other adverse conditions.

4.0 MONITORING OF ENVIRONMENTAL CONDITIONS

4.1 Temperature and humidity conditions inside the calibration laboratory shall be regularly monitored and recorded. Calibrations shall be stopped when the environmental conditions fall outside the specified limits.

5.0 SHOCK AND VIBRATION

5.1 The laboratory shall take all special/ protective precautions, like mounting of sensitive apparatus on vibration free tables and pillars etc., isolated from the floor if necessary.

6.0 SPECIAL REQUIREMENTS OF LABORATORY

6.1 The calibration laboratory shall make arrangements for regulated and uninterrupted power supply. The recommended regulation level is ±1% or better, on the calibration bench.

6.2 Relevant IS specifications (IS: 1248, IS: 4722) regarding total harmonic content and variation in supply frequency should be followed. Voltage stabilizers of low harmonic content should be used to comply with requirement.

6.3 Adequate arrangements shall be made by the laboratory so as to ensure temperature gradient not exceeding 1.5°C per hour inside the laboratory in case of power failure.

6.4 The laboratory shall use if necessary, isolation transformers and filters etc. to ensure minimisation of ground current and effects of mains hum interference.

6.5 The power supply to the calibration laboratory shall be directly obtained from the sub-station as far as possible and shall not be on the same feeder line which is supplying power to workshops and other production areas which require operation of heavy duty machines.

6.6 Effective mains earthing shall be provided in accordance with relevant specification IS: 3043. This shall be periodically checked and stary couplings minimised.

6.7 Special care shall be taken about the location of magnetic field sources like, transformers, looped wires, ferrous materials etc., in order to minimise magnetic interference in the measurements.

6.8 Adequate screening of the laboratory against electromagnetic interference shall be done if necessary. By-pass filters should also be provided to minimise conducted interference effect on the electronic equipment. Special shielding chambers shall be provided in the laboratory for measurements, particularly when signal to noise ratio is a disturbing factor for accurate measurements.

6.9 The reference standards shall be maintained at temperatures specified for their maintenance on order to ensure their conformance to the required level of operation and traceability. The laboratory should have specific facilities required for carrying out the calibrations of parameters chosen.

6.10 The laboratory shall be sealed against dust and external air pressure. Positive air pressure shall be maintained inside the laboratory.

6.11 Adequate protective measures, like use of transient suppressors etc. shall be taken by the laboratory toward off high current spikes and transients emanating from switching on and off, of the heavy machines, surges in power lines and other such reasons, from reaching the electronics equipment in general and computer based systems involving data storage facilities in particular.

Special Requirements for Acoustical measurement

a For acoustic pressure and power measurements, anechoic or free field condition is required.

b For vibration amplitude/ acceleration measurements, controlled laboratory conditions with perfect isolation are required.

c For general acoustic measurements including attenuation, frequency etc. anechoic chamber/ controlled lab/ reverberation chamber is required.

d It should be ascertained that the magnitude of vibration and ambient noise or other disturbing noise should be sufficiently low so as not to affect the results of measurements. Direct sunlight should not fall either on the standards or devices under test. Devices likely to be affected by moisture should be kept in desiccators or otherwise humidity-free environment.

7.0 REPAIR AND MAINTENANCE

7.1 A separate repair and maintenance facility, adequate equipped with repair facilities and qualified and experienced manpower, shall be available in house or by any other means effectively accessible to the calibration laboratory. This facility shall also assist in identifying the preventive maintenance procedures which should be brought to the attention of the personnel engaged in calibration work for taking necessary precautions. The repair facility should cover digital and programmable instruments also.

7.2 Every repaired equipment shall invariably be re-calibrated through in house facility or by higher accuracy laboratory before being used for further calibration work.

8.0 STORAGE AND PACKAGING

8.1 The standards/ measuring instruments/ equipment received by the laboratory for calibration, shall be safely stored in proper environmental conditions, according to the instructions given by the supplier.

8.2 The laboratory shall have adequate arrangements for packing of calibrated instruments and may assist the user, if necessary, about the procedure and precautions to be taken by the organisation for packing and transportation of the equipment to the calibration laboratory and back.

9.0 SAFETY PRECAUTIONS

9.1 Relevant fire extinguishing equipment for possible fire hazards, should be available in the corridors or convenient places in the laboratory. Adequate safety measures against electrical, chemical fire hazards must be available at the work place. Laboratory rooms/ areas where highly inflammable materials are used/ stored should be identified. Access to the relevant fire equipment should be assured near these rooms/ areas.

9.2 Specification SP.31- 1986, a special publication in the form of a wall chart, giving the method of treatment in case of electric shock, should be followed. The chart should be placed near the power supply switchgear and at other prominent places as prescribed under Indian Electricity Rules 1956.

PART – III

GUIDELINES REGARDING LEVELS OF ACCURACY OF STANDARDS AND MEASUREMENT UNCERTAINTY IN CALIBRATION FOR MECHANICAL MEASUREMENTS

GENERAL REMARKS

The following pages may be referred as guidelines and not mandatory recommendations for the laboratories. The accredited calibration laboratories are no longer required to be categorized into Echelon/ level I, II, III. Part III of this document is aimed to provide guidance to the laboratories regarding the precautions they should take with respect to Environmental conditions as appropriate to respective Best Measurement Capability of the laboratories. The laboratories, on their own, should decide/ determine to have environmental conditions in their premises, for the best measurement capability claimed corresponding to their scope of accreditation applied for. Further to note that:

1) The measurement capability is expressed as uncertainty (±) at a confidence probability level of 95%

2) The term Uncertainty in these tables pertains to the corresponding measurement capability of the laboratory in respect of each parameter.

3) The values of Accuracy/Uncertainty of measurement shown in the following tables are at 95% CL unless stated otherwise.

ENVIRONMENTAL CONDITIONS

Standards atmospheric conditions for calibration in a Mechanical Measurement Laboratory shall be as follows:

	Temperature			Humidity		
LEVEL	I	II	III	I	II	III
Length	$20^0C \pm 1^0C$	$20^0C \pm 2^0C$	$20^0C \pm 5^0C$	40	to	60%
Other parameters	$25^0C \pm 2^0C$	$25^0C \pm 3^0C$	$25^0C \pm 5^0C$	40	to	60%

1. LENGTH AND ANGLE MEASUREMENT

ACCURACY OF STANDARDS

Parameter		Standard	Range	Level-I	Level-II	Level-III
Length	(i)	Wavelength/ Optical	__	1 part in 10^9	1 part in 10^7	__
		Frequency Standards				
	(ii)	Artifact Standards	>0-100mm >0-1m	0.01µm 0.5µm	1µm upto 10 µm	Upto 1µm Upto 50µm
Angle		Artfact	0-360^0	1 sec of arc	5 sec of arc	5 sec-1 min of arc

Best Measurement Capability expressed as uncertainty

Parameter	Range	Level-I	Level-II	Level-III
Length	100mm 1m	0.1µm 5.0µm	0.5µm 5.0µm	2µm 5.0µm
Angle	0-360^0	1 sec of arc	5 sec of arc	5sec.- 1 min of arc

Standard Temperature for Calibration (for length and angle standards)

Parameter	Level-I	Level-II	Level-III
Temperature	20°C ± 1°C	20°C ± 2°C	20°C ± 5°C
Measurement Chamber Temperature (Variation from mean)	± 0.2°C	± 1°C	± 2°C
Uncertainty in Temperature Measurement	± 0.02°C	± 0.1°C	± 0.5°C

Remarks: 1) Measurement results are to be given at 20^0C after applying correction for thermal expansion.

2) The measurement capability is expressed as uncertainty (±) at a confidence probability level of 95%.

2.0 MASS, VOLUME AND DENSITY MEASUREMENT

2a) MASS MEASUREMENT

Accuracy of Standards

Denomination	Level I (mg)	Level II mg	Level II mg
50kg	10	25	25-250
20kg	5	10	10-100
10kg	2	5	5-50
5kg	1.0	2.5	2.5-25
2kg	0.3	1.0	1.0-10
1kg	0.1	0.5	0.5-5
500kg	0.1	0.25	0.25-2.5
200kg	0.03	0.10	0.10-1
100g	0.02	0.05	0.05-0.5
50g	0.01	0.03	0.03-0.3
20g	0.008	0.025	0.025-0.25
10g	0.005	0.020	0.02-0.2
5g	0.005	0.015	0.015-0.015
2g	0.004	0.010	0.01-0.1
1g	0.003	0.010	0.01-0.1
500mg	0.003	0.008	0.008-0.08
200mg	0.002	0.006	0.006-0.06
100mg	0.002	0.005	0.005-0.05
50mg	0.001	0.004	0.004-0.04
20mg	0.001	0.003	0.003-0.03
10mg	0.001	0.002	0.002-0.02
5mg	0.001	0.002	0.002-0.02
2mg	0.001	0.002	0.002-0.02
1mg	0.001	0.002	0.002-0.02

Contd.

Measurement Uncertainty

Denomination	Level I (mg)	Level II (mg)	Level III (mg)
50kg-2000kg	25	75	25-750
20kg	10	30	10-100
10kg	5	15	5-15
5kg	2.5	7.5	2.5-7.5
2kg	1.0	3.0	1.0-3.0
1kg	0.5	1.5	0.5-1.5
500kg	0.25	0.75	0.25-7.5
200kg	0.10	0.30	0.10-3.0
100gm	0.05	0.15	0.05-1.5
50gm	0.03	0.10	0.03-1.0
20gm	0.025	0.08	0.025-0.8
10gm	0.020	0.06	0.020-0.6
5gm	0.015	0.05	0.015-0.5
2g	0.010	0.04	0.010-0.4
1g	0.010	0.03	0.010-0.3
500mg	0.008	0.025	0.008-0.25
200mg	0.006	0.020	0.006-0.020
100mg	0.005	0.015	0.005-0.15
50mg	0.004	0.012	0.004-0.12
20mg	0.003	0.010	0.003-0.10
10mg	0.002	0.008	0.002-0.8
5mg	0.002	0.006	0.002-0.6
2mg	0.002	0.006	0.002-0.6
1 mg	0.002	0.006	0.002-0.6

2b) VOLUME MEASUREMENT

Accuracy of Standards of Capacity (content type)

Capacity	Uncertainty		
	Level I	Level II	Level III
cm^3	(Gravimetric method)	cm^3	cm^3
10.000		0.5	1.0-5.0
5.000		0.2	0.5-2.0
2.00	Standards of capacity at	0.1	1.2-1.0
1,000	Level I are based on	0.08	0.1-0.8
500	Standard of mass (accuracy:	0.05	0.05-0.5
200	$1x10^{-6}$) and stated density	0.04	0.04-0.4
100	of water (accuracy:$5x10^{-6}$)	0.03	0.03-0.3
50	alongwith appropriate	0.02	0.02-0.2
20	balance	0.01	0.01-0.1
10		0.01	-

Measurement Uncertainty

Capacity	Level I			Level II	Level III
	Gravimetric Transfer			Gravimetric Transfer	
dm^3	(Gravimetric method)			cm^3	cm^3
$5000dm^3$	--	1500	--	5000	1500-15000
$2000dm^3$	--	600	--	2000	600-6000
$1000dm^3$	--	300	--	1000	300-3000
$500dm^3$	50	150	--	500	50-1500
$200dm^3$	20	60	--	200	20-600
$100dm^3$	100	30	--	--	--
$50dm^3$	50	15	--	100	10-300

Contd.

25/20dm^3	2.5/2.0	--	--	50	5-150
10dm^3	1.0	--	--	10	2.0-3.0
5dm^3	0.2	--	--	5.0	1.0-8
2dm^3	0.1	--	0.6	2.0	0.2-6
1dm^3	0.08	--	0.2	0.8	0.08-8
500dm^3	0.05	--	0.15	0.5	0.05-1.5
200dm^3	0.04	--	0.1	0.4	0.04-0.5
100dm^3	0.03	--	0.1	0.4	0.03-1.0
50dm^3	0.02	--	0.05	0.2	0.02-0.2
Volumetric measures from 100cm^3 pipette level	0.01 or 1/15 to 1/3 of prescribed tolerance	--	0.03 or 1/3 to 1/2 of prescribed tolerance	01	0.01-0.1 or 1/5 to 1/2 of prescribed tolerance

Accuracy of Standards of Capacity (delivery type)

Capacity	Uncertainty		
dm^3	Level I cm^3	Level II cm^3	Level III cm^3
500	50	150	150-500
200	20	60	60-200
100	10	30	30-100
50	5	15	15-50
25	2.5	7.5	7.5-25
10	2.5	3.0	3.0-10
5	Standard based on Stated density of water and standards of mass	1.5	1.5-5
2		0.6	0.6-6
1 below and up to 0.01ml		1/5 to 1/3 of the prescribed tolerance	1/5 to 1/2 of the prescribed tolerance

Measurement Uncertainty

Capacity	Level I		Level II		Level III
	Gravimetric method cm^3	Transfer method cm^3	Gravimetric method cm^3	Transfer method cm^3	
$5000dm^3$	-	1500	-	5000	1500-15000
$2000dm^3$	-	600	-	2000	600-6000
$1000dm^3$	-	300	-	1000	300-3000
$500dm^3$	50	150	-	500	50-1500
$200dm^3$	20	60	-	200	20-600
$100dm^3$	100	30	-	-	-
$50dm^3$	50	15	-	100	10-300

Contd.

Capacity	Level I		Level II		Level III
	Gravimetric method cm^3	Transfer method cm^3	Gravimetric method cm^3	Transfer method cm^3	
	2.5/2.0	-	-	50	5-150
	1.0	-	-	10	2.0-3.0
	0.2	-	-	5.0	1.0-8
	0.1	-	0.6	2.0	0.2-6
	0.08	-	0.2	0.8	0.08-8
	0.05	-	0.15	0.5	0.05-1.5
	0.04	-	0.1	0.4	0.4-1.5
	0.03	-	0.1	0.4	0.03-1.0
	0.02	-	0.05	0.2	0.02-0.2
	0.01 or 1/5 to 1/3 of the prescribed tolerance	-	0.03 or 1/3 to 1/2 of the prescribed tolerance	0.1	0.01-01 or 1/5 to 1/2 of the prescribed tolerance

2c) DENSITY MEASUREMENT

Accuracy of standards

Standards	Level I	Level II	Level III
Solid Cyliner of known volume	$5x10^{-6}$	-	-
Master Hydrometer	$1x10^{-5}$	-	-
Hydrometers			
L-20	$5x10^{-5}$	$1x10^{-4}$	$5\text{-}10x10^{-4}$
L-50-S	-	$1x10^{-4}$	$1x10^{-4}$
L50-N	-	$2x10^{-4}$	$2x10^{-4}$
M-50-S	-	-	$2x10^{-4}$
M-50-N	-	-	$5x10^{-4}$
M-100	-	-	$1x10^{-4}$
S-50	-	-	$1x10^{-4}$

Measurement Uncertainty

Item		Uncertainty				
		Level-I		Level-II		Level-III
		Hydrostatic Method	Comparison Method	Hydrostatic Method	Comparison Method	
1.	Density of solids of regular shape	$1x10^{-5}$	-	$1x10^{-4}$	-	$1\text{-}10x10^{-5}$
2.	Density of liquids	$1x10^{-4}$	$1x10^{-4}$	$1x10^{-4}$	$2x10^{-4}$	$1\text{-}5x10^{-4}$
	L-20	$5x10^{-5}$	$1x10^{-4}$	-	-	$5\text{-}10x10^{-5}$
	L-50-S	$5x10^{-5}$	$1x10^{-4}$	-	-	$5\text{-}10x10^{-5}$
	L-50-N	-	$2x10^{-4}$	-	$5x10^{-4}$	$2\text{-}5x10^{-4}$
	L-50-S	-	$2x10^{-4}$	-	$5x10^{-4}$	$2\text{-}5x10^{-4}$

Contd.

M-50-N	-	$5x10^{-4}$	-	$1x10^{-3}$	$5\text{-}10x10^{-4}$
M-100	-	$1x10^{-3}$	-	$1x10^{-3}$	$1\text{-}2x10^{-3}$
S-50	-	$1x10^{-3}$	-	$1x10^{-3}$	$1\text{-}2x10^{-3}$
Other Special purpose hydro meters like alcoholometers	1/5 to 1/2 of the value of the smallest graduation	-	-	1/2 of the value of the smallest graduation	1/5 to 1/2 of the value of the smallest graduation

3.0 FORCE MEASUREMENT

3.1 The accredited calibration laboratory in the field of force shall be concerned with the following

a) Calibration of
   i) Proving devices
   ii) Force measuring devices

b) Verification of testing machines

3.2 Best Measurement Capability/Uncertainty

Level I	Level II	Level III
±0.002% (Up to 199kN)	±0.025% (For class o force proving Devices ±0.05% (For class 1 Force proving Devices)	Force proving Devices of Class 0 Class 1 Class 2
0.01% (Over 100kN and upto 1MN	±0.1% (For class 2 Force proving Devices)	as per IS: 4169-1988 In case the Testing Machine is verified with Dead Weights, the relative error of the force generated by these weights shall be less than or equal to ± 0.1%

3.3 Special Environmental Conditions for force measurement

For proving devices, please refer to the guidelines for approval of a laboratory in mechanical calibration together with the following:-

Temperature control will not be necessary for calibration of Force measuring devices provided the rate of change of temperature of 1^0C/hour is not exceeded and the calibration room is free from droughts.

In case of verifications of testing machines, it must be ascertained that the result of the verification is not affected by direct sunlight falling on the force proving devices, local heating droughts or other adverse conditions.

4.0 PRESSURE MEASUREMENT

4.1 The accredited calibration laboratory will provide calibration for the following parameters:

i) Pressure

ii) Differential Pressure

a) Uncertainty of Measurements

Range (Pascal)	Uncertainty		
	Level I	Level II	Level III
$1x10^5$ to $4x10^6$	0.003%	0.05%	0.05% to 1%
$4x10^6$ to $2x10^7$	0.0004 %	0.07 %	0.07% to 2%
$2x10^7$ to $3x10^8$	0.0008%	0.1%	0.17% to 5%
$3x10^8$ to $7x10^8$	0.02%	0.3%	1 to 5%
$3x10^8$ to $1x10^9$	0.04%	0.5%	1 to 5%

b) Measurement Uncertainty in Calibration of Differential Pressure at high line pressure upto $8x10^6$ Pa

Range (Pascal)	Range (Bar)	Uncertainty
$5x10^1$ to $5x10^3$	$5x10^{-4}$ to $5x10^{-2}$	$5x10^{-5}$ to $1x10^{-4}$
$1x10^3$ to $4x10^4$	$1x10^{-2}$ to $4x10^{-1}$	$8x10^{-5}$ to $15x10^{-5}$

4.2 Environmental Conditions

Pressure standards and instrument/gauge under calibration should be placed on vibration free platform.

Humidity should be maintained between. 45% to 55%

Temperature should be maintained at 23°C ±1°C

5.0 VACUUM MEASUREMENT

5.1 The accredited Calibration Laboratory will provide calibration for the following parameters:

a) Vacuum

b) Altitude*

5.2 Measurement Uncertainty

Range (mbar)	Level I	Level II	Level III
10^{3} to 10^{1}	0.002%	0.01%	0.1% to 1%
1.0	0.02%	0.05%	2%
10^{-1} to 10^{-3}	0.25%	1.0%	1 to 5%
10^{-4} to 10^{-5}	0.6%	2.0%	2 to 10%
10^{-6} to 10^{-7}	1.0%	5.0%	5 to 10%
10^{-7} to 10^{-8}	3.0%	10.0%	10 to 50%

* Altitude, i.e. Barometric Region for civil aviation and aircraft industries.

5.3 Environmental Condition

Vacuum standards and instrument/gauge under calibration should be placed on vibration free platform.

Humidity should be maintained between 45 to 50%

Temperature should be maintained at $23^{0}C \pm 1^{0}C$

6.0 ULTRASONICS MEASUREMENT

6.1 The accredited Calibration Laboratory in the field of ultrasonics will be concerned with the measurement of the following parameters:

i) Ultrasonic pressure

ii) Ultrasonic total power

iii) Vibrational amplitude

iv) Ultrasonic velocity

6.2 Ranges and Uncertainty of measurement

Parameter	Range	Frequency	Uncertainty		
			Level I	Level II	Level III
Ultrasonic Pressure	50 kPa to 5 MPa	0.5 to 10 MHZ	7%	20%	25%
Ultrasonic total Power	0.5 to 20 W	0.5 to 5 MHz	5%	10%	15%
Vibrational amplitude (Air Borne displacement)	0.3 to 150 nm	0.2 to 15 MHz	1 to 7%	-	-
Ultrasonic velocity	-	-	0.025%	-	-

7.0 ACOUSTICAL MEASUREMENT

7.1.1 The accredited calibration laboratory in the field of acoustical measurements shall be concerned with the measurement of following parameters:

i) Acoustic Pressure

ii) Vibration amplitude/acceleration

iii) Acoustic Power

iv) Frequency

v) Attenuation

7.1.2 Special Requirements

a. For acoustic pressure and acoustic power measurements, anechoic or free field condition is required.

b. For vibration amplitude/acceleration measurements, controlled laboratory conditions with perfect isolation are required.

c. For general acoustical measurements including attenuation, frequency etc. anechoic chamber/controlled lab/reverberation chamber is required.

d. The ambient noise level in the various levels should be less than

(Level I)	(Level II)	(Level III)
20 dB(A)	30 dB(A)	50-60 dB(A)

e. Relative humidity should be maintained between 30% and 50% for all the three levels.

f. It should be ascertained that the magnitude of vibration and ambient noise or other disturbing noise should be sufficiently low so as not to affect the results of measurements. Direct sunlight should not fall either on the standards or devices under test. Devices likely to be affected by moisture should be kept in desicators or otherwise humidity-free environment.

7.2 ACCOUSTIC PRESSURE

Accuracy of Standards

Measurement Range	Frequency Range	Uncertainty		
		Level I	Level II	Level III
40 to 60 dB (Reciprocity Technique)	250 Hz	0.05 dB	To be worked out later	

Measurement Capability

Measurement	Frequency Range	Uncertainty		
		Level I	Level II	Level III
94 dB Microphone Calibrator	1000 Hz	0.2 dB	0.5 dB	0.5 dB
124 dB Piston phone	250 Hz	0.2 dB	0.2 dB	0.5 dB
40-100 dB comparison method	100-5 kHz	-	0.2 dB	0.5 dB 0-160 dB

7.3 VIBRATION AMPLITUDE/ ACCELERATION

Accuracy of Standards

Measurement Range		Frequency Range	Uncertainty		
			Level I	Level II	Level III
a)	Amplitude 1-10mm (Cathetometer)	5Hz-80 Hz	0.5%	1.0%	-
	0.001 to 0.1 mm (interferometer)	50 Hz to 1 kHz	0.5%	1.0%	-
b)	Acceleration				
	1g(10 m/s^2)	50 Hz to 1kHz	2.0%	5.0%	-
	0.01-1g	10 Hz to 10kHz	0.5%	2.0%	-
	(0.1-10 m/s^2)				

Measurement Capability

Measurement Range		Frequency Range	(Uncertainty)		
			Level I	Level II	Level III
a)	Amplitude 1-10 mm	10 Hz to 10 kHz	0.5%	2.0%	5.0% (0-10 mm)
b)	Acceleration 1-100 g (frequency dependent)	10 Hz to 10 kHz	0.5% to 2.0%	2.0%	5.0%, 0-100 g (Frequency dependent)

7.4 ACOUSTIC POWER

Measurement Capability

Measurement Range	Frequency Range	Uncertainty		
		Level I	Level II	Level III
0 to 140 dB (Frequency dependent)	100 Hz to 5 kHz	0.5 dB	1 dB	2 dB

7.5 ACCOUSTIC FREQUENCY

Measurement Capability

Frequency Range	Uncertainty		
	Level I	Level II	Level III
1 Hz to 20kHz	0.01%	0.1%	0.1%

7.6 ACOUSTIC ATTENUATION

Measurement Capability

Measurement Range	Frequency Range	Uncertainty		
		Level I	Level II	Level III
0 to 50 dB	100 Hz to 10 kHz	0.5 dB	1 dB	2 dB 0-60 dB

COMPOSITION OF THE TECHNICAL ADVISORY COMMITTEE

1	Prof. D.A.Tantrigoda Professor of Physics, Department of Physics, University of Sri Jayewardenepura, Gangodawila, Nugegoda.	Chairman
2	Mr. H P N Gunasekera Former Deputy Director, ITI	Member
3	Dr. S.M.A.Nanayakkara Senior Lecturer,Department of Civil Engineering, University of Moratuwa,Katubedda,Moratuwa.	Member
4	Mrs. Champika Janashanthi Electronic Engineer, Arthur C Clarke Institute for Modern Technologies	Member
5	Mr. H. L. R. W. Madanayake Former Director , MUSSD	Member
6	Mr. S. N. Niles Senior Lecturer, Department of Textile & Clothing Technology, University of Moratuwa.	Member
7	Ms. Nayana Wijesiriwardena, Head, Department of Electrical & Electronics, National Engineering Research & Development Centre of Sri Lanka	Member
8	Mr. T Wickremasinghe Director / CEO Sri Lanka Accreditation Board for Conformity Assessment (SLAB)	Member